Otway Offshore Gas Victoria Project

Offshore Project Proposal

V-1000-01-MP-0001

Review record (record the last 3 revisions here or the revisions required to achieve current approval version)

Revision	Date	Reason for issue	Reviewer/s	Consolidator	Approver
A	21/08/2023	Draft for internal review	PW	GN	PW
0	11/09/2023	Issued to NOPSEMA	PW	GN	PW
1	21/12/2023	Revised to address NOPSEMA comments	PW	GN	PW
2	15/02/2024	Revised to address NOPSEMA comments	PW	GN	PW
3	21/06/2024	Revised after Public Comment	NK	AC	NK
4	31/10/2024	Revised to address NOPSEMA comments	NK	AC	NK
5	7/03/2025	Revised to address NOPSEMA comments	NK	AC	NK
6	2/04/2025	Revised to address NOPSEMA comments	NK	ZP	NK

Review due	Review frequency
N/A	N/A

THE THREE WHATS
What can go wrong?
What could cause it to go wrong?
What can I do to prevent it?

Table of contents

Table of figures

List of tables

List of appendices

Acronyms

Terms/acronym	Definition/Expansion
ACAP	Agreement on the Conservation of Albatrosses and Petrels
ADAPS	Anchor Distance and Positioning
AEMO	Australian Energy Market Operator
AFMA	Australian Fisheries Management Authority
AHO	Australian Hydrographic Office
ALARP	As Low as Reasonably Practicable
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
APPEA	Australian Petroleum Production and Exploration Association
ASAP	As soon as practicable
ASX	Australian Stock Exchange
Bass Strait CZSF	Bass Strait Central Zone Scallop Fishery
bbl	Barrel
Beach	Beach Energy (Operations) Limited
BIA	Biologically Important Area
BOM	Bureau of Meteorology
BOP	Blow-out Preventer
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAMBA	China Australia Migratory Bird Agreement
CMMS	Computerised Maintenance Management System
CMT	Crisis Management Team
COLREG	Convention on The International Regulations for Preventing Collisions at Sea
CO	Carbon monoxide
CRA	Corrosion Resistant Alloy
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CUTP	Clean-up to plant
DAFF	Department of Agriculture, Fisheries and Forestry
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water formerly DAWE
DEECA	Victorian Department of Energy, Environment and Climate Action (formerly Victorian Department of Jobs, Precincts and Regions)
DEECA: ERR	Victorian Department of Energy, Environment and Climate Action: Earth Resources Regulation

Terms/acronym	**Definition/Expansion**
DELWP	Victorian Department of Environment, Land, Water and Planning now DEECA
DIIS	Department of Industry, Innovation and Science
DISER	Department of Industry, Science, Energy and Resources
DJPR	Victorian Department of Jobs, Precincts and Regions now DEECA
DJPR: ERR	Victorian Department of Jobs, Precincts and Regions: Earth Resources Regulation now DEECA: ERR
DN100	diameter nominal (100 millimetres)
DN500	diameter nominal (500 millimetres)
DNP	Commonwealth Director of National Parks
DO	Dissolved Oxygen
DotEE	Commonwealth Department of the Environment and Energy now DCCEEW
DNRET	Department of Natural Resources and Environment Tasmanian
DP	Dynamic Positioning
DPIPWE	Tasmanian Department of Primary Industries, Parks, Water and Environment (now DNRET)
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
EAC	East Australian current
EFL	Electrical Flying Leads
EFL	Electrical Flying Lead
EIS	Environmental Impact Statement
EMBA	Environment That May Be Affected
EMPCA	*Environmental Management and Pollution Control Act 1994*
EMT	Emergency Management Team
ENSO	El Niño – Southern Oscillation
EP	Environment Plan
EPA	Environmental Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EDP/LMRP	Emergency Disconnect and Lower Marine Riser Package
EPO	Environment Performance Outcome
EPS	Environment Performance Standard
ERT	Emergency Response Team
ESD	Ecologically Sustainable Development
ETBF	Eastern Tuna and Billfish Fishery
FLNG	Floating Liquified Natural Gas
FPSO	Floating Production Storage and Offloading
GHG	Greenhouse gas

Terms/acronym	Definition/Expansion
GMTOAC	Gunditj Mirring Traditional Owners Aboriginal Corporation
H_2S	Hydrogen Sulphide
HBWS	Halladale-Black Watch-Speculant
HDD	Horizontal Directional Drilled
HFC	Hydrofluorocarbons
HISC	Hydrogen Induced Stress Cracking
HPU	Hydraulic Power Unit
HSE	Health, Safety and Environment
HSEMS	Health, Safety and Environment Management System
HTT	Hot Tap tee
Hz	Hertz
IAPP	International Air Pollution Prevention
IBC	Intermediate Bulk Container
IMO	International Maritime Organisation
IMOS	Integrated Marine Observing System
IMS	Invasive Marine Species
IMT	Incident Management Team
IOGP	International Association of Oil and Gas Producers
IPCC	Intergovernmental Panel on Climate Change
ISP	Integrated System Plan
IUCN	International Union for Conservation of Nature
JAMBA	Japan Australia Migratory Bird Agreement
JRCC	Joint Rescue Coordination Centre
KEF	Key Ecological Feature
Lattice	Lattice Energy Limited
LOWC	Loss of Well Control
LOC	Loss of Containment
LOR	Limit of Reporting
LPG	Liquefied Petroleum Gas
MARPOL	International Convention for The Prevention of Pollution from Ships
MC	Measurement Criteria
MCRA	Marine and Coastal Regionalisation of Australia
MCS	Master Control Station
MDO	Marine Diesel Oil
MDRT	Measured depth rotary table
MEG	Monoethylene Glycol

Terms/acronym	Definition/Expansion
MMscf	Million Standard Cubic Feet
MMscfd	Million Standard Cubic Feet per day
MNES	Matters of National Environmental Significance
MNP	Marine National Park
MO	Marine Order
MoC	Management of Change
MODIS	Moderate Resolution Imaging Spectroradiometer
MODU	Mobile Offshore Drilling Unit
MT	Metric Tonne
N_2O	Nitrous oxide
NatPlan	National Plan for Maritime Environmental Emergencies
NDC	Nationally Determined Contributions
NEM	National Energy Market
NEBA	Net Environmental Benefit Analysis
NEPMs	National Environment Protection Measures
NGER	National Greenhouse and Energy Reporting
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administrator
NORMs	Naturally Occurring Radioactive Materials
NO_2	Nitrogen dioxide
NPI	National Pollution Inventory
NRE	Department of Natural Resources and Environment (Tas)
NSW	New South Wales
NUI	Normally Unmanned Installation
O_3	Ozone
ODS	Ozone Depleting Substance
OEMS	Operations Excellence Management System
OGP	Otway Gas Plant
OGPP	Otway Gas Production Pipeline
OGUK	Oil and Gas UK
OGV	Offshore Gas Victoria
OPEP	Oil Pollution Emergency Plan
OPGGS Act	Offshore Petroleum and Greenhouse Gas Storage Act 2006
OPGGS Regulations (Vic)	Victorian Offshore Petroleum and Greenhouse Gas Storage Regulations 2011
OPGGS (Environment) Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023

Terms/acronym	Definition/Expansion
OPP	Offshore Project Proposal
Origin	Origin Energy Resources Limited
ORP	Oxidation-Reduction Potential
OSCP	Oil Spill Contingency Plan
OSMP	Operational and Scientific Monitoring Plan
OSTM	Oil Spill Trajectory Modelling
OSV	Offshore Support Vessel
OWR	Oiled Wildlife Response
PAH	Polyaromatic hydrocarbons
P&A	Plug and Abandon
Pb	Lead
PCB	Polychlorinated biphenyls
PCM	Pipeline Corrosion Monitor
PFC	Perfluorocarbons
Platform	Thylacine A Platform
PMST	Protected Matters Search Tool
POB	persons on board
POLREP	Marine Pollution Report
POWBONS Act	Pollution of Waters by Oil and Noxious Substances Act 1986
ppm	Parts Per Million
Project	The Otway Offshore Gas Victoria Project
PSZ	Petroleum Safety Zone
PTS	Permanent Threshold Shift
RFSU	Ready for start-up
RNTBC	Registered Native Title Body Corporate
ROKAMBA	Republic or Korea-Australia Migratory Bird Agreement
ROV	Remotely Operated Vehicle
SBDF	Synthetic Based Drilling Fluids
SBTF	Southern Bluefin Tuna Fishery
SCCP	Source Control Contingency Plan
SCM	Subsea Control Module
SCSSV	Surface Controlled Subsurface Safety Valve
SDU	Subsea Distribution Unit
SEEMP	Ship Energy Efficiency Management Plan
SEL	Sound Exposure Level
SEMR	South-East Marine Region

Terms/acronym	Definition/Expansion
SESSF	Southern and Eastern Scalefish And Shark Fishery
SETFIA	South East Trawl Fishing Industry Association
SF6	Sulphur hexafluoride
SHX	Subsea Heat Exchanger
SIMAP	Spill Impact Mapping Analysis Program
SIV	Seafood Industry Victoria
SMC	Subsea Manifold Cooler
SMPEP	Shipboard Marine Pollution Emergency Plan
SMS	Short Message Service
SO_2	Sulphur dioxide
SOLAS	Safety of Life at Sea
SPCU	Subsea Power and Control Unit
SPF	Small Pelagic Fishery
SPL	Sound Pressure Level
SRW	Southern Right Whale
SSSV	Subsurface Safety Valve
SST	Sea surface temperature
STCW	Standards of Training, Certification and Watch keeping
SVS	Subsea Valve Skid
T-DIS	Thylacine Diverless Interface Skid
TEC	Threatened Ecological Community
TOLC	Top of Line Corrosion
TRH	Total Recoverable Hydrocarbon
TSSC	Threatened Species Scientific Committee
TTS	Temporary Threshold Shift
TUTA	Topside Umbilical Termination Assembly
UTA	Umbilical Termination Assembly
VFA	Victorian Fisheries Authority
VLSFO	Very Low Sulphur Fuel Oil
VWMS	Victorian Waterway Management Strategy
VSP	Vertical Seismic Profiling
WBDF	Water-Based Drilling Fluid
WECS	Well Engineering and Construction Management System
WHP	Wellhead Platform
WOMP	Well Operations Management Plan
Woodside	Woodside Petroleum Ltd

Terms/acronym	Definition/Expansion
WRSSV	Wireline Retrievable Subsurface Safety Valve

Executive Summary

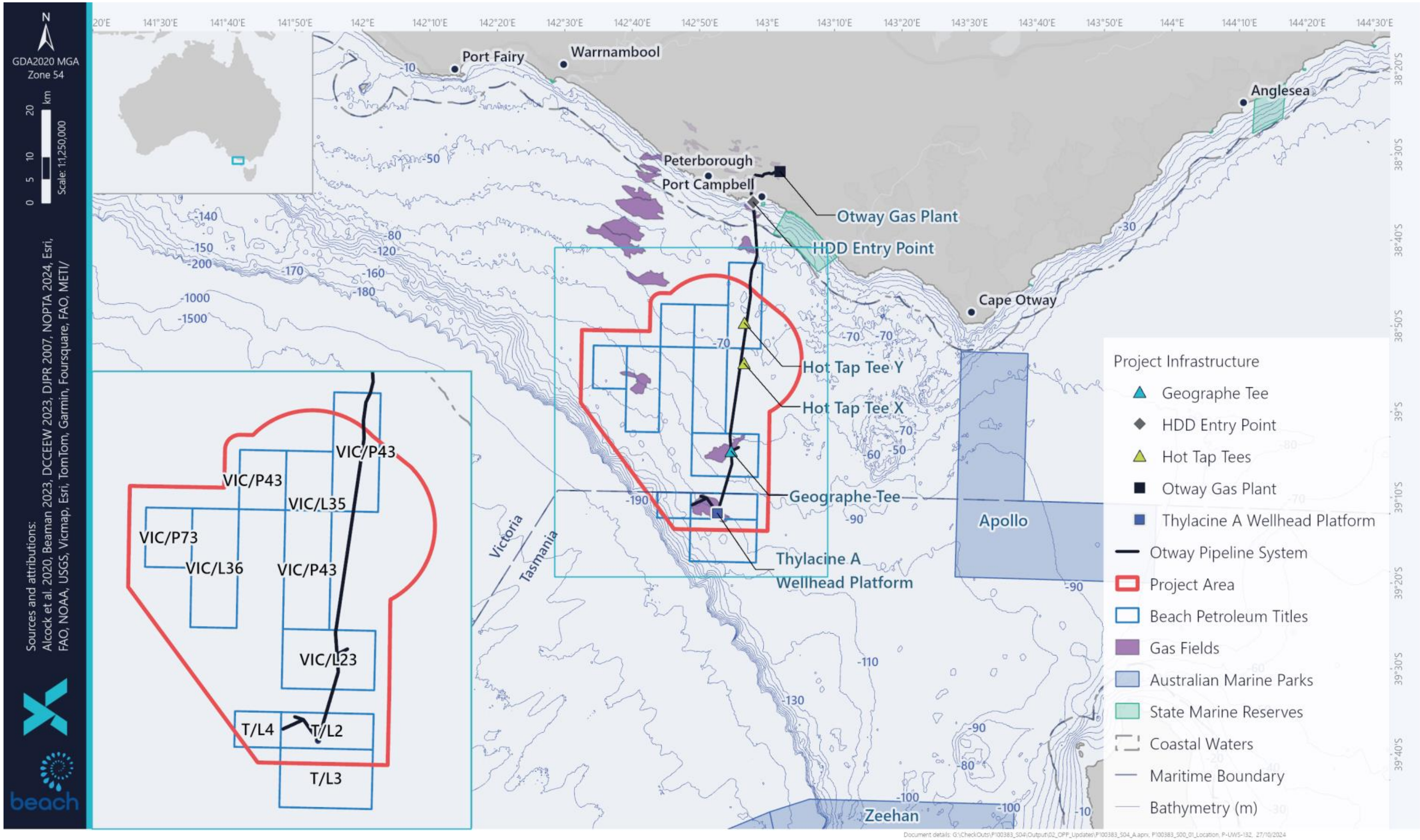
ES1 Introduction

The Otway Offshore Gas Victoria (OGV) Project (the Project) is designed to explore and develop new gas discoveries in the offshore Otway Basin. The Project provides an opportunity to develop currently stranded gas reserves and future resources in the offshore Otway Basin through integrated subsea drilling and installation campaigns and by utilising Beach's existing offshore infrastructure.

The development concept selected for the Project is a subsea tie-back to existing facilities. The stages of the Project will include an initial drilling campaign operated by a semi-submersible MODU. Successful wells will be tied back to existing Otway Gas Production Pipeline (OGPP) and/or Thylacine A platform via installation of new subsea flowlines and facilities. Recovered gas will be transported through the OGPP to the onshore OGP located onshore near Port Campbell, Victoria. The OGP supplies gas to the domestic market in south-east Australia.

The Project focuses on exploration, appraisal and development of existing and future gas discoveries in Beach's exploration permits (VIC/P43 and VIC/P73). On 30 September 2024, the Artisan field (1 block within VIC/P43) was converted to production licence, VIC/L35 and the La Bella field (2 blocks within VIC/P73) was converted to production licence, VIC/L36. For the purpose of the OPP, all references to VIC/P43 are defined as VIC/P43 and VIC/L35 and all reference to VIC/P73 are defined as VIC/P73 and VIC/L36.

The Project covers an area that is located approximately 17 km south of the Victorian mainland and 80 km north-west of Tasmania (King Island) at its closest points (ES Figure 0-1). The Project is adjacent to Beach's current production operations at the Geographe and Thylacine gas fields in the offshore Otway Basin.



ES Figure 0-1: Project Location

The petroleum activities planned for the Project include full lifecycle of petroleum operations summarised in the below ES Table 0-1.

ES Table 0-1: Project Summary

Project Stage	Key Activities
Surveys	Geotechnical and geophysical surveys will occur over a maximum of 200 days and are undertaken to assess the suitability of the seabed for drilling and infrastructure placement.
Drilling and Completions	• Drilling campaign(s) for up to 8 wells to include: ◦ Campaign commencing 2025 for up to 3 wells (plus options to drill 5 additional wells) ◦ Future drilling campaign(s) may be carried out in the OPP Project Area • Completions (in success case) of up to 9 wells (including up to 8 wells from above drilling campaign and Artisan 1 re-entry and completion): ◦ Campaign commencing 2025-2026 for well completions and subsea tree installations ◦ Future well completion campaign(s) may be carried out in the OPP Project Area • Drilling operations will be succeeded by: ◦ Permanent plug and abandon, or, ◦ Temporary suspension.
Facilities Installation and Commissioning	• Installation of subsea infrastructure to connect gas discoveries Artisan, La Bella and any successful exploration or appraisal wells from the initial drilling campaign to the OGPP including wellheads, flowlines, umbilicals, manifolds and skids • Commissioning and testing of new equipment including flowlines • Unload of drilling and completion fluid from the well is planned through new and existing subsea infrastructure to the onshore Otway Gas Plant (OGP). Well unload and testing to the MODU is a contingent option. • Future tie backs of successful exploration or appraisal wells comprising similar subsea infrastructure to the initial development may be undertaken in the Project Area during the life of the Project. • There is the potential for future tie-ins in the vicinity of the Project Area by other operators comprising similar subsea infrastructure to the initial development.
Operations and Maintenance	• Production from Artisan, La Bella and future prospects is expected to have an operation life of up to 20 years with end of field life estimated as 2045. • However, subject to future investment and developments in surrounding fields, operations and infrastructure life may be extended. • Further well and installation campaigns required to support future developments within the Project Area may be undertaken during the operations stage. • Operations stage may include well intervention and inspection, maintenance and repair of wells and subsea infrastructure as required.
Decommissioning	• Well plug and abandonment • Decommissioning of subsea infrastructure

Proponent

Beach Energy (Operations) Limited (Beach) is the proponent for the Project and is the operator and titleholder (60% participating interest) of the petroleum titles. Beach also owns and operates existing production assets and infrastructure in the Otway Basin at Thylacine and Geographe fields, Thylacine A platform and Offshore Otway Gas Pipeline.

Offshore Project Proposal

This Offshore Project Proposal (OPP) has been prepared in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023 (OPGGS (Environment) Regulations) and associated guidelines, which require an OPP to be submitted for all offshore projects. The OPP is an early-stage project assessment which, subject to acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), will form the basis for future activity-specific Environment Plans.

For completeness, this OPP includes description of exploration and appraisal drilling activity which is an activity that does not require an accepted OPP as part of the environmental permitting framework.

This OPP also described existing petroleum infrastructure for Thylacine and Geographe which was approved under the *Environment Protection and Biodiversity Conservation Act 1999*.

ES2 Environmental Legislation and Other Requirements

The OGV Project is located entirely in Commonwealth waters. The key legislation and regulations for petroleum activities are:

- *Offshore Petroleum Greenhouse Gas Storage Act 2006* - provides a legal framework for the exploration and recovery of petroleum (and greenhouse gas activities) in Commonwealth waters. The OPGGS Act establishes the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) as the independent regulator for environmental management, health and safety, and well integrity and for all offshore petroleum (and greenhouse gas storage) activities in Commonwealth waters

- *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* - provides a legal framework to protect and manage important flora, fauna, ecological communities and heritage places defined in the EPBC Act as matters of national environmental significance. Specific to petroleum activities in Commonwealth waters:

    - In February 2014, a Program was endorsed under the EBPC Act to provide for NOPSEMA to assess and make approval decisions for new offshore petroleum development projects and shorter-term activities. NOPSEMA’s environmental assessment processes consider all project and activity specific environmental impacts and risks, including but not limited to those relevant to matters protected under Part 3 of the EPBC Act. Decision-making under the Program ensures that environmental impacts and risks, including to matters protected under Part 3 of the EPBC Act, will be of an acceptable level and reduced to as low as reasonably practicable (ALARP).

    - Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2023 - provide for the regulation of environmental management of petroleum (and greenhouse gas storage) activities in Commonwealth waters, and aim to ensure that petroleum activities in these areas are carried out in a manner that is consistent with ecologically sustainable development and consistent with the objective that environmental impacts and risks are of an acceptable level and reduced to ALARP

ES3 Description of the Project

Key characteristics of the Project are described in ES Table 0-2.

ES Table 0-2: Key Project Areas

Project Characteristics	Description
Project Area	The Project Area is defined in ES1 Introduction
Key Project Stages	• Surveys (geotechnical and geophysical) • Drilling and completions • Facilities installation and commissioning • Operations and maintenance • Decommissioning
Proposed Wells	Eight wells are anticipated to be drilled and completed (in a success case) and one re-entered and completed as part of the initial drilling campaign: • Re-entry and completion of Artisan 1 • Drilling and completion of La Bella 2 • Maximum 5 wells drilled and completed (in success case) in VIC/P43 (defined as VIC/P43 and VIC/L35 - see section 1.1). Maximum 2 wells drilled and completed (in a success case) in VIC/P73 (defined as VIC/P73 and VIC/L36 – see section 1.1).
Subsea Infrastructure	Installation of subsea infrastructure to connect gas discoveries (Artisan 1, La Bella 2) and future connections of successful wells (from above drilling and completion campaigns) to the OGPP or Thylacine Platform including: • Wellheads, flowlines, umbilicals, manifolds and skids.

Project Areas

The Project will be carried out in the defined Project Area shown in above ES Figure 0-1. The Project Area includes the Artisan and La Bella gas discoveries, future exploration prospects located in VIC/P43 and VIC/P73. The Project Area also includes the proposed locations of subsea flowlines and facilities (with buffer areas) for future subsea tie-back to the OGPP or the Thylacine platform.

Project Stages and Schedule

Beach is planning an initial drilling campaign commencing in 2025, installation of new subsea facilities commencing in 2026 with the earliest achievable date for commissioning and first gas in 2026 subject to corporate, joint venture and regulatory approvals. See ES Table 0-3 for an indicative project schedule.

ES Table 0-3: Indicative Project Schedule

Project Stage	Indicative Timing
Execution Decision Gate	Q3 2024
Initial Exploration & Appraisal Drilling Campaign	Commencing Q2 2025
Installation of Subsea Infrastructure	Earliest commencement Q1-2 2028

Commissioning & RFSU	Earliest commencement Q2-3 2028
Future Drilling and Tie-backs	Within operating life of the Project
End of Field Life	2045
Decommissioning (Wells and Subsea Infrastructure)	Decommissioning will be managed in compliance with Sections 572(3) and 270 of the OPGGS Act (unless alternative arrangements are accepted)

ES4 Description of the Environment

The OPP describes the physical, ecological, and socio-economic environment that may be affected (Planning Area) from planned and unplanned events associated with the Project, including MNES protected under the EPBC Act. This description informs the assessment of environmental impacts and risks.

The outer boundary of the Planning Area is the worst-case and largest spatial extent where unplanned hydrocarbon releases from Project activities could have an environmental consequence. All planned activities will occur within the Project Area (ES Figure 0-1).

Physical Environment

The dominant seabed character is medium to coarse carbonate sands with areas of low relief exposed limestone. There are no known bathymetric features such as reefs, shoals or banks within the Project Area. The continental shelf slope is in close proximity to the Project Area and has been designed to not include the deeper waters off the continental shelf.

Otway is a high-energy environment exposed to frequent storms and significant wave heights. Winds in the area generally exceed 13 knots (23.4 km/h) for more than 50% of the time contributing to the moderate to high wave-energy environment.

The region is oceanographically complex, with subtropical influences from the north and subpolar influences from the south. The Leeuwin Current transports warm, subtropical water southward along the Western Australian coast and then eastward into the Great Australian Bight where it mixes with the cool waters from the Zeehan Current running along the west coast of Tasmania. These currents are stronger in winter than in summer.

Water and sediment quality within the Project Area is high, with little evidence of contamination.

The climate in the Otway is typical of a cool temperate region with cold, wet winters and warm dry summers. In winter, when the subtropical ridge moves northwards over the Australian continent, cold fronts generally create sustained west to south-westerly winds and frequent rainfall in the region. In summer, frontal systems are often shallower and occur between two ridges of high pressure, bringing more variable winds and rainfall.

Ecological Environment

The benthic habitat is similar across the Project Area, consisting of carbonate rich coarse to medium sands with areas of exposed limestone substrate. This type of seabed is highly mobile making it difficult for filter feeders and soft body invertebrates to survive and establish in significant populations. Epifauna is dominated by low density, patchy assemblages of branching bryozoans, gorgonian cnidarians and sponges.

No benthic species or ecological communities listed as threatened under the Environmental Protection and Biodiversity Conservation Act 1999 (the EPBC Act) were identified.

No benthic species or ecological communities listed as threatened under the Environmental Protection and Biodiversity Conservation Act 1999 (the EPBC Act) were identified.

A range of other communities and habitats occur within the Planning Area beyond the Project Area, including:

- benthic habitats such as bare substrate, seagrasses, and macroalgae.
- coastal habitats such as mangroves and saltmarsh.

A number of listed threatened, migratory, marine or cetacean species protected under the EPBC Act were identified within the Project Area and Planning Area, including:

- 12 fishes (including sharks) (9 within the Project Area and another 3 within the Planning Area beyond the Project Area)
- 111 birds (33 within the Project Area and another 78 within the Planning Area beyond the Project Area)
- 34 marine mammals (29 within the Project Area and another 5 within the Planning Area beyond the Project Area)
- 3 marine reptiles (within both the Project Area and Planning Area beyond the Project Area)

Socio-Economic Environment

No protected areas overlap the Project Area, although a number occur within the Planning Area beyond the Project Area, including:

- 2 Commonwealth Australian Marine Parks (AMPs)
- 12 Victorian marine protected areas
- 13 Victorian terrestrial protected areas
- 13 Tasmanian terrestrial protected areas
- 1 wetland of international importance (Ramsar wetland)

Eight Commonwealth commercial fisheries have jurisdictions to fish within the Planning Area.

There are 8 Victorian state-managed commercial fisheries that overlap the Planning Area. Of these, catch effort was identified within the Project Area for the Giant Crab Fishery, Rock Lobster Fishery and Wrasse (Ocean) Fishery.

There are 8 Tasmanian state-managed commercial fisheries that may overlap the Planning Area. No fishing effort for Tasmanian fisheries has been identified within the Project Area.

There are 5 South Australian-state managed commercial fisheries that may overlap the Planning Area. No fishing effort for South Australian fisheries has been identified within the Project Area.

No World, Commonwealth or National Heritage properties occur within the Project Area. Only 3 National Heritage Places occur within the Planning Area beyond the Project Area.

Within the Planning Area there is a 130 km stretch of coastline known as the 'Shipwreck Coast' because of the large number of shipwrecks present, with most wrecked during the late nineteenth century. The strong waves, rocky reefs and cliffs of the region contributed to the loss of these ships.

First Nations people groups inhabited the south-west Victorian coast as is evident from the terrestrial sites of Aboriginal archaeological significance throughout the area. During recent ice age periods (the last ending approximately 12,000-14,000 years ago), sea levels were significantly lower, and the coastline was a significant distance seaward of its present location, enabling occupation and travel across land that is now submerged.

The Eastern Maar are Traditional Owners of south-west Victoria, and currently occupy a registered Native Title claim on the land adjacent to the Project Area and Planning Area and 100 m out to sea. Their land extends as far north as Ararat and encompasses Warrnambool, Port Fairy, and other areas along the Great Ocean Road, it also stretches 100 m out to sea from low tide and therefore includes the iconic Twelve Apostles (EMAC 2020). According to EMAC (2020), one of the services provided by the Eastern Maar group is the involvement/consultation and conducting of fieldwork with Cultural Heritage Management Plans in conjunction with a Heritage Advisor, with this collaboration reflecting the notion of "Working on Country together" (EMAC 2020).

Coastal Aboriginal heritage sites include mostly shell middens, some stone artefacts, a few staircases cut into the coastal cliffs, and at least one burial site. The various shell middens within the Port Campbell National Park and Bay of Islands Costal Park are close to coastal access points that are, in some cases, now visitor access points (Parks Victoria 1998). The Aboriginal Heritage Register (AHR) lists over 13,000 sites; however, there is no searchable database to identify any sites in the Planning Area.

The south-east marine region is one of the busiest shipping regions in Australia and Bass Strait is one of Australia's busiest shipping routes. Commercial vessels use the route when transiting between ports on the east, south and west coasts of Australia, and there are regular passenger and cargo services between mainland Australia and Tasmania.

Ongoing consultation with Department of Defence has identified that the Project Area is located within restricted airspace, but no other defence areas were identified. The Department of Defence also advised that unexploded ordnance (UXO) may be present on and in the sea floor.

ES5 Environment Impacts and Risks Assessment Methodology

Beach has undertaken environmental impact and risk assessments for the Project in accordance with the Beach OEMS Risk Management Standard.

The impact or risk for each activity and associated hazards was assessed following the application of controls. For planned events, only the consequence of the impact was assessed. Likelihood was not assessed, as the occurrence of planned events is effectively certain. The consequence for planned events was based on all controls functioning effectively. For unplanned events, the environmental residual risk of the event was determined based on the likelihood and consequence of the events.

The likelihood of an unplanned event occurring was based on all controls functioning effectively. The consequence was based on a worst-case event occurring with all controls having failed. This provides a conservative approach to assessing consequence, as the likelihood of a worst-case event with the failure of all controls is remote.

The resulting consequence (planned events) or residual risk (unplanned events) was then compared to Beach acceptable levels of impact and risk, including receptor-specific acceptable levels of impact. If the impact or residual risk was determined to not be acceptable, additional controls were applied and the impact or risk was assessed again. This process was repeated until each impact or residual risk was reduced to an acceptable level.

In addition to assessing each aspect and its associated hazards independently, Beach has also undertaken a cumulative impact assessment (Section 8). This cumulative impact assessment considered potential synergistic impacts on environmental values and sensitivities from all aspects of the Project and third-party activities. The cumulative impact assessment was only undertaken for planned events. No consideration of cumulative impacts from unplanned events was made, as these events are not expected to occur during the Project activities.

ES6 Environmental Performance Outcomes and Control Measures

The specific EPOs and control measures of the Project relevant for each impact and risk are provided in Sections 6 and 7.

Each EPO for the Project is listed below with the control measures for planned activities provided in ES Table 0-4 and provided for unplanned events in ES Table 0-5.

- EPO1: Implement CM05 and CM06 for the establishment and maintenance of petroleum safety zones, temporary exclusion zones and cautionary zones.
- EPO2: Decommissioning of Project facilities in compliance with Section 572 (3) of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth).
- EPO3: Implement CM08 Project Execution Plans and CM09 MODU and Vessel Anchoring Plan to ensure placement of infrastructure and anchors will avoid unique seafloor habitats in the Project Area.
- EPO4: Implement CM 10 Seabed assessments to identify seabed composition, benthic habitats and communities and ensure areas of unique seafloor habitats, maritime archaeology, UXOs, submerged cultural heritage and landscapes are avoided where practicable within technical and safety constraints.
- EPO5: No impact on underwater cultural heritage.
- EPO6: Implement CM11 Cultural heritage assessments to identify any maritime archaeological and submerged cultural heritage and landscapes to inform protection priorities, and develop and implement management measures and reporting requirements, where required, to prevent potential impacts.

- EPO7: No death or injury[1] to listed threatened or migratory species from Project activities.
- EPO8: Biologically important behaviours[2] can continue while Project Activities are being undertaken.
- EPO9: Implement CM13 Lighting Management Procedure as per the National Light Pollution Guidelines (DCCEEW 2023a) to ensure artificial light in biologically important areas will be managed such that biologically important behaviours within or outside a BIA can continue while Project activities are being undertaken.
- EPO10: Anthropogenic noise in biologically important areas and habitat critical to the survival of a species will be managed such that:
  - Any blue whale continues to utilise biologically important areas without injury[1], and is not displaced from a foraging area.
  - It does not prevent any southern right whale from utilising biologically important areas or habitat critical to the survival of a species or cause auditory impairment (TTS and PTS).
- EPO11: Implement CM15, CM16, CM17, CM18 Whale Management Procedures to ensure impacts and risks to whales from underwater sound are managed in accordance with relevant recovery plans.
- EPO12: Implement CM19 Noise Assessments to ensure impacts and risks to whales from underwater sound evaluated in relevant activity specific Environment Plans are based on the latest available scientific research on noise effect criteria.
- EPO13: Manage atmospheric emissions from the combustion of fuel during vessel and MODU operations in accordance with MARPOL Annex VI (Prevention of Air Pollution from Ships) enacted in the *Navigation Act 2012*.

---

[1] Injury to cetaceans as defined as auditory impairment from the onset of TTS and PTS, where DAWE (2021a) defines 'injury to blue whales' as: For the purpose of interpreting and applying Action Area A.2 of the Blue Whale CMP, injury is both permanent and temporary hearing impairment (Permanent Threshold Shift and Temporary Threshold Shift) and any other form of physical harm arising from anthropogenic sources of underwater noise

[2] Biologically important behaviours such as reproduction, feeding, migration and resting (DCCEEW, 2023j).

- EPO14: Implement CM22 Emissions Abatement Opportunities Register to maintain a register of opportunities for emissions reduction across its asset portfolio to reduce emissions.
- EPO15: GHG emissions related to the Project, including (scope 1 [Inside Project Boundary, scope 1* [Outside Project Boundary] and scope 3) emissions are consistent with Australia's international GHG emissions commitments, as outlined in the Climate Change Act 2022. Emissions are to be determined based on the NGER scheme and managed by the Safeguard Mechanism.
- EPO16: Implement CM28 Well design to ensure all wells to be drilled with WBDF, with SBDF only to be used where technical requirements preclude the use of WBDF.
- EPO17: Implement CM29 Chemical selection process to ensure chemicals used are environmentally acceptable whilst also meeting technical requirements.
- EPO18: Implement CM30 Drilling fluid inventory to reduce or avoid discharge of bulk materials including excess powders, brines, and drilling fluids.
- EPO19: Implement CM31 Solids control equipment to recover and reduce residual SBDF content prior to overboard discharge, if SBDF is used.
- EPO20: Implement CM32 Minamata convention to ensure drilling fluids will have concentrations of mercury and cadmium less than 1 mg/kg and 3 mg/kg respectively in stock barite (WBM and SBM).
- EPO21: Defined well locations and immediate surrounds (<2 km from well location) within the Project Area will not contain unique seafloor habitats.
- EPO 22: Implement CM33 Cementing program to reduce or avoid discharge of cement to the marine environment, including the reduction and avoidance of excess cement discharge upon completion of the drilling program.
- EPO 23: Implement CM34 Hydrotest assessment to detail the hydrotesting requirements including the definition of discharge characteristics (i.e. chemical additives and concentrations), discharge locations and volumes, methodology and species impact thresholds.
- EPO24: Implement CM35 Marine orders to manage routine discharges of operational wastes from vessels in accordance with Marine Orders 91 and 95.
- EPO25: No introduction of a known or potential invasive marine species.
- EPO26: No unplanned discharge of materials or waste to the marine environment.
- EPO27: No unplanned loss of containment of hydrocarbons or chemicals to the marine environment during Project activities.
- EPO28: In event of an unplanned release of chemicals or hydrocarbons, spill response control measures will be implemented in accordance with accepted EP, OPEP and OSMP (CM48 EP, OPEP and OSMP).

ES Table 0-4: Aspect Specific Control Measures for Planned Activities

Aspect	Residual Impact		Control Measures
Physical Presence - Interaction with Other Users	Minor	CM01 Navigation safety	Beach Marine Assurance System ensures that the MODU and vessels meet relevant maritime laws and includes pre-commencement MODU and vessel inspections of class certification requirements under the *Navigation Act 2012* and associated Marine Orders. All vessels operating within the project area will adhere to the navigation safety requirements including: • International Regulations for Preventing Collisions at Sea 1972 • Chapter 5 of International Convention for the Safety of Life at Sea 1974 • International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 *Navigation Act 2012* and any subsequent Marine Orders that specify standards for crew training and competency, navigation, communication, and safety measures
		CM02 Notifications	The Australian Hydrographic Office will be notified of the Project activities and installed subsea infrastructure prior to commencement to facilitate the issuing of Notice to Mariners and maintain nautical charts. Relevant stakeholders are notified prior to the activity so that third party marine users are aware of vessel location and timing
		CM03: Fair Ocean Access Procedure	Beach's Fair Ocean Access Procedure was developed with input from commercial fishing industry organisations. The procedure details the process whereby a commercial fisher can claim compensation for an economic loss associated with Beach's offshore activities where impacts cannot be avoided
		CM04 Stakeholder consultation	Beach will undertake consultation with relevant persons for all petroleum activities in accordance with the OPGGS (Environment) Regulations and detailed in Section 10 of this OPP. Observation, incidents, and opportunities for improvement regarding the interaction with other users will be reported to other petroleum titleholders.
		CM05 Petroleum safety zones	The Project will comply with OPGGS Act 2006 – Section 616(2) petroleum safety zones, which includes establishment and maintenance of petroleum

			safety zones around wells, offshore structures or equipment which prohibits vessels entering without written consent
		CM06 Temporary exclusion/cautionary zones	500m temporary exclusion and 2 km cautionary zones will be established and maintained around drilling and installation activities
		CM07 Decommissioning	Decommissioning of subsea wells and infrastructure in compliance with Section 572 of the OPGGS Act.
Physical Presence – Seabed disturbance	Minor	CM08 Project Execution Plans	Infrastructure will be positioned on the seabed within design footprint to reduce seabed disturbance and avoid unique seafloor habitats in the Project Area.
		CM09 MODU and vessel anchoring plan	A MODU and vessel anchoring plan will identify suitable areas for anchors to be placed within the Project Area to avoid unique seafloor habitats.
		CM10 Seabed assessments	Seabed assessments undertaken of each well location and tie-back route prior to final selection to identify seabed composition, benthic habitats and communities and ensure areas of high relief outcrops, reefs, sponge beds, maritime archaeology, UXOs, submerged cultural heritage and landscapes are avoided where practicable within technical and safety constraints. Seabed assessment data will be provided to the following appropriately qualified specialists to identify sensitive benthic receptors: • Marine benthic ecologist to identify seabed habitat types including areas of high relief outcrops, reefs or sponge beds that are likely to be associated with site-attached fish. • Underwater archaeologist to identify shipwrecks and other maritime archaeological heritage. • Geophysical data analyst to identify location of unexploded ordinances. • Underwater archaeologist to identify submerged cultural heritage and landscapes. Reports from each specialist evaluation of seabed assessment data will be provided to Beach. Beach will assess the reports and identify any areas of overlap, potential risks from Project activities, and determine any exclusion areas that may be required.

		CM11 Cultural heritage assessments	Imagery and data from seabed surveys and assessments will be provided to appropriately qualified underwater archaeologists to identify any maritime archaeological and submerged cultural heritage and landscapes and inform protection priorities, management measures and reporting requirements. Should any maritime archaeological and submerged cultural heritage and landscapes be identified, Beach will report the findings in accordance with the *Underwater Cultural Heritage Act 2018*, and will consult with the relevant First Nations groups and determine any exclusion areas or further cultural heritage management procedures that may be required.
		CM07 Decommissioning	Refer above - Physical Presence - Interaction with Other Users.
Light emissions	Minor	CM01 Navigational safety	Refer above - Physical Presence - Interaction with Other Users.
		CM02 Notifications	Refer above - Physical Presence - Interaction with Other Users.
		CM12 MODU and vessel lighting	MODU and vessel lighting will be limited to the minimum required for navigational and safety requirements, with the exception of emergency events.
		CM13 Light Management Procedure	Beach will contract appropriately qualified lighting practitioners, together with an appropriately qualified marine biologist or ecologist to develop and support the implementation of a Light Management Procedure as per the National Light Pollution Guidelines for Wildlife (CoA 2023). MODU and vessels will implement a Light Management Procedure as per the National Light Pollution Guidelines (DCCEEW 2023a) for Project activities. The Light Management Procedure will detail additional adaptive mitigations to manage light based on the information in the Seabird Light Mitigation Toolbox and Beach Energy’s Vessel Light Management Procedure Guidance (CDN/ID 19012450). Specifically, the Light Management Plan for vessels and rigs is required to cover: • Requirements to minimise non-essential lights and outward facing lights ensuring safety navigational lighting and safe work condition requirements are met. • Program for managing grounded birds. • Reporting and recording requirements.

			Prior to commencement of an initial flaring event at each well, the area extending from the tip of the flare will be visually confirmed to be clear of birds [**PC249**]. Adaptive management will be detailed the light management procedure to be included in future EPs under this OPP when scheduling of the activity is known in greater detail.
Underwater sounds emissions	Moderate	CM14 EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans	Vessels will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans. Helicopters will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans
		CM15 Geophysical Survey Whale Management Procedure	Development and implementation of a whale management procedure which outlines specific measures to minimise anthropogenic noise threats to relevant species, including the implementation of safe operating distances between vessels and whales, night-time and low visibility controls and pre-activity surveys for geophysical surveys using a boomer or SBP. This procedure provides a framework for minimising noise impacts to whales and details specific measures to be implemented that will ensure impacts and risks meet or are better than acceptable levels 1, 2 and 3. By meeting these acceptable levels, impacts will be consistent with Conservation Management Plan for the Blue Whale 2015-2025 (CoA, 2015b) and National Recovery Plan for the Southern Right Whale Eubalaena australis (DCCEEW 2024o). Specific measures in the procedure will include the following: • pre-start-up visual observations. Visual observations for the presence of whales carried out at least 30 minutes out to a distance of at least 300m from the source before startup of the boomer or SBP. • If during the prestart visual observation period, a whale is sighted within 300m of the vessel the equipment activation will be delayed until the whale has moved outside of the 300m zone or 30 minutes has lapsed since the last whale sighting within 300m. • SBP equipment will not be started at night if there have been three or more delays to the start-up of the equipment due to whales in the previous 24 hours.

		Use of suitably trained Marine Mammal Observers Once the survey has commenced CM14 applies where the vessel is required to maintain a 300m distance to all whales. Adaptive management will be detailed the procedure to be included in future EPs under this OPP when scheduling of the activity is known in greater detail.
	CM16 VSP Whale Management Procedure	Development and implementation of a whale management procedure which outlines specific measures to minimise anthropogenic noise threats to relevant species, including the implementation of safe operating distances, night-time and low visibility controls and pre-activity surveys for VSP activities that complies with 'Standard Management Procedures' set out in EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines (DEWHA 2008c) (or the contemporary requirements at the time of the activity). This procedure provides a framework for minimising noise impacts to whales and details specific measures to be implemented that will ensure impacts and risks meet or are better than acceptable levels 1, 2 and 3. By meeting these acceptable levels, impacts will be consistent with Conservation Management Plan for the Blue Whale 2015-2025 (CoA, 2015b) and National Recovery Plan for the Southern Right Whale Eubalaena australis (DCCEEW 2024o). Specific measures in the procedure will include the following: • pre-start-up visual observations. • start-up and normal operating procedures, including a process for delayed start-up/recommencement, should whales be sighted. • night time and low visibility procedures • use of suitably trained Marine Mammal Observers • Adaptive management will be detailed the procedure to be included in future EPs under this OPP when scheduling of the activity is known in greater detail.
	CM17 Drilling Whale Management Procedure	Development and implementation of a whale management procedure which outlines specific measures to minimise anthropogenic noise threats to relevant species, including the implementation of safe operating distances between vessels and whales, pre-activity surveys for specific activities, night-time and low visibility controls and establishment of safe points for operational activities in accordance with the Safety Case and Well Integrity requirements for drilling activities. This procedure provides a framework for minimising noise impacts to

		whales and details specific measures to be implemented that will ensure impacts and risks meet or are better than acceptable levels 1, 2 and 3. By meeting these acceptable levels, impacts will be consistent with Conservation Management Plan for the Blue Whale 2015-2025 (CoA, 2015b) and National Recovery Plan for the Southern Right Whale Eubalaena australis (DCCEEW 2024o). Specific measures in the procedure will include the following: • pre-start-up visual observations. • start-up and normal operating procedures, including a process for delayed start-up/recommencement, should whales be sighted. • night time and low visibility procedures • use of suitably trained Marine Mammal Observers • weekly aerial surveys to detect and report the presence of whales within 20 km for anchor pre-lay, rig mooring and resupply activities in the shelf edge locations • Adaptive management will be detailed the procedure to be included in future EPs under this OPP when scheduling of the activity is known in greater detail.
	CM18 Vessel Whale Management Procedure	Development and implementation of a whale management procedure which outlines specific measures to minimise anthropogenic noise threats to relevant species, including the implementation of safe operating distances between vessels and whales, night-time and low visibility controls and pre-activity surveys for installation, IMR and vessel transit/resupply activities. This procedure provides a framework for minimising noise impacts to whales and details specific measures to be implemented that will ensure impacts and risks meet or are better than acceptable levels 1, 2 and 3. By meeting these acceptable levels, impacts will be consistent with Conservation Management Plan for the Blue Whale 2015-2025 (CoA, 2015b) and National Recovery Plan for the Southern Right Whale Eubalaena australis (DCCEEW 2024o). Specific measures in the procedure will include the following: • pre-start-up visual observations. • start-up and normal operating procedures, including a process for delayed start-up/recommencement, should whales be sighted. • night-time and low visibility proceduresuse of suitably trained Marine Mammal Observers

			• Adaptive management will be detailed the procedure to be included in future EPs under this OPP when scheduling of the activity is known in greater detail.
		CM19 Noise Assessments	Acoustic noise assessments of significant noise generating activities associated with the Project will be detailed in relevant activity specific Environment Plans prior to activities commencing. The EPs will detail the sound levels and distances to noise effect criteria, with the mitigations required to ensure the acceptable levels and Environmental Performance Outcomes of this OPP are met and ensure consistency against Conservation Management Plan for the Blue Whale 2015-2025 (CoA, 2015b) and National Recovery Plan for the Southern Right Whale Eubalaena australis (DCCEEW 2024o).
Atmospheric emissions	Minor	CM20 MARPOL Annex VI (Prevention of Air Pollution from Ships)	Vessels and MODU will comply with MARPOL Annex VI (Prevention of Air Pollution from Ships), the Navigation Act 2012, the Protection of the Sea (Prevention of Pollution from Ships) Act 1983 and Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution (appropriate to vessel class) for emissions from combustion of fuel including: • valid International Air Pollution Prevention (IAPP) certificate and a current international energy efficiency certificate • have a Ship Energy Efficiency Management Plan (SEEMP) as per MARPOL 73/78 Annex VI • engine NOx emission levels will comply with Regulation 13 of MARPOL 73/78 Annex VI • use low sulphur content fuel oil/diesel (≤0.5% m/m S) or an approved measure that achieves an equivalent air quality outcome
		CM21 Emissions Monitoring	Measure, monitor or estimate facility fuel and flare emissions (in accordance with the National Pollutant Inventory) to inform and optimise management practices and minimise environmental impact of emissions
		CM22 Emission Abatement Opportunities Register	Per the requirements of the OEMS Sustainability Standard, Beach will maintain a register of opportunities for emissions reduction across its asset portfolio to reduce emissions.

Greenhouse gas emissions	Minor	CM22 Emission Abatement Opportunities Register	Refer above – atmospheric emissions. Refer above – atmospheric emissions.
		CM23 GHG Management Plan	The intent of this plan is to guide activities needed to manage Beach Scope 1 and Scope 1* GHG emissions, including the Project, in line with relevant policy and legislative requirements such as the Safeguard Mechanism and NGER. Implementation of Beach GHG Emissions Management Plan incorporates: • the framework and specific techniques used to ensure that GHG emission related EPOs will be met over the life of the facility • emissions monitoring • emissions forecasting • an adaptive management approach to facilitate a continuous cycle of monitoring, evaluating and implementing improvements to minimise GHG emissions to ALARP and acceptable levels over the life of the Project
		CM24 GHG Emissions Monitoring	Beach reports scope 1 and scope 2 emissions under the *National Greenhouse and Energy Reporting Act 2007* (NGER). This includes annual, mandatory reporting of emissions by 31 October for the prior financial year. We track our progress against emissions reduction targets according to the methods defined by NGER. Beach calculates scope 3 emissions based on the Greenhouse Gas Protocol's Corporate Value Chain (scope 3) Accounting and Reporting Standard and scope 3 guidance documents. Scope 3 emissions derived from the use of product will be reviewed against forecasts, with this focus reflecting the proportional contribution of final product use to overall Otway asset Scope 3 emissions. GHG emissions forecasts are prepared periodically using data such as production forecasts. This data informs the disclosures in our Sustainability Report and Climate Transition Action Plan [**PC206**].
		CM25 Fugitive Leak Detection and Repair Program	Beach undertakes periodic leak detection and repair (LDAR) fugitive emissions surveys at the Otway Gas Plant and Thylacine Platform. The scope, methodology, frequency, and repair guidance is detailed in the GHG Management Plan

		CM26 Preventative Maintenance System	Combustion equipment is inspected and maintained in accordance with the preventative maintenance system to ensure efficient operations
		CM27 Logistics Planning	Operations planning is undertaken for supply vessel and helicopter movements, thereby minimising unnecessary travel and minimising fuel combustion
Planned Discharge – Drill Cuttings and Fluids	Minor	CM10 Seabed assessments	Refer above – physical presence seabed disturbance
		CM11 Cultural heritage assessments	Refer above – physical presence seabed disturbance
		CM28 Well design	All wells to be drilled with WBDF, with SBDF only to be used where technical requirements preclude the use of WBDF
		CM29 Chemical selection process	A process for chemical selection will be implemented to ensure chemicals used are environmentally acceptable whilst also meeting technical requirements
		CM30 Drilling fluid inventory	Drilling fluids inventory will be developed and tracked to reduce or avoid discharge of bulk materials including excess powders, brines, and drilling fluids
		CM31 Solids control equipment	If SBDF is used, drill cuttings will be processed on the MODU to recover and reduce residual SBDF content prior to overboard discharge
		CM32 Minamata convention	Drilling fluids will have concentrations of mercury and cadmium less than 1 mg/kg and 3 mg/kg respectively in stock barite (WBM and SBM)
Planned Discharge – Cement	Minor	CM10 Seabed assessments	Refer above – physical presence seabed disturbance
		CM11 Cultural heritage assessments	Refer above – physical presence seabed disturbance
		CM33 Cementing program	Cementing programs shall be developed to reduce or avoid discharge of cement to the marine environment, including the reduction and avoidance of excess cement discharge upon completion of the drilling program.
		CM29 Chemical selection process	Refer above – planned discharge drill cuttings and fluids.
Planned Discharge – Commissioning and Operational Fluids	Minor	CM29 Chemical selection process	Refer above – planned discharge drill cuttings and fluids.
		CM34 Hydrotest assessment	Hydrotest assessments will be detailed in the relevant activity specific EPs developed during the detailed engineering and design studies of the Project. The EPs will detail the hydrotesting requirements including the definition of

			discharge characteristics (i.e. chemical additives and concentrations), discharge locations and volumes, methodology and species impact thresholds
Planned Discharge – Routine Operational Wastes from MODU and Vessels	Minor	CM29 Chemical selection process	Refer above – planned discharge drill cuttings and fluids.
		CM35 Marine Orders	All wastewater discharges will comply with relevant MARPOL 73/78, Navigation Act 2012, Protection of the Sea (Prevention of Pollution) Act 1983 and subsequent Marine Order requirements (as appropriate for vessel classification): • Marine Order 91 (Marine Pollution Prevention – Oil), which implements Annex I of MARPOL 73/78, including (as required by vessel class): ◦ Machinery space bilge/oily water shall have IMO-approved oil filtering equipment (oil/water separator) with an on-line OIW monitoring device ◦ OIW content to be less than 15 ppm prior to discharge. ◦ A deck drainage system capable of controlling the content of discharges for areas of high risk of fuel/oil/grease or hazardous chemical contamination. ◦ Valid International Oil Pollution Prevention Certificate. • Marine Order 95 (Marine Pollution Prevention – Garbage), which implements Annex V of MARPOL 73/78, including: ◦ Garbage management plan in place. ◦ Garbage record book maintained onboard. • Marine Order 96 (Marine Pollution Prevention – Sewage), which implements Annex IV of MARPOL 73/78, including (as required by vessel class): ◦ a valid International Sewage Pollution Prevention Certificate, ◦ an IMO-approved sewage treatment plant, ◦ a sewage comminuting and disinfecting system, a sewage holding tank sized appropriately to contain all generated waste (sewage and grey water) ◦ discharge of sewage will occur at a moderate rate while vessel is proceeding (more than 4 knots)

Cumulative Impacts with other reasonably foreseeable projects	Minor	CM51 Cumulative Impact Review	Each future EP resulting from the OGV OPP will undertake a review for additional or significantly revised reasonably foreseeable projects. Additional or significantly revised projects will be assessed as per CIA methodology (Section 8.2). Any cumulative impacts from new, significantly revised or currently unknown activities that results in an unacceptable level of impact to receptors, will be subject to new or revised control measures within the appropriate EP to reduce cumulative impacts to ALARP

ES Table 0-5: Aspect Specific Control Measures for Unplanned Activities

Aspect	Residual Impact		Control Measures
Invasive Marine Species	Low	CM36 IMS Management Plan	Implementation of Beach IMS Management Plan which includes the following minimum requirements: • compliance with relevant Australian legislation and current regulatory guidance • outline of when an IMS risk assessment is required and the associated inspection, cleaning and certification requirements • implementation of management measures commensurate with the level of risk based on outcomes if the IMS risk assessment, such as inspections, cleaning and movement restrictions anti-fouling prevention measures, including vessels (of appropriate class) having a valid International Anti Fouling Systems (IAFS) Certificate
		CM37 Australian Ballast Water Management Requirements	The MODU and vessels fulfil the requirements of the Australian Ballast Water Management Requirements (DAWR, 2020, v8). This includes requirements to: • Carry a valid Ballast Water Management Plan (BWMP). • Submit a Ballast Water Report (BWR) through the Maritime Arrivals Reporting System (MARS). • If intending to discharge internationally sourced ballast water, submit BWR through MARS at least 12 hours prior to arrival. • If intending to discharge Australian sourced ballast water, seek a low-risk exemption through MARS. • Hold a Ballast Water Management Certificate (BWMC). • Ensure all ballast water exchange operations are recorded in a Ballast Water Record System (BWRS)
Physical Presence – Interaction with Marine Fauna	Low	CM14 EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans	Refer above – underwater sound emissions
	Low	CM10 Seabed assessments	Refer above – physical presence seabed disturbance

Accidental Discharge - Hazardous and Non-Hazardous Materials		CM11 Cultural heritage assessments	Refer above – physical presence seabed disturbance
		CM35 Marine orders	Refer above – planned discharge routine operational wastes from MODU and vessels
		CM38 Waste Management Plan	Beach Waste Management Plan implemented that includes details of: • Classification and segregation of wastes • Appropriate storage of wastes • Transportation and disposal of wastes to licensed treatment and disposal facilities onshore
		CM39 Lifting	Crane and lifting operations will comply with the following: • Lifting equipment will be inspected and certified • Preventative maintenance will be carried out • Lifting operators will be competent and qualified
Loss of Containment - Hydrocarbons and Chemicals	Medium (MDO) Low (Condensate)	CM01 Navigation safety	Refer above - Physical Presence - Interaction with Other Users
		CM02 Notifications	Refer above - Physical Presence - Interaction with Other Users
		CM03: Fair Ocean Access Procedure	Refer above - Physical Presence - Interaction with Other Users
		CM05 Petroleum safety zones	Refer above - Physical Presence - Interaction with Other Users
		CM06 Temporary exclusion/cautionary zones	Refer above - Physical Presence - Interaction with Other Users
		CM40 WOMP	The Well Operations Management Plan (WOMP) is a regulatory requirement under the Offshore Petroleum and Greenhouse Gas Storage Act 2006 and the associated Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011. It is the primary approval document for ensuring a high standard of well integrity and details the risk assessment, critical procedures and safety mechanisms to be implemented throughout the duration of the relevant petroleum activity
		CM41 MODU Safety Case	The Safety Case for the MODU is a regulatory requirement under the OPGGS Act and the associated Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011 The Safety Case identifies hazards and risks specific to drilling wells, describes how the risks are controlled and describes the safety management system in

	place to ensure the controls are effectively and consistently applied. This includes the subsea control system configured for all wells to fail-safe in the event of loss of communication and/or hydraulics. Prevention of loss of well control and subsequent release of hydrocarbons is a key focus as this is the source of major accident events
CM42 Well Engineering and Construction Management System (WECS)	Beach Well Engineering and Construction Management System (WECS) that ensures well activities are fit for purpose with operational risks managed to a level that is as low as reasonably practicable. It also ensures that changes are made in a controlled manner, that appropriate standards are adhered to, and that a sufficiently resourced and competent organisation is in place. The Beach Operations Excellence Management System consists of Well Integrity Standard and WECS.
CM43 Workforce capability	Beach Workforce Capability Requirements Matrix to ensure Operations personnel are qualified, trained and certified as competent to operate and maintain Beach facilities
CM44 Crisis and Emergency Management	Beach's Crisis and Emergency Management Standard requires Beach to have plans, procedures and resources in place to effectively respond to crisis and emergency situations, including hydrocarbon spills
CM45 Preventative maintenance	Computerised Maintenance Management System to ensure all wells and subsea infrastructure is maintained to schedule
CM46: SMPEP or SOPEP (appropriate to class)	In accordance with MARPOL Annex I and AMSA's MO 91 [Marine Pollution Prevention – oil], a SMPEP or SOPEP (according to class) is required to be developed based upon the Guidelines for the Development of Shipboard Oil Pollution Emergency Plans, adopted by IMO as Resolution MEPC.54(32) and approved by AMSA. To prepare for a spill event, the SMPEP/SOPEP details: • response equipment available to control a spill event; • review cycle to ensure that the SMPEP/SOPEP is kept up to date; and • testing requirements, including the frequency and nature of these tests. In the event of a spill, the SMPEP/SOPEP details: • reporting requirements and a list of authorities to be contacted; • activities to be undertaken to control the discharge of hydrocarbon; and • procedures for coordinating with local officials.

		Specifically, the SMPEP/SOPEP contains procedures to stop or reduce the flow of hydrocarbons to be considered in the event of tank rupture.
	CM47 Bunkering procedure	Bunkering procedures to manage fuel transfers that include: • Weather limits on bunkering operations • Bunkering equipment specifications and inspection • Visual observations during transfers • Emergency shutdowns
	CM48 EP, OPEP and OSMP	Accepted Environment Plans (EP) Oil Pollution Emergency Plans (OPEP) and Operational and Scientific Monitoring Plans (OSMP) in place for all relevant Project activities and oil spills responded to in accordance with the plans
	CM49 Oil spill modelling	Oil spill modelling and environmental risk assessments for the Project EPs and OPEPs will consider the full range of worst-case scenario LOWC consequences
	CM50 Source control	Source Control Emergency Response Plans in place for all drilling activities

ES7 Environmental Management Implementation Approach

The Operations Excellence Management System (OEMS) is Beach's framework which provides the basis by which it defines, aligns, standardises and implements company processes to manage risks and ensure successful outcomes in its operations.

The OEMS defines the minimum standards, expectations and behaviours that ensure the company operates successfully in all core business processes including Health & Safety, Environmental Management, Production & Reliability, Financial & Stakeholder Management and Project Delivery. The OEMS applies to all personnel performing work within the company's jurisdiction.

The OEMS defines Beach's key elements and standards and how the proponent will deliver the OGV Project.

ES Figure 0-2: Operational Excellence Management System

ES8 Stakeholder Consultation

To complement the NOPSEMA assessment process for OPPs and provide stakeholders with sufficient time to consider the project, Beach will adopt a phased consultation approach for this OPP:

- Phase 1: Consultation on the Project prior to OPP public comment period
- Phase 2: Formal consultation via the OPP public comment period
- Phase 3: Ongoing consultation for development activities.

Beach will consider all feedback provided by stakeholders and, where relevant, incorporate information provided by stakeholders into the environmental management of the Project.

1 Introduction

1.1 Project Overview

The Otway Offshore Gas Victoria (OGV) Project (the Project) is designed to explore and develop new gas discoveries in the offshore Otway Basin. The Project covers an area that is located approximately 17 km south of the Victorian mainland and 80 km north-west of Tasmania (King Island) at its closest points.

Beach Energy (Operations) Limited (Beach) is the proponent for the Project and also owns and operates existing production assets and infrastructure in the Otway Basin including the Thylacine A production platform, Thylacine platform wells and subsea wells, flowlines and facilities, Geographe subsea wells flowlines and facilities, and Otway Gas Production Pipeline (OGPP) which transports gas and liquid hydrocarbons to the onshore Otway Gas Plant (OGP) located near Port Campbell (Figure 1-1). The OGP supplies gas to the domestic market in south-east Australia.

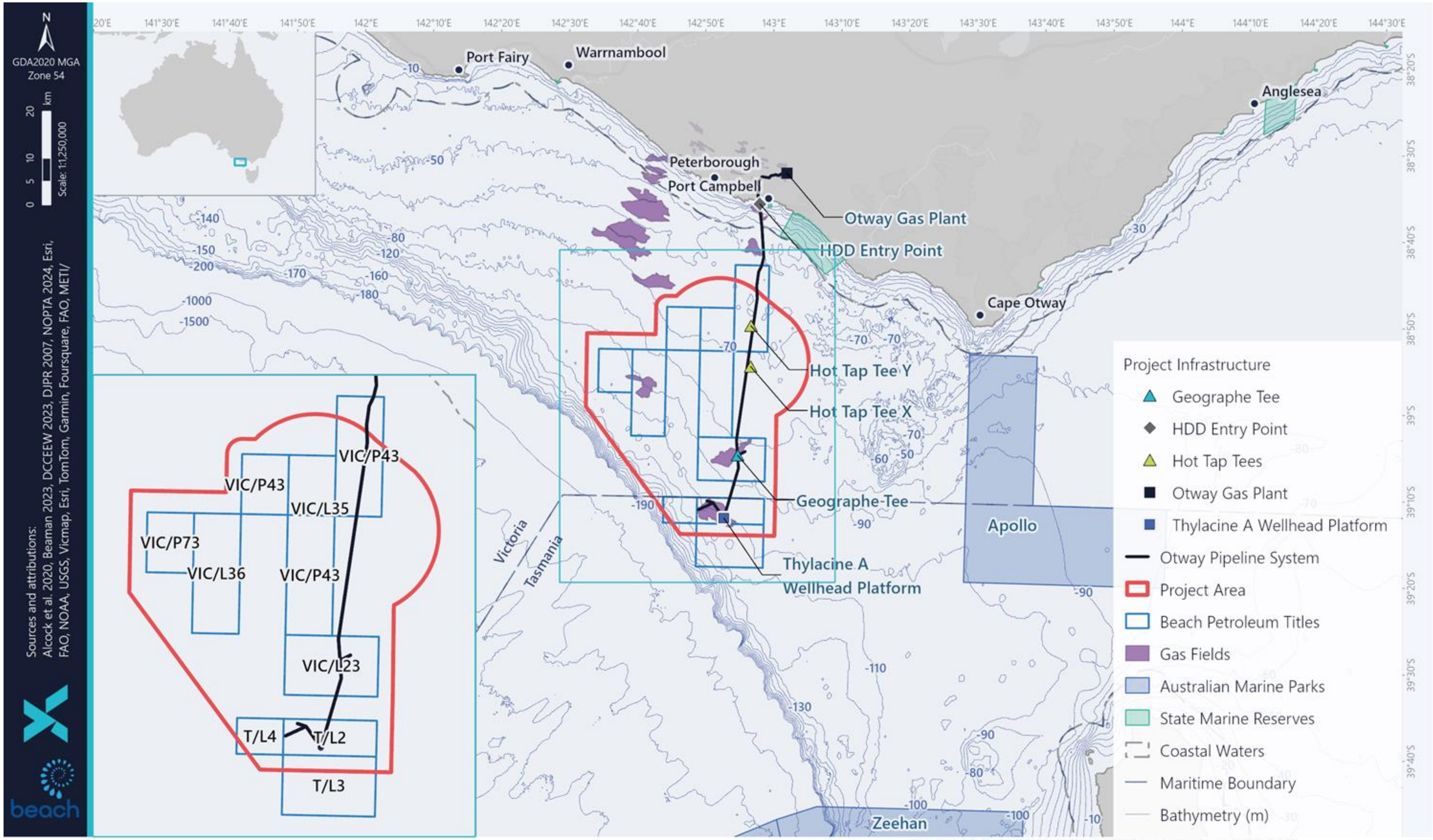
The Project provides the opportunity to develop currently stranded gas reserves and future resources using Beach's existing offshore infrastructure through exploration, appraisal and development activities in Beach's exploration permits, VIC/P43 and VIC/P73. On 30 September 2024, the Artisan field (1 block within VIC/P43) was converted to production licence, VIC/L35 and the La Bella field (2 blocks within VIC/P73) was converted to production licence, VIC/L36. For the purpose of the OPP, all references to VIC/P43 are defined as VIC/P43 and VIC/L35 and all reference to VIC/P73 are defined as VIC/P73 and VIC/L36.

The Artisan and La Bella gas discoveries, are in close proximity to Beach's existing production assets. The development of Artisan and La Bella gas discoveries will involve the drilling and completion of subsea wells, and the tie-back of these wells to the existing OGPP through which it will be transported to the OGP.

The development of undrilled future prospects will involve the same subsea development concept as Artisan and La Bella and will be tied back to existing infrastructure either directly to the OGPP or via the Thylacine platform.

The petroleum exploration, appraisal and development activities planned for the Project will commence in 2025 with an initial multi-well drilling campaign. Installation of new subsea facilities is anticipated to commence in 2028 with the earliest achievable date for commissioning and first gas also in 2028 subject to corporate, joint venture and regulatory approvals.

Additional subsea developments from new exploration success in future drilling campaigns may also be carried out and are in the scope of this OPP.



Sources and attributions: Alcock et al. 2020, Beaman 2023, DCCEEW 2023, DJPR 2007, NOPTA 2024, Esri, FAO, NOAA, USGS, Vicmap, Esri, TomTom, Garmin, Foursquare, FAO, METI/

Figure 1-1: Project Location

1.2 Proponent

The Project proponent is Beach Energy (Operations) Limited (Beach) which is a wholly owned subsidiary of Beach Energy Limited.

Beach is the operator of the Otway Joint Venture which includes Thylacine (production licences T/L2, T/L3, T/L4), Geographe, Artisan and La Bella (production licences VIC/L23, VIC/L36 and VIC/L35), and exploration permits VIC/P43 and VIC/P73. The participating interests in the Otway Joint Venture are Beach, 60% interest and OGOG (Otway) Pty Ltd, 40% interest.

The contact details for Beach are provided in the below Table 1-1.

Table 1-1: Proponent Details

Details	
Business Address	Level 8 80 Flinders Street Adelaide South Australia 5000
Contact Details	Brad Muir Project Manager T: (08) 8338 2833 F: (08) 8338 2336 E: info@beachenergy.com.au

Beach Energy Limited is an ASX listed, oil and gas exploration and production company headquartered in Adelaide, South Australia. It has operated and non-operated, onshore and offshore, oil and gas production from five producing basins across Australia and New Zealand and is a key supplier to the Australian east coast gas market.

Beach Energy Limited’s asset portfolio includes ownership interests in strategic oil and gas infrastructure, as well as a suite of high potential exploration prospects. Beach Energy Limited’s gas exploration and production portfolio includes acreage in the Otway, Bass, Cooper/Eromanga and Perth basins in Australia, and the Taranaki Basin in New Zealand.

1.3 Project Scope

The Project aims to develop stranded gas reserves and future resources in the Otway Basin through utilisation of the existing offshore infrastructure and creating further efficiencies through consolidated drilling and installation campaigns.

A summary of the key elements and activities for the Project is presented in Table 1-2. The development concept is consistent for all Beach’s nearby gas fields in the Otway Basin and involves subsea wells, flowlines and facilities to be tied back to the existing OGPP or Thylacine platform. The scope covers multiple small fields that may be developed in stages.

All activities will be carried out within the Project Area defined in Section 3.8.

Table 1-2: Project Summary

Project Stage	Key Activities
Surveys	Geotechnical and geophysical surveys undertaken to assess the suitability of the seabed for drilling and infrastructure placement
Drilling and Completions	Drilling & Completion campaign(s)
Facilities Installation and Commissioning	• Installation of subsea infrastructure to connect gas discoveries Artisan, La Bella and any successful exploration or appraisal wells from the initial drilling campaign to the OGPP including; wellheads, flowlines, umbilicals, manifolds and skids • Commissioning and testing of new equipment including flowlines, • Unload of drilling and completion fluid from the well is planned through new and existing subsea infrastructure to the onshore Otway Gas Plant (OGP). Well unload and testing to the MODU is a contingent option. • Future tie backs of successful exploration or appraisal wells comprising similar subsea infrastructure to the initial development may be undertaken in the Project Area during the life of the Project: • There is the potential for future tie-ins in the vicinity of the Project Area by other operators comprising similar subsea infrastructure to the initial development.
Operations and Maintenance	• Production from Artisan, La Bella and future prospects is expected to have an operational life of up to 20 years with EOFL estimated as 2045. • However, subject to future investment and developments in surrounding fields, operations and infrastructure life may be extended. • Operations stage may include well intervention and inspection, maintenance and repair of wells and subsea infrastructure as required
Decommissioning	• Well abandonment • Decommissioning of subsea infrastructure

1.4 **Project Location**

The Project Area is located in the Otway Basin in offshore Commonwealth waters, approximately 17 km south of the Victorian mainland and 80 km north-west of Tasmania (King Island) (Figure 1-1). The Project location is further defined in Section 3.4.

The Project Area is defined in Section 3.5.

1.5 **OPP Purpose and Scope**

1.5.1 OPP Purpose

This Offshore Project Proposal (OPP) has been prepared by Beach, as the proponent of the Project, in accordance with the requirements of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023 (OPGGS (Environment) Regulations), and associated guidelines.

The purpose of the OPP process is to allow assessment and decision-making at the whole-of project level for offshore projects in Commonwealth waters. This, together with the assessment of activity specific Environment Plans, are part of the broader environmental management authorisations process for offshore petroleum activities. These processes aim to ensure that activities in the offshore area are carried out in a manner consistent with the principles of ecologically sustainable development (ESD), and that the environmental impacts and risks of the activities will be of an acceptable level.

The OPP is an early-stage project assessment which, subject to acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), will form the basis for future activity-specific Environment Plans (EPs). An OPP must be accepted by NOPSEMA before the proponent can submit EPs for activities that make up an offshore project. This pre-requisite does not apply to exploration and appraisal activities such as seismic surveys and exploratory drilling, however Section 15 of the OPGGS (Environment) Regulations allows for the use of the OPP arrangements for exploration and appraisal activities if a proponent choses to do so.

More information can be found on the OPP process on NOPSEMA's website.

1.5.2 Out of Scope Activities not covered by this OPP

The Project Area (defined in Section 3.5) also includes the location of existing Otway Development at Thylacine and Geographe which was approved by the Environment Minister under Part 9 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC No 2002/621).

In March 2010, Origin Energy Resources Ltd (Origin) commenced operatorship of the development (later changing its name to Lattice Energy Limited (Lattice)). In February 2018, Beach acquired Lattice, which included the Otway Development. The EIS covered development activities at the Geographe and Thylacine fields which make up the existing Otway Development. As these development activities have been approved under Part 9 of the EPBC Act they are not required to be covered by this OPP.

The transit of vessels to and from the offshore locations is excluded from this OPP as this is outside the scope of the OPGGS Act and is regulated by maritime legislation, including the *Commonwealth Navigation Act 2012*.

1.5.3 Scope of Activities covered by this OPP

The scope of activities covered by the OPP is defined by the Project summary provided in Section 1.3 and the description of the Project provided in Section 3.

1.6 Document Structure

The structure of this OPP is detailed in Table 1-3. This structure is concordant with the requirements of the OPGGS (Environment) Regulations and NOPSEMA's Offshore Project Proposal Content Requirements Guidance Note (N-04790-GN-1663, 10.8.2020) and Offshore Project Proposal Assessment Policy (N-04790-PL-1650, 11.8.2020) as set out in in Table 1-4.

Table 1-3: Structure of this Document

Section		Content
1	Introduction	Development overview, location, proponent details and outlines the purpose and structure of the OPP.
2	Environmental Legislation and Other Requirements	Legislation, other regulatory requirements, relevant standards and guidelines.
3	Description of the Project and Alternatives Analysis	A description of all activities associated with the project and an analysis of alternatives
4	Description of the Environment	A description of the existing environment highlighting significant physical, ecological and socioeconomic values.

5	Environmental Impact and Risk Assessment Methodology	The methodology for identifying and evaluating environmental impacts and risks.
6	Environmental Impact Evaluation - Planned Activities	Results and justification of environmental impact assessments.
7	Environmental Risk Evaluation – Unplanned Events	Results and justification of environmental risk assessments.
8	Cumulative Impact Assessment	Provides an assessment of cumulative impacts for the Project.
9	Implementation Strategy	Details how environmental performance outcomes stated within this OPP will be implemented.
10	Stakeholder Consultation	A summary of Beach's stakeholder consultation methods which includes the process of stakeholder identification and consultation history and future consultation requirements.
11	References	A summary of documents referred to within this OPP.

Table 1-4: Concordance of this Document with the OPGGS (Environment) Regulations

OPGGS (Environment) Regulations	**Requirements**	**Relevant section of the OPP**
Section 7 – Contents of Offshore Project Proposal		
7(2) (a)	The proponent's name and contact details.	Section 1
7(2) (b)	A summary of the Project, including the following: • a description of each activity that is part of the Project • the location or locations of each activity • a proposed timetable for carrying out the Project • a description of the facilities that are proposed to be used to undertake each activity • a description of the actions proposed to be taken, following completion of the project, in relation to those facilities.	Section 2.2.2
7(2) (c)	A description of the existing environment that may be affected by the project.	Section 4
7(2) (d)	Details of the relevant values and sensitivities (if any) of that environment.	Section 4.2
7(2) (e)	The environmental performance outcomes for the Project.	Section 6 and 7
7(2) (f)	A description of any feasible alternative to the Project, or an activity that is part of the Project, including: • a comparison of the environmental impacts and risks arising from the Project or activity and the alternative. • an explanation, in adequate detail, of why the alternative was not preferred.	Section 2.2.2
7(3)	Requirement to address relevant values and sensitivities (as defined in the EPBC Act).	Section 2
7(4)	The proposal must describe:	Section 2 and 0

	• the requirements, including legislative requirements, that apply to the Project and are relevant to the environmental management of the project, and • how those requirements will be met.	
7(5)	The proposal must include: • details of the environmental impacts and risks of the activities that are part of the Project, and • an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk.	Section 6 and 7

2 Environmental Legislation and Other Requirements

The Project is located in Commonwealth waters and is governed by Commonwealth legislation and regulations for petroleum, environment, health and safety and maritime activities which are set out in the below sections.

2.1 **Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act)**

The *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act) provides a legal framework for the exploration and development of petroleum in Commonwealth waters (beyond the 3 nm), including licensing, health, safety, environment and royalties. Subordinate regulations include:

- Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023 (OPGGS (Environment) Regulations)
- Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009
- Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011

The OPGGS Act establishes the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) as the independent regulator for environmental management, health and safety, and well integrity and for all offshore petroleum (and greenhouse gas storage) activities in Commonwealth waters.

2.2 **Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2023**

The OPGGS (Environment) Regulations provide for the regulation of environmental management of petroleum (and greenhouse gas storage) activities in Commonwealth waters, and aim to ensure that petroleum activities in these areas are:

- Carried out in a manner that is consistent with ecologically sustainable development (ESD) and
- Consistent with the objective that environmental impacts and risks are of an acceptable level.

The OPGGS (Environment) Regulations also set out the requirements for an OPP and Environment Plans (EP) as described in the below sections.

2.2.1 Offshore Project Proposal Requirements

The OPGGS (Environment) Regulations defines an offshore project as one or more activities that are '*undertaken for the purpose of the recovery of petroleum, other than on an appraisal basis, including any conveyance of recovered petroleum by pipeline*'.

The OPGGS (Environment) Regulations (Section 6(1)) requires that "before commencing an offshore project, a person must submit an offshore project proposal for the Project to NOPSEMA". However, section 6(2) states that section 6(1) does not apply if the Environment Minister:

- has made a decision under section 75 of the EPBC Act that an action that is equivalent to or includes the Project is not a controlled action; or
- has made a component decision under section 77A of the EPBC Act that a particular provision of Part 3 of that Act is not a controlling provision for an action that is equivalent to or includes the Project, because the Environment Minister believes the action will be taken in a particular manner; or
- has approved, under Part 9 of the EPBC Act, the taking of an action that is equivalent to or includes the Project.

2.2.2 Environment Plans

The OPGGS (Environment) Regulations require a titleholder to have an accepted EP in place for a petroleum (or greenhouse gas) activity. EPs for activities that form part of the OPP can only be submitted to NOPSEMA once the OPP has been accepted.

The exploration and appraisal activities, specifically the initial and future drilling campaigns, are included in this OPP under section 15 of the OPGGS (Environment) Regulations. In including the exploration and appraisal activities in the OPP, the proponent notes that acceptance of an OPP prior to submission of a related EP does not apply to exploration and appraisal activities. The proponent submitted an Environment Plan for the drilling campaign for assessment by NOPSEMA in February 2024.

Under the OPGGS (Environment) Regulations, an EP must be appropriate for the nature and scale of the activity and describe the activity, the existing environment, details of environmental impacts and risks and the control measures for the activity. In addition, the EP must include an implementation strategy to demonstrate that the impacts and risks can be managed to as low as reasonably practicable (ALARP) and an acceptable level and to describe how appropriate environmental performance outcomes (EPOs), environmental performance standards (EPS) and measurement criteria detailed in the EP will be met. The EP must also provide a summary of all consultation undertaken with relevant persons. The EPs required in support of the Project will address activities related to:

- drilling and completion of development wells for production
- installation, commissioning and operation of wells and subsea infrastructure
- progressive decommissioning activities

2.2.3 Other Petroleum Activity Approvals

In addition to environmental approvals, the OPGGS (Safety) Regulations 2009 require that a Safety Case and the OPGGS (Resource Management and Administration) Regulations 2011 require a Well Operations Management Plan (WOMP), be assessed and accepted by NOPSEMA for petroleum facilities, along with any relevant licences to support pipelines, infrastructure and production. Beach will prepare and submit the required licence and permit applications, Safety Cases and WOMPs to NOPSEMA as the Project is progressed.

2.3 Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act is the Commonwealth Government’s primary environmental legislation administered by the Department of Climate Change, Energy, the Environment and Water (DCCEEW)) (formerly the Department of Agriculture, Water and Environment, DAWE). The EPBC Act provides a legal framework to protect and manage important flora, fauna, ecological communities and heritage places defined in the EPBC Act as Matters of National Environmental Significance (MNES) listed under Part 3 of the EPBC Act. Under the EPBC Act, any action that is likely to have a significant impact on the MNES must not be undertaken without the approval of the Minister. Actions with the potential to impact on the MNES trigger the Commonwealth environmental assessment and approval process.

From 28 February 2014, following streamlining of regulatory processes under the OPGGS Act (Section 2.1) and s146 EPBC Act, certain offshore petroleum activities can be authorised under the OPGGS Act without requiring a separate authorisation process under the EPBC Act.

These changes took effect following the approval by the Minister for the Environment under section 146B of the EPBC Act, for the taking of actions in accordance with an endorsed “Program” The ‘Program’ is described in ”Program Report – Strategic Assessment of the environmental management authorisation process for petroleum and greenhouse gas storage activities administered by the National Offshore Petroleum Safety and Environmental Management Authority under the Offshore Petroleum and Greenhouse Gas Storage Act 2016”. The Program outlined the environmental management authorisation process for offshore petroleum and greenhouse gas activities under the OPGGS Act to be administered by NOPSEMA. The objective of the Program Report was to demonstrate how the Program will ensure activities are conducted in a manner consistent with the principles of ecologically sustainable development and will not result in unacceptable impacts to matters protected under Part 3 of the EPBC Act. Specifically, the report outlined the commitments and undertakings of NOPSEMA to ensure adequate protection of EPBC Act Part 3 protected matters (MNES).

The streamlined approach enabled by the approved ‘Program’ excludes actions which are petroleum and greenhouse gas activities that:

- have, will have or are likely to have a significant impact on the environment on Commonwealth land
- are taken in any area of sea or seabed that is declared to be a part of the Great Barrier Reef Marine park under the Great Barrier Reef Marine Park Act 1975 (Cth)
- have, will have or are likely to have a significant impact on the work heritage values of the Great Barrier Reef National Heritage place

- are taken in the Antarctic
- are injection and/or storage of greenhouse gas

Additionally, actions taken in state or territory waters are also noted to not be covered by the approved class of actions. The scope of this OPP does not include any of the excluded actions.

To support the streamlining, several changes to the OPGGS (Environment) Regulations were made to environmental approvals processes for offshore petroleum activities. In addition to changes to the existing EP assessment processes, the changes included the introduction of the OPP authorisation process for offshore projects to allow for public comment on a project early in the Project lifecycle. The OPP process reflects the level of transparency and opportunity for public comment that is provided for as part of the 'Environmental Impact Statement/Public Environmental Review' assessment process under the EPBC Act.

Unlike the EPBC Act assessment process previously applicable to offshore petroleum activities, the OPP and EP assessment process under the OPGGS Act apply to all offshore petroleum activities regardless of the potential level of impact or risk to the environment that the proposal may present.

2.3.1 Listed Threatened Species Management / Recovery Plans and Conservation Advice

Under Part 13 of the EPBC Act, species can be listed as one, or a combination, of the following protection designations:

- Threatened (further divided into categories; extinct, extinct in the wild, critically endangered, endangered, vulnerable, conservation dependent)
- Migratory
- Whales and other cetaceans
- Marine

Threatened species are managed through management plans, recovery plans and / or conservation advice. These plans provide advice on relevant impacts and threats and set requirements for management and protection.

Species management plans, recovery plans and conservation advice have been considered during the development of this OPP to identify the appropriate management of the Project activities. These have been considered in the assessment of impacts and risks, the assessment of acceptability, and the development of EPOs. Table 2-1 outlines the management plans, recovery plans and conservation advice and associated key threats and conservation actions relevant to the Project. Threatened species of state and local significance relevant to the Project are also considered and are included in appropriate state management or recovery plans.

In addition to species specific management plans, recovery plans and conservation advice, the following plans have also been taken into consideration:

- The Action Plan for Australian Cetaceans (Bannister et al. 1996)

- National Recovery Plan for Ten Species of Seabirds (DEH 2005a)
- King Island Biodiversity Management Plan (DPIPWE 2012)

Table 2-1: Summary of EPBC Management / Recovery Plans and Conservation Advice Relevant to the Project

Relevant Plan/Advice	**Description**	**Applicable Threats and Conservation Actions**
South-east Marine Parks Network Draft Management Plan 2024	Draft management plan developed for the South-east Marine Parks Network. Outlines management of the parks to protect biodiversity and other natural, social and cultural values and allow for ecologically sustainable use.	*Climate change* *Invasive species (including marine pests)* *Marine pollution (emission of noise or light, marine debris and discharge of oil, noxious substances (including chemicals and heavy metals) or sewage waste).* No explicit management actions relevant to climate change, invasive species or marine pollution.
South-east Marine Parks Network Management Plan 2013-2023 (DNP 2013)	Outlines management of the parks to protect biodiversity and other natural, social and cultural values and allow for ecologically sustainable use.	*Noise pollution* *Oil pollution* *Invasive species* *Light pollution* No explicit management actions relevant to noise/ light/ oil pollution or invasive species.
Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (CoA 2018a)	Threat abatement plan for the impacts of marine debris on vertebrate marine life	*Marine debris* Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented.
The National Strategic Plan for Marine Pest Biosecurity (2018-2023) (DAWR 2018)	Australia's national strategic plan for marine pest biosecurity.	*Invasive Marine Species* There are five objectives in the plan: 1. Minimise the risk of marine pest introductions, establishment and spread 2. Strengthen the national marine pest surveillance system 3. Australia's preparedness and response capability for marine pest introductions 4. Support marine pest biosecurity research and development 5. Engage stakeholders to better manage marine pest biosecurity.
National Marine Pest Surveillance Work Plan (DAWE, 2022)	Guideline for implementation of the National Marine Pest Surveillance Strategy (2021-2026). Identifies suggested projects and stakeholders to achieve surveillance strategy activities.	*Invasive Marine Species* Identifies gas and oil industry as key stakeholder for the following activities: 1. Relevant authorities to identify priority surveillance locations for marine pests

		2. Provide advice on use of surveillance techniques such that methods used across and between jurisdictions are quantifiable 3. Review and provide guidance on pest distribution modelling techniques that may be used in surveillance programs 4. Review marine pest surveillance activities and data sets relevant to Australia 5. Identify and engage stakeholder groups (including government) and educate on the importance of marine pest surveillance
Wildlife Conservation Plan for Seabirds (CoA, 2020a)	Outlines national activities to support seabird conservation initiatives and provides a strategic framework to ensure these activities plus future research and management actions are integrated and remain focused on the long-term survival of seabird populations and their habitats.	*Anthropogenic disturbance* Ensure all areas of important habitat for seabirds are considered in the development assessment process. Manage the effects of anthropogenic disturbance to seabird breeding and roosting areas. *Pollution (marine debris, light, water)* Enhance contingency plans to prevent and/or respond to environmental emergencies that have an impact on seabirds and their habitats. *Invasive species* Ensure seabirds are protected from the adverse effects of invasive species. *Climate Change* *Habitat loss and degradation from pollution* No explicit management actions relevant to climate change or habitat loss and degradation form pollution.
Wildlife Conservation Plan for Migratory Shorebirds (CoA, 2015a)	Sets out the research and management actions necessary to support survival of one or more migratory, marine, conservation dependant or cetacean species listed under the Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act).	*Habitat loss* *Habitat modification (chronic and acute pollution, invasive marine species)* *Anthropogenic disturbance (aircraft over-flights, industrial operations and construction, artificial lighting)* Investigate the significance of cumulative impacts on migratory shorebird habitat and populations in Australia. Ensure all areas important to migratory shorebirds in Australia continue to be considered in development assessment processes (specifically for coastal developments). *Climate variability and change* Investigate the impacts of climate change on migratory shorebird habitat and populations in Australia.
National Light Pollution Guideline for Wildlife including Marine Turtles, Seabirds and	Guideline to raise awareness of the potential impacts of artificial light on wildlife and provide a framework for assessment and managing	*Light Emissions* Evaluate risk of artificial light on wildlife and, if required, appropriate mitigation measures are implemented.

Migratory Shorebirds (DCCEEW 2023a)	these impacts around susceptible listed wildlife.	
National Recovery Plan for Albatrosses and Petrels 2022 (CoA 2022)	The recovery plan is a co-ordinated conservation strategy for albatrosses and giant petrels listed as threatened.	*Marine pollution* Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented. *Marine debris* Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented. *Climate change* Appropriate monitoring strategies are implemented to fill information gaps; and Mitigation actions are identified and adopted where feasible and appropriate.
Approved Conservation Advice for *Pterodroma mollis* (soft-plumaged petrel) (TSSC 2015a)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the soft-plumaged petrel.	None identified.
Approved Conservation Advice for *Sternula nereis nereis* (Australian Fairy Tern) (TSSC 2011a)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the fairy tern.	*Marine pollution* Ensure appropriate oil-spill contingency plans are in place for the subspecies' breeding sites which are vulnerable to oil spills, such as the breeding colonies in Victoria
National Recovery Plan for the Australian Fairy Tern (*Sternula nereis nereis*) (CoA 2020)	National recovery plan for actions so species no longer qualifies for listing as threatened under any of the EPBC Act listing criteria.	*Habitat degradation and loss of breeding habitat / Pollution / Climate variability* No explicit relevant management actions
Conservation Advice for *Numenius madagascariensis* (Far Eastern Curlew) (DCCEEW, 2023)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the eastern curlew.	*Habitat loss / Pollution* No explicit relevant management actions
Conservation Advice for *Limosa lapponica baueri* (Bar-tailed Godwit (Western Alaskan)) (DCCEEW 2024e)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the bar-tailed godwit (Western Alaskan).	*Habitat loss, degradation and fragmentation* No explicit relevant management actions
Conservation Advice for *Limosa limosa* (black-tailed godwit) (DCCEEW 2024f)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the black-tailed godwit (Western Alaskan).	*Habitat loss, degradation and fragmentation* Ensure that future development projects avoid any activities that disproportionately affect the upper-tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies and site managers. *Acute Pollution* *Climate Change*

		No explicit relevant management actions for climate change or acute pollution.
Conservation Advice for *Arenaria interpres* (ruddy turnstone) (DCCEEW 2024d)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the ruddy turnstone.	*Habitat loss, degradation and fragmentation* Ensure that future development projects avoid any activities that disproportionately affect the upper-tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies and site managers. *Acute Pollution* *Climate Change* No explicit relevant management actions for climate change or acute pollution.
Approved Conservation Advice for *Calidris acuminata* (sharp-tailed sandpiper) (DCCEEW 2024g)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the sharp-tailed sandpiper.	*Habitat loss, degradation and fragmentation* Ensure that future development projects avoid any activities that disproportionately affect the upper-tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies and site managers. *Acute Pollution* *Climate Change* No explicit relevant management actions for climate change or acute pollution.
Conservation Advice for *Calidris tenuirostris* (great knot) (DCCEEW 2024l)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the great knot.	*Habitat loss, degradation and fragmentation* Ensure that future development projects avoid any activities that disproportionately affect the upper-tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies and site managers. *Acute Pollution* *Climate Change* No explicit relevant management actions for climate change or acute pollution.
Conservation Advice for *Ardenna grisea* (sooty shearwater (DCCEEW 2023d)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the sooty shearwater.	*Climate Change* No explicit management actions relevant to climate change.
Conservation Advice for *Aphelocephala leucopsis* (southern whiteface) (DCCEEW 2023g)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the southern whiteface.	*Climate Change* No explicit management actions relevant to climate change.
Conservation Advice for *Gallinago hardwickii* (Latham's snipe) (DCCEEW 2024j)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Latham's snipe.	*Climate Change* No explicit management actions relevant to climate change.
Conservation Advice for *Neophema chrysostoma* (blue-	Conservation advice provides management actions that can be undertaken to ensure the	*Climate Change* No explicit management actions relevant to climate change.

winged parrot) (DCCEEW 2024h).	conservation of the blue-winged parrot.	
Approved Conservation Advice for *Pluvialis squatarola* (grey plover) (DCCEEW 2024k)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the grey plover.	*Habitat loss, degradation and fragmentation* Ensure that future development projects avoid any activities that disproportionately affect the upper-tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies and site managers. *Acute Pollution* *Climate Change* No explicit relevant management actions for climate change or acute pollution.
Conservation Advice for *Stagonopleura guttata* (diamond firetail) (DCCEEW 2023e)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the diamond firetail.	*Climate Change* No explicit management actions relevant to climate change.
Approved Conservation Advice for *Xenus cinereus* (Terek sandpiper) (DCCEEW 2024i)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Terek sandpiper.	*Habitat loss, degradation and fragmentation* Ensure that future development projects avoid any activities that disproportionately affect the upper-tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies and site managers. *Acute Pollution* *Climate Change* No explicit relevant management actions for climate change or acute pollution.
Approved Conservation Advice for *Pachyptila subantarctica* (Fairy prion (Southern)) (TSSC 2015b)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Fairy Prion (Southern).	None identified.
Approved Conservation Advice for *Rostratula australis* (Australian Painted Snipe) (DSEWPaC 2013a)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Australian Painted Snipe.	None identified.
National Recovery Plan for *Rostratula australis* (Australian Painted Snipe) (CoA 2022a)	National recovery plan for actions so species no longer qualifies for listing as threatened under any of the EPBC Act listing criteria.	*Deterioration of water quality / human disturbance* No explicit relevant management actions
Conservation Advice for *Charadrius leschenaultia* (Greater Sand Plover) (TSSC 2016b)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Greater Sand Plover.	*Habitat degradation/ loss (oil pollution)* No explicit relevant management actions
Conservation Advice *Calidris ferruginea*	Conservation advice provides management actions that can	*Habitat degradation/ loss (oil pollution)*

(Curlew Sandpiper) (DCCEEW 2023f)	be undertaken to ensure the conservation of the Curlew Sandpiper.	No explicit relevant management actions
Approved Conservation Advice for *Calidris canutus* (Red Knot) (DCCEEW 2024m)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Red Knot.	*Habitat degradation/ loss* No explicit relevant management actions; oil pollutions recognised as a threat. *Climate change* No explicit relevant management actions
National Recovery Plan for the Australasian Bittern (*Botaurus poiciloptilus*) (DCCEEW 2023h).	The recovery plan provides management actions that can be undertaken to ensure the conservation of the Australasian Bittern.	*Reduced water quality as a result of increasing salinity, siltation and pollution* *Climate change* No explicit relevant management actions.
Approved Conservation Advice for *Botaurus poiciloptilus* (Australasian Bittern) (TSSC 2019)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Australasian Bittern.	Habitat degradation/ loss (pollution) No explicit relevant management actions. Climate change No explicit relevant management actions
National Recovery Plan for Gould's Petrel (*Pterodroma leucoptera leucoptera*) (DEC NSW 2006)	The recovery plan provides management actions that can be undertaken to ensure the conservation of the Gould's Petrel.	None identified.
National Recovery Plan for the Orange-bellied Parrot (*Neophema chrysogaster*) (DELWP 2016)	The recovery plan is a co-ordinated conservation strategy for the Orange-bellied Parrot.	*Barriers to migration and movement* Illuminated boats and structures: Evaluate risk of lighting on vessels and offshore structures. *Climate change* Minimise the impacts of climate change by reducing greenhouse gas concentrations
Conservation advice *Lathamus discolor* Swift Parrot (TSSC 2015f)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Swift Parrot	None identified.
National Recovery Plan for the Swift Parrot (*Lathamus discolor*) (DCCEEW 2024n)	The recovery plan is a co-ordinated conservation strategy for the Swift parrot.	*Climate change* No explicit relevant management actions
Approved Conservation Advice for the Blue Petrel (*Halobaena caerulea*) (TSSC 2015c)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Blue petrel	*Habitat loss, disturbance and modification* Continue to manage Macquarie Island and its surrounds in such a way that human disturbance is minimised.
National Recovery Plan for the Australian Grayling (*Prototroctes*	The recovery plan is a co-ordinated conservation strategy for the Australian Grayling.	*Climate Change* No specific management actions in relation to climate change. *Poor water quality*

maraena) (Backhouse et al. 2008)		Manage water quality where Australian Grayling occurs to maintain waters free of significant levels of nutrient, sediment, pesticide and other pollutants, consistent with the ANZECC guidelines for water quality.
Conservation Advice *Prototroctes maraena* Australian Grayling (TSSC 2021)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Australian Grayling.	*Climate change* No explicit management actions relevant to habitat modification or climate change.
Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC 2013c)	The recovery plan is a co-ordinated conservation strategy for the White Shark.	*Habitat modification* *Climate change* No explicit management actions relevant to habitat modification or climate change.
Recovery Plan for Marine Turtles in Australia, 2017-2027 (CoA 2017)	The long-term recovery plan objective for marine turtles is to minimise anthropogenic threats to allow for the conservation status of marine turtles	*Climate change and variability* No specific management actions in relation to climate prescribed in the plan relevant to industry. *Marine debris* Support the implementation of the EPBC Act Threat Abatement Plan for the impacts of marine debris on vertebrate marine life *Chemical and terrestrial discharge* Ensure spill risk strategies and response programs adequately include management for marine turtles and their habitats, particularly in reference to 'slow to recover habitats', e.g. nesting habitat, seagrass meadows or coral reefs *Light pollution* Artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these habitats; Identify the cumulative impact on turtles from multiple sources of onshore and offshore light pollution. *Habitat modification* No explicit relevant management actions *Vessel disturbance* No explicit relevant management actions *Noise interference* No explicit relevant management actions
Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA 2008)	See above for Recovery Plan for Marine Turtles in Australia, 2017-2027.	
Conservation Management Plan for	The long-term recovery plan objective for blue whales is to minimise anthropogenic	*Noise interference* Assess and address anthropogenic noise.

the Blue Whale, 2015-2025 (CoA 2015b)	threats to allow for their conservation status to improve	Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area. *Vessel disturbance* Ensure all vessel strike incidents are reported in the National Ship Strike Database. Ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur and, if required, appropriate mitigation measures are implemented. *Habitat degradation* (Includes Acute and chronic chemical discharge (Marine pollution)). Maintain and improve existing legal and management protection. *Climate variability and change* Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica.
Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC 2015e)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the sei whale.	*Noise interference* Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. *Vessel disturbance* Minimise vessel collision. Ensure all vessel strike incidents are reported in the National Vessel Strike Database. *Climate variability and change* Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica. *Pollution (persistent toxic pollutants)* No explicit relevant management actions; pollution identified as a threat.
Listing Advice *Megaptera novaeangliae* (Humpback Whale) (TSSC 2022)	Listing advice provides threats in the context of the Humpback Whale which has been recovering strongly for at least five decades following intense exploitation during the period of commercial whaling.	*Noise interference* Assess and address anthropogenic noise. *Vessel disturbance and strike* Ensure the risk of vessel strike on humpback whales is considered when assessing actions that increase vessel traffic in areas where humpback whales occur and, if required appropriate mitigation measures are implemented to reduce the risk of vessel strike. Maximise the likelihood that all vessel strike incidents are reported in the National Ship Strike Database. *Climate and oceanographic variability and change*

		Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica.
National Recovery Plan for the Southern Right Whale *Eubalaena australis* (DCCEEW 2024o)	The recovery plan is a co-ordinated conservation strategy for the Southern Right Whale.	*Anthropogenic underwater noise* Assess, manage and mitigate impacts from anthropogenic noise *Vessel collision* Manage, minimise and mitigate the threat of vessel strike *Habitat degradation from coastal and offshore development* Address habitat degradation impacts from coastal and offshore marine infrastructure developments
Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale) (TSSC 2015d)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the fin whale.	*Noise interference* Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. *Vessel disturbance* Minimise vessel collision. Ensure all vessel strike incidents are reported in the National Vessel Strike Database. *Climate variability and change* Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica. *Pollution (persistent toxic pollutants)* No explicit relevant management actions; pollution identified as a threat.
Conservation Advice *Neophoca cinerea* Australian sea lion (TSSC 2020x)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the Australian Sea Lion	*Habitat degradation and pollution – Oil spills* Require all vessels to have oil spill mitigation measures in place, and implement jurisdictional oil spill response strategies as required *Human disturbance – Noise* Monitor and mitigate impacts (including cumulative impacts) of human interactions on Australian Sea Lion colonies
Recovery Plan for the Australian sea lion (*Neophoca cinerea*) (DSEWPaC 2013d)	The plan considers the conservation requirements of the species across its range and identifies the actions to be taken to ensure its long-term viability in nature and the parties that will undertake those actions.	*Habitat degradation* No explicit relevant management actions *Vessel strike* Collect data on direct killings and confirmed vessel strikes *Pollution (oil spills, toxins)* implement jurisdictional oil spill response strategies as required *Climate change* No explicit relevant management actions

2.3.2 Biologically Important Areas

Biologically important areas (BIAs) are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration. They are designed to assist decision-making under the EPBC Act.

BIAs have been identified using expert scientific knowledge about species' distribution, abundance and behaviour in the region. The presence of the observed behaviour is assumed to indicate that the habitat required for the behaviour is also present. The selection of species for which BIAs have been identified was informed by the availability of scientific information, the conservation status of listed species and the importance of the region for the species.

The level of certainty attached to a BIA has two dimensions:

- the certainty of the species' occurrence
- the certainty of the behaviour occurring

BIAs that overlap the Project Area are detailed in Section 4.4.9.2.

2.3.3 Australian Marine Parks Management Principles

Under the EPBC Act, Australian Marine Parks (AMPs) are recognised for the purpose of conserving marine habitats and species that live and rely on these habitats. AMPs which are relevant to the Project are detailed in Section 4.2.2. These AMPs are currently managed as per the South-East Commonwealth Marine Reserves Network Management Plan 2013 – 2023 (DNP 2013) and Transitional management arrangements (DNP 2023). The South-east Marine Parks Network Draft Management Plan (DNP 2024) under development and while not currently in force (as of February 2025), has been considered within the assessment.

2.3.4 Other Protected Area Management Plans

The following protected area management plans have been considered during the preparation of this OPP to identify the appropriate management of the activities; in particular these have been considered in the assessment of impacts and risks, the assessment of acceptability, and the development of EPOs:

- South-east Commonwealth Marine Reserves Network Management Plan 2013-2023 (DNP 2013)
- Management Plan for Twelve Apostles Marine National Park and The Arches Marine Sanctuary (Parks Victoria 2006d)
- Management Plan for Point Addis Marine National Park, Point Danger Marine Sanctuary and Eagle Rock Marine Sanctuary (Parks Victoria 2005b)
- Barwon Bluff Marine Sanctuary Management Plan (Parks Victoria 2007b)
- Bunurong Marine National Park Management Plan (Parks Victoria 2006b)
- Cape Liptrap Coastal Park Management Plan (Parks Victoria 2003)
- Great Otway National Park and Otway Forest Park Management Plan (Parks Victoria and DSE 2009)

- Lavinia Ramsar Site Ecological Character Description. Lloyd Environmental (DSEWPaC 2012c)
- Marengo Reefs Marine Sanctuary Management Plan (Parks Victoria 2007a)
- Mornington Peninsula National Park and Arthurs Seat State Park Management Plan (Parks Victoria 2013)
- Mushroom Reef Marine Sanctuary Management Plan (Parks Victoria 2007d)
- Ngootyoong Gunditj Ngootyoong Mara South West Management Plan (Parks Victoria 2015)
- Port Phillip Heads Marine National Park Management Plan (Parks Victoria 2006c)
- Port Campbell National Park and Bay of Islands Coastal Park (Parks Victoria 1998)
- Western Port Ramsar Site Management Plan (DELWP 2017a)
- Western Port Ramsar Wetland Ecological Character Description. (Kellogg et al. 2010 for DSEWPaC)
- Wilsons Promontory Marine National Park and Wilsons Promontory Marine Park Management Plan May 2006 (Parks Victoria 2006a)

2.4 **Commonwealth Legislation**

The Commonwealth Government legislation and international conventions that are relevant to the Project are summarised in Table 2-2.

Of particular relevance to this proposal, specific consideration is given to the:

- Matters of National Environmental Significance - Significant Impact Guidelines 1.1 published by the DoEE (DoE 2013a). These have been used to inform the definition of acceptability of impacts, and are described in further detail in Section 5, and carried into the subsequent evaluation of impacts and risks in Section 6 and 7.

- EPBC Act Policy Statement 'Indirect consequences' of an action: Section 527E of the EPBC Act (Department of Sustainability, Environment, Water, Population and Communities ((DSEWPaC) 2013a). This has been consideration in the specific context of indirect consequences of a proposal with regard to GHG emissions.

2.5 **State Legislation**

Although offshore petroleum activities within the scope of this OPP are located entirely in Commonwealth waters, Victorian and Tasmanian legislation relevant to offshore petroleum activities are described in Table 2-3 and Table 2-4 on the basis that modelling indicates a worst-case credible oil spill Section has the potential to intersect Victorian or Tasmanian waters. Although the worst-case credible oil spill does not extend into South Australian state waters there is still potential for South Australian fisheries to be impact (see Section 4.5.13 and Table 2-5).

2.6 **International Agreements**

Relevant international agreements and conventions that Australia is signatory to are summarised in Table 2-7. These are typically implemented by Commonwealth legislation.

Table 2-2: Relevant Commonwealth Legislation

Legislation/Regulation	Scope	Related International Conventions	Administering Authority
Air Navigation Act 1920 Air Navigation Regulations 1947 Air Navigation (Aircraft Engine Emissions) Regulations 1995 Air Navigation (Aircraft Noise) Regulations 1984	This Act and associated regulations relate to the management of air navigation. **Relevance to Project**: Applies to helicopter activities undertaken during all stages. The requirements under this Act are related to safety, and therefore not relevant to the environmental management of the Project.	Chicago Convention 1947	Department of Infrastructure, Transport, Regional Development, Communications and the Arts
Australian Maritime Safety Authority Act 1990	This Act facilitates international cooperation and mutual assistance in preparing and responding to a major oil spill incident and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. Requirements are affected through Australian Maritime Safety Authority (AMSA) who administers the National Plan for Maritime Environmental Emergencies (NatPlan). **Relevance to Project** AMSA is the designated Control Agency for oil spills from vessels in Commonwealth waters. These arrangements will be detailed in the OPEP associated with the relevant EPs for petroleum activities.	International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000 International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 1969 Articles 198 and 221 of the United Nations Convention on the Law of the Sea 1982	AMSA
Biosecurity Act 2015 Biosecurity Regulations 2016	This Act and associated regulations replaced the Quarantine Act 1908 in 2015 and is the primary legislation for the management of the risk of diseases and pests that may cause harm to human, animal or plant health, the environment and the economy. The objects of this Act are to provide for: (a) managing biosecurity risks; human disease; risks related to ballast water; biosecurity emergencies and human biosecurity emergencies	International Convention for the Control and Management of Ships' Ballast Water and Sediments (adopted in principle in 2004 and in force on 8 September 2017)	Department of Agriculture, Fisheries and Forestry (DAFF)

	(b) to give effect to Australia's international rights and obligations, including under the International Health Regulations, the Sanitary and Phytosanitary Agreement and the Biodiversity Convention **Relevance to Project**: The Biosecurity Act and regulations apply to 'Australian territory' which is the airspace over and the coastal seas out to 12 nm from the coastline. The Act regulates vessels entering Australian territory regarding ballast water and hull fouling. Biosecurity risks associated with the activity are detailed in Section 7.1.		
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	This Act applies to actions that have, will have or are likely to have a significant impact on matters of national environmental or cultural significance. The Act protects matters of national environmental significance (MNES) and provides for a Commonwealth environmental assessment and approval process for actions. There are eight MNES, these being: • World heritage properties • Ramsar wetlands • Listed threatened species and communities • Listed migratory species • Protection of the environment from nuclear actions • Marine environment (Commonwealth) • Great Barrier Reef Marine Park • Protection of water resources from coal seam gas developments and large coal mining developments **Relevance to Project**: Petroleum activities are excluded from within the boundaries of a World Heritage Area (Sub regulation 10A(f)). The Project is not within a World Heritage Area. The OPP must describe matters protected under Part 3 of the EPBC Act and assess any impacts and risks to these.	1992 Convention on Biological Diversity and 1992 Agenda 21 Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 Agreement between the Government and Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment 1974 Agreement between the Government and Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 Agreement between the Government of Australia and the Government of the Republic of Korea on The Protection of Migratory Birds 2006 Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971 (Ramsar)	DCCEEW

	The OPP must assess any actual or potential impacts or risks to MNES from the activity. Section 6 provides an assessment of the impacts and risks from the activity to matters protected under Part 3 of the EPBC Act.	International Convention for the Regulation of Whaling 1946 Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979	
Environment Protection (Sea Dumping) Act 1981 Environment Protection (Sea Dumping) Regulations 1983	This Act and associated regulations provide for the protection of the environment by regulating dumping matter into the sea, incineration of waste at sea and placement of artificial reefs. **Relevance to Project**: The Project plans decommissioning to include complete removal of plant and property as a base case, however, in the event equipment cannot be removed or retrieved and remains on the seabed, activities will be undertaken in accordance with the Act.	London Protocol	DCCEEW
Fisheries Management Act 1991	This Act and associated regulations protect Australia's fishery resources and establish responsibilities in ecologically sustainable development. **Relevance to Project**: The Project overlaps several Commonwealth-managed fisheries, described in Section 4.5.10. Impacts and risks to Commonwealth-managed fisheries are assessed in Section 6.1	United Nations Convention on the Law of the Sea (UNCLOS) (1982) Unite Nations Fish Stocks Agreements (UNFSA) (1995) Code of Conduct for Responsible Fisheries (1995)	AFMA DAFF
National Environment Protection Measures (Implementation) Act 1998 National Environment Protection Measures (Implementation) Regulations 1999	This Act and associated regulations provide for the implementation of National Environment Protection Measures (NEPMs) to protect, restore and enhance the quality of the environment in Australia and ensure that the community has access to relevant and meaningful information about pollution. The National Environment Protection Council has made NEPMs relating to ambient air quality, the movement of controlled waste between states and territories, the national pollutant inventory, and used packaging materials. **Relevance to Project**: Activities associated with the Project will meet any relevant requirements of the Act including energy and greenhouse gas reporting.	-	DCCEEW

National Greenhouse and Energy Reporting Act 2007 (NGER Act)	The Act provides for the reporting and dissemination of information related to greenhouse gas emissions (GHG), greenhouse gas projects, energy production and energy consumption, and for other purposes. **Relevance to Project**: GHG emissions and energy use from offshore facilities, vessels and mobile offshore drilling unit (MODU) will be reported in accordance with the requirements of the NGER Act. Applicable requirements are specified as controls to relevant impacts and risks.	-	Clean Energy Regulator
Navigation Act 2012	This Act regulates ship-related activities and invokes certain requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) relating to equipment and construction of ships. Several Marine Orders (MO) are enacted under this Act relating to offshore petroleum activities, including: • MO 27: Safety of navigation and radio equipment • MO 30: Prevention of collisions • MO 31: Safety of Life at Sea (SOLAS) and non-SOLAS certification **Relevance to Project**: Vessels (according to class) will adhere to the relevant Marine Orders with regard to navigation and preventing collisions in Commonwealth waters.	Certain sections of MARPOL International Convention for the SOLAS 1974 COLREG 1972	AMSA
Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act)	The OPGGS Act sets out the requirements for maintenance and removal of all property. Under subsection 572(2) of the OPGGS Act, a titleholder must must maintain in good condition and repair all structure, property and equipment within a title area. Under subsection 572(3) of the OPGGS Act, a titleholder must remove from the title area all structures that are, and all equipment and other property that is neither used nor to be used in connection with the operations. Under subsection 270 of the OPGGS Act, before title surrender, all property brought into the surrender area must be removed to the satisfaction of NOPSEMA, or arrangements that are		NOPSEMA / NOPTA

	satisfactory to NOPSEMA must be made relating to the property. **Relevance to Project**: Proponent must comply with maintenance and decommissioning of all property in accordance with the OPPGS Act		
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995	This Act and associated regulations provide for measures to protect ozone in the atmosphere by controlling and ultimately reducing the manufacture, import and export of ozone depleting substances (ODS) and synthetic greenhouse gases, and replacing them with suitable alternatives. **Relevance to Project**: The Act will only apply to Beach if it manufactures, imports or exports ODS. Activities undertaken as a part of this project will adhere to the requirements of this Act including restrictions on import and use of ODS (in refrigeration and air conditioning equipment) through control measures in procurement. Applicable requirements are specified as controls to relevant impacts and risks.	Vienna Convention for the Protection of the Ozone Layer, the Montreal Protocol on Substances that Deplete the Ozone Layer, and the United Nations Framework Convention on Climate Change and its Kyoto Protocol	DCCEEW
Protection of the Sea (Harmful Antifouling Systems) Act 2006	Under this Act, it is an offence for a person to engage in negligent conduct that results in a harmful anti-fouling compound being applied to or present on a ship. The Act also provides that Australian ships must hold 'anti-fouling certificates', provided they meet certain criteria. **Relevance to Project**: Vessels will comply with anti-fouling system requirements in accordance with this Act. MO 98: Marine Pollution Prevention – Anti-fouling Systems is enacted under this Act.	International Convention on the Control of Harmful Anti-fouling Systems on Ships 2001	AMSA
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994	This Act and associated regulations regulate Australian regulated vessels with respect to ship-related operational activities and invokes certain requirements of the MARPOL Convention relating to discharge of noxious liquid substances, sewage, garbage, air pollution etc. **Relevance to Project**: Vessels are required to abide to the requirements under this Act.	Various parts of MARPOL	AMSA

	Several MOs are enacted under this Act relating to the Project activities, including: • MO 91: Marine Pollution Prevention – Oil • MO 93: Marine Pollution Prevention – Noxious Liquid Substances • MO 94: Marine Pollution Prevention – Packaged Harmful Substances • MO 95: Marine Pollution Prevention – Garbage • MO 96: Marine Pollution Prevention – Sewage • MO 97: Marine Pollution Prevention – Air Pollution		
Underwater Cultural Heritage Act 2018	This Act protects the heritage values of shipwrecks, sunken aircraft and relics (older than 75 years) including submerged Aboriginal archaeological sites [**PC321**] in Australian Territorial waters from the low water mark to the outer edge of the continental shelf (excluding the State's internal waterways). The Act allows for protection through the designation of protection zones. Activities / conduct prohibited within each zone will be specified. **Relevance to Project**: In the event of removal, damage or interference to shipwrecks, sunken aircraft or relics declared to be historic under the legislation, activity is proposed with declared protection zones, or there is the discovery of shipwrecks or relics. Section 4.2.5 identifies no known shipwrecks or sunken aircrafts in the Project Area.	Agreement between the Netherlands and Australia concerning old Dutch Shipwrecks 1972	DCCEEW

Table 2-3: Relevant Victorian Legislation

Legislation/Regulation	**Scope**	**Application to Activity**	**Administering Authority**
Environment Protection Act 2017 (& Environmental Protection Regulations 2021)	This is the key Victorian legislation which controls discharges and emissions (air, water) to the environment within Victoria (including state and territorial waters). It gives the Environment Protection Authority (EPA) powers to licence	Oil pollution management in Victorian State waters	Environment Protection Authority (EPA)

	premises discharges to the marine environment, control marine discharges and to undertake prosecutions. Provides for the maintenance and, where necessary, restoration of appropriate environmental quality.		
	The State Environment Protection Policy (Waters of Victoria) designates: • Spill response responsibilities by Victorian Authorities to be undertaken in the event of spills (DJPR) with EPA enforcement consistent with the *Environment Protection Act 2017* and the *Pollution of Waters by Oil & Noxious Substances Act 1986*. • Requires vessels not to discharge to surface waters sewage, oil, garbage, sediment, litter or other wastes which pose an environmental risk to surface water beneficial uses. To protect Victorian State waters from marine pests introduced via domestic ballast water, ballast water management arrangements applying to all ships in State and territorial waters must be observed as per the Environment Protection (Ships' Ballast Water) Regulations 2006, Waste Management Policy (Ships' Ballast Water) and the Protocol for Environmental Management. High risk domestic ballast water (ballast water which leachates from an Australian port or within the territorial sea of Australia (to 12 nm)), regardless of the source, must not be discharged into Victorian State waters. Ship masters must undertake a ballast water risk assessment on a voyage by voyage basis to assess risk level, provide accurate and comprehensive information to the EPA on the status and risk of ballast water contained on their ships (i.e. domestic/international), and to manage domestic ballast water discharges with EPA written approval.	Discharge of domestic ballast water from emergency response vessels into Victorian State waters must comply with these requirements.	
Emergency Management Act 2013	Provides for the establishment of governance arrangements for emergency management in Victoria, including the Office of the Emergency Management Commissioner and an Inspector-General for Emergency Management.	Emergency response structure for managing emergency incidents within Victorian State waters. Emergency management structure will be	Department of Justice and Community Safety (Inspector General for Emergency Management)

	Provides for integrated and comprehensive prevention, response and recovery planning, involving preparedness, operational co-ordination and community participation, in relation to all hazards. These arrangements are outlined in the Emergency Management Manual Victoria.	triggered in the event of a spill impacting or potentially impacting State waters.	
Fisheries Act 1995 (& Regulations 2019)	The purpose of this Act is to provide legislative framework for the regulation, management and conservation of Victorian fisheries including aquatic habitats.	The Project overlaps Victorian commercial fisheries and may overlap areas where recreational fishing occurs, as described in Section 4.5.11. Impacts and risks to fishing are assessed in Section 6.1.	Victorian Fisheries Authority (VFA)
Flora and Fauna Guarantee Act 1988 (FFG Act) (& Regulations 2020)	The purpose of this Act is to protect rare and threatened species; and enable and promote the conservation of Victoria's native flora and fauna and to provide for a choice of procedures that can be used for the conservation, management or control of flora and fauna and the management of potentially threatening processes. Where a species has been listed as threatened an Action statement is prepared setting out the actions that have or need to be taken to conserve and manage the species and community.	Action Statement controls for threatened species present in the zone of potential impact as adopted (as relevant) within this OPP. Triggered if an incident results in the injury or death of an FFG Act listed species (e.g. collision with a whale).	Victoria Department of Energy, Environment and Climate Action (DEECA)
Heritage Act 2017	The purpose of the Act is to provide for the protection and conservation of historic places, objects, shipwrecks and archaeological sites in state areas and waters (complementary legislation to Commonwealth legislation). Part 4 Underwater cultural heritage of the Act is focused on historic shipwrecks, which are defined as the remains of all ships that have been situated in Victorian State waters for 75 years or more. The Act addresses, among other things, the registration of wrecks, establishment of protected zones, and the prohibition of certain activities in relation to historic shipwrecks.	May be triggered in the event of impacts to a known or previously un-located shipwreck in Victorian State waters whilst undertaking emergency response activities.	Heritage Victoria Department of Transport and Planning

Marine Safety Act 2010 (& Regulations 2023)	Act provides for safe marine operations in Victoria, including imposing safety duties on owners, managers and designers of vessels, marine infrastructure and marine safety equipment; marine safety workers, masters and passengers on vessels; regulation and management of vessel use and navigation in Victorian State waters; and enforcement provisions of Police Officers and the Victorian Director of Transport Safety. This Act reflects the requirements of international conventions - Convention on the International Regulations for Preventing Collisions at Sea & International Convention for the Safety of Life at Sea. The Act also defines marine incidents and the reporting of such incidents to the Victorian Director of Transport Safety.	Applies to vessel masters, owners, crew operating vessels in Victorian State waters.	Maritime Safety Victoria
National Parks Act 1975	Established a number of different types of reserve areas onshore and offshore, including Marine National Parks and Marine Sanctuaries. A lease, licence or permit under the OPGGS Act 2010 that is either wholly or partly over land in a marine national park or marine sanctuary is subject to the *National Parks Act 1975* and activities within these areas require Ministerial consent before activities are carried out.	Applies where there are activities within marine reserve areas.	DEECA
Pollution of Waters by Oil and Noxious Substances Act 1986 (POWBONS) (& Regulations 2022)	The purpose of the Pollution of Waters by Oils and Noxious Substances Act 1986 (POWBONS) is to protect the sea and other waters from pollution by oil and noxious substances. This Act also implements the MARPOL Convention (the International Convention for the Prevention of Pollution from Ships 1973) in Victorian State waters. Requires mandatory Reporting of marine pollution incidents. Act restricts within Victorian State waters the discharge of treated oily bilge water according to vessel classification (>400 tonnes); discharge of cargo substances or mixtures; prohibition of garbage disposal and packaged harmful substances; restrictions on the discharge of sewage; regulator reporting requirements for incidents; ship construction certificates and survey requirements. Restriction on discharges within Victorian State waters incorporated into EP.	Triggered in the event of a spill impacting or potentially impacting State waters.	Jointly administered by DECCA and EPA

Wildlife Act 1975 (& Regulations 2024)	The purpose of this Act is to promote the protection and conservation of wildlife. Prevents wildlife from becoming extinct and prohibits and regulates persons authorised to engage in activities relating to wildlife (including incidents). The Wildlife (Marine Mammal) Regulations 2019 prescribe minimum distances to whales and seals/seal colonies, restrictions on feeding/touching and restriction of noise within a caution zone of a marine mammal (dolphins (150m), whales (300m) and seals (50m).	Applies where vessels are within State waters responding to a spill event. Prescribed minimum proximity distances to whales, dolphins and seals will be maintained. Triggered if an incident results in the injury or death of whales, dolphins or seals.	DECCA
Aboriginal Heritage Act 2006 [**PC320**]	The primary purpose of the Act is to provide for the protection of Aboriginal cultural heritage in Victoria.	Applies to underwater cultural heritage in Victorian State waters	First Peoples – State Relations (Department of Premier and Cabinet)

Table 2-4: Relevant Tasmanian Legislation

Legislation/Regulation	Scope	Application to Activity	Administering Authority
Environmental Management and Pollution Control Act 1994 (EMPCA) (& Regulations)	EMPCA is the primary environment protection and pollution control legislation in Tasmania. It is a performance-based style of legislation, with the fundamental basis being the prevention, reduction and remediation of environmental harm. The clear focus of the Act is on preventing environmental harm from pollution and waste. Relevant regulations under the EMPCA include: • Environmental Management and Pollution Control (General) Regulations 2017 • Environmental Management and Pollution Control (Waste Management) Regulations 2010 The EPA Division Compliance Policy provides the Director of the Environment Protection Authority (EPA) powers of compliance.	Defines the EPA's jurisdiction during a spill event. Prescribes the fee structure to waste events and environmental protection notices. Regulates the management and control of controlled wastes.	EPA Tasmania - Department of Natural Resources and Environment (NRE)
Living Marine Resources Management Act 1995 (& Regulations)	The Act promotes the sustainable management of living marine resources to provide for management plans relating to fish resources and protect marine habitats.	The Project overlaps Tasmanian commercial fisheries and may overlap areas where recreational fishing occurs, as described in Section 4.5.12. Impacts and risks to fishing are assessed in Section 6.1.	NRE (Tasmania) Wild Fisheries Management Branch – Fishing Tasmania
Marine-related Incidents (MARPOL Implementation) Act 2020	Pollution of the sea in Tasmanian State waters may be regulated by general pollution laws such as the EMPCA (see above), but the deals specifically with discharges of oil and other pollutants from ships. It gives effect in Tasmania to the MARPOL international convention on marine pollution	Gives effect to MARPOL in Tasmanian waters.	NRE (Tasmania)
Threatened Species Protection Act 1995	Provide for the protection and management of threatened native flora and fauna and to enable and promote the conservation of native flora and fauna.	Identification of species that are also protected under Tasmanian legislation.	NRE (Tasmania)
Aboriginal Heritage Act 1975 (Tas) [**PC168, PC169**]	The Act defines Aboriginal heritage and how that heritage must be managed and protected	Applies to underwater cultural heritage in Tasmanian State waters	Department of Premier and Cabinet

Table 2-5: Relevant South Australian Legislation

Legislation/Regulation	Scope	Application to Activity	Administering Authority
Fisheries Management Act 2007 *(& Regulations)*	The Act provides for the conservation and management of the aquatic resources of the State, the management of fisheries and aquatic reserves, the regulation of fishing and the processing of aquatic resources and the control of exotic aquatic organisms and disease in aquatic resources, and for other purposes.	The Project overlaps South Australian commercial fisheries areas, as described in Section 4.5.13. Impacts and risks to fishing are assessed in Section 6.1.	Department of Primary Industries and Regions (South Australia)

Table 2-6: Relevant New South Wales Legislation

Legislation/Regulation	Scope	Application to Activity	Administering Authority
Aboriginal Land Rights Act 1983	An Act to make provisions with respect to the land rights of Aboriginal persons, including provisions for or with respect to the constitution of Aboriginal Land Councils, the vesting of land in those Councils, the acquisition of land by or for those Councils and the allocations of funds to and by those Councils; to amend certain other Acts; and to make provisions for certain other purposes.	There is the potential for aboriginal heritage and Registered Aboriginal Land Councils within the Planning Areas.	
Heritage Act 1977	Act provides for the identification, registration and interim protection of items of State heritage significance (including shipwrecks within state waters) in NSW.	Applies where an oil spill or oil spill response activities may pose a risk to items of State heritage significance.	Heritage Council of NSW
Marine Estate Management Act 2014	To provide for the management of the marine estate of New South Wales consistent with the principles of ecologically sustainable development	Applies where an oil spill or oil spill response activities may pose a risk to NSW marine parks.	NSW Department of Primary Industries
Marine Pollution Act 2012	This Act is the NSW state legislation giving effect to the requirements of MARPOL 73/78 within state waters. The Act provides the power to respond to oil and chemicals listed within MARPOL.	Applies to oil spill response in NSW waters. Provides the portfolio Minister with powers of intervention in regard to the detention or direction of commercial and trading vessels and for preventing, combating, and cleaning up of oil and chemical spills in State waters.	Transport for NSW
National Parks and Wildlife Act 1974	This Act provides for the care, control and management of all national parks, historic sites, nature reserves, conservation reserves, Aboriginal areas and game reserves, and the protection and care of native flora and fauna, and Aboriginal places and objects.	Applies where oil spill poses a risk to NSW National parks, historic sites, nature reserves, conservation reserves, Aboriginal areas and game reserves, and the protection and care of native flora and fauna protected under the Act.	NSW National Parks and Wildlife Service (NPWS)
Protection of the Environment Operations Act 1997	The object of the Act is to achieve the protection, restoration, and enhancement of the quality of the NSW environment.	Applies where oil spill poses a risk to NSW waters or lands.	NSW Environmental Protection Authority

Table 2-7: Relevant International Agreements and Conventions

Agreement / Convention	Summary	Relevance to the Project
Convention on the Conservation of Migratory Species of Wild Animals 1979 (the Bonn Convention)	This convention aims to conserve migratory fauna species throughout their ranges, particularly where their range crosses international jurisdictional boundaries. It is implemented in Commonwealth law by the EPBC Act, which makes provision for species listed under the Bonn Convention to be listed as migratory under the EPBC Act. Species listed as migratory under the EPBC Act are MNES.	Several species listed as migratory under the EPBC Act were identified as potentially being impacted by the petroleum activities considered in this OPP. Refer to Section 4.4.9.
The Agreement on the Conservation of Albatrosses and Petrels (ACAP)	ACAP through its 13 Parties strives to conserve albatrosses and petrels by coordinating international activities to mitigate threats to their populations.	Several albatross and petrel species were identified as potentially being impacted by the petroleum activities considered in this OPP. Section Refer to Section 4.4.9.
Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974 (JAMBA)	This agreement aims to conserve migratory bird species that travel between Japan and Australia. This includes many species of shorebirds that use the East Asian - Australasian Flyway. It is implemented in Commonwealth law by the EPBC Act, which makes provision for species listed under JAMBA to be listed as migratory under the EPBC Act. Species listed as migratory under the EPBC Act are MNES.	Several birds listed as migratory under the EPBC Act were identified as potentially being impacted by the petroleum activities considered in this OPP. Section Refer to Section 4.4.9.
Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 (CAMBA)	This agreement aims to conserve migratory bird species that travel between China and Australia. This includes many species of shorebirds that use the East Asian - Australasian Flyway. It is implemented in Commonwealth law by the EPBC Act, which makes provision for species listed under CAMBA to be listed as migratory under the EPBC Act. Species listed as migratory under the EPBC Act are MNES.	Several birds listed as migratory under the EPBC Act were identified as potentially being impacted by the petroleum activities considered in this OPP. Refer to Section 4.4.9.
Agreement between the Government of Australia and the Government of the Republic of Korea for the Protection of Migratory Birds and their Environment 2007 (ROKAMBA)	This agreement aims to conserve migratory bird species that travel between the Republic of Korea and Australia. This includes many species of shorebirds that use the East Asian - Australasian Flyway. It is implemented in Commonwealth law by the EPBC Act, which makes provision for species listed under ROKAMBA to be listed as migratory under the EPBC Act. Species listed as migratory under the EPBC Act are MNES.	Several birds listed as migratory under the EPBC Act were identified as potentially being impacted by the petroleum activities considered in this OPP. Refer to Section Refer to Section 4.4.9.
International Convention on Wetlands of International Importance 1975 (Ramsar)	This convention aims to conserve and promote the sustainable human use of wetlands. Many wetlands have been identified as important habitat for migratory bird species, and Ramsar wetlands are of importance in	The Lavinia Ramsar wetland was identified as potentially being impacted in the event of an unplanned release of large volumes of

	conserving many species of migratory shorebirds and waders. Ramsar wetlands are protected under the EPBC Act and are MNES.	hydrocarbons (e.g. loss of well control). Refer to Section 7.4.4.
London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention)	This convention is an agreement to control pollution of the sea by intentional disposal at sea of potentially harmful materials. It is implemented under Commonwealth law by the *Environment Protection (Sea Dumping) Act 1981*.	Chemical inventories onboard vessels and MODUs may potentially breach this convention if unpermitted via this OPP and deliberately discharged to the sea.
Minamata Convention on Mercury 2017	This convention is an agreement to protect human and environmental health from the effects of releases of mercury and mercury-containing compounds to the environment. The convention is not yet ratified by Australia, and hence is not currently implemented in Commonwealth law. Australia has signed the convention and is currently undertaking an assessment process prior to ratification.	Drilling activities may result in mercury compounds being produced from wells as a by-product. Mercury may pose a risk to the environment if not managed appropriately.
International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (commonly known as MARPOL 73/78)	This convention is an agreement to minimise the pollution of the marine environment by ships. The convention provides a standardised approach to the environmental management of international and domestic shipping. The convention is implemented in Commonwealth law by the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and a series of Marine Orders made under this Act.	All marine support vessels are required to comply with MARPOL.
International Convention on Standards of Training, Certification and Watch keeping for Seafarers 1978 (STCW)	This convention provides a standardised approach to the qualifications and competencies of masters, officers and watch personnel. It is implemented in Commonwealth law by the *Navigation Act 2012* and a series of Marine Orders made under this Act.	All project vessels and crew are required to comply with STCW.
International Convention for the Safety of Life at Sea 1974 (SOLAS)	This convention provides internationally agreed minimum standards for the construction, equipment and operation of vessels. It is implemented in Commonwealth law by the *Navigation Act 2012* and a series of Marine Orders made under this Act.	All project vessels are required to comply with SOLAS.
International Regulations for Preventing Collisions at Sea 1972 (COLREGS)	These regulations provide internationally agreed rules for the navigation of vessels, which are intended to reduce the likelihood of vessel collisions. COLREGS are implemented in Commonwealth law by the *Navigation Act 2012* and a series of Marine Orders made under this Act.	All project vessels are required to comply with COLREGS.
Paris Agreement on Climate Change (2015)	The Paris Agreement is an instrument made under the UNFCCC, with the central aim of strengthening the global response to the threat of climate change by keeping the global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit	The Paris Agreement provides the international framework and context around Australia's NDC, which is important to

	the temperature increase even further to 1.5 degrees Celsius in order to prevent dangerous human caused interference with the climate system. It deals with GHG emissions mitigation, adaptation, and finance. The agreement's language was negotiated by representatives of 196 state parties, including Australia, and adopted by consensus on 12 December 2015, before entering in to force in late 2016. Australia has since ratified the Paris Agreement. The Paris Agreement requires each party to: volunteer its own Nationally Determined Contributions (NDCs), to report against them annually, and improve them if it is determined that the collective commitment to NDCs is considered ineffective or insufficient to keep global temperature increases to less than 2ºC below pre-industrial levels. This allows for variation in emissions reduction performance according to the development status of the country; and determine, plan, and regularly report on the contribution that it undertakes to mitigate global warming. No mechanism forces a country to set a specific emissions target by a specific date, but each target should go beyond previously set targets. The Intergovernmental Panel on Climate Change (IPCC) released a report in October 2018 on the 1.5 degrees Celsius target; it concluded that global emissions need to reach net zero around mid-century to give a reasonable chance of limiting warming to 1.5 degrees Celsius.	establishing the defined acceptable level of GHG emissions from the Otway Project.

3 Description of the Project and Alternatives Analysis

3.1 Overview

The purpose of this section is to provide a description of the key project stages and the Project activities for the development of new discoveries at Artisan and La Bella and development of future discoveries in surrounding petroleum permits identified by initial and future drilling campaigns.

3.2 Project Concept and Design

A key feature of the Project is the use of existing production assets to develop surrounding gas discoveries. The development of the Thylacine and Geographe gas fields was approved under Part 9 of the Environment Protection and Biodiversity Act (EPBC Decision No. 2002/621). Development of the gas fields commenced in 2004 by Woodside Petroleum Ltd under a joint venture arrangement, with first production in mid-2007. Since this date, additional wells have been drilled at the Geographe location (VIC/L23) and the Thylacine location (T/L2) to maintain supply. A further exploration well was drilled in 2021 at the Artisan location (VIC/P43), which was cased and suspended as a potential future producer.

Natural gas is produced from Thylacine gas fields via a combination of subsea wells and Thylacine offshore production platform, while Geographe field is produced via subsea wells and infrastructure. Gas from Geographe and Thylacine fields is transport by the OGPP to the OGP. Currently, production from these fields is in natural decline with end of field life expected by 2038.

The current project provides an opportunity for Artisan, La Bella and surrounding fields to be developed through existing infrastructure. The concept therefore relies on existing pipeline and production operations at Thylacine platform with the following concepts:

- Suspending successful wells with two verified barriers and installation of completions and Christmas Tree (Tree)
- Subsea tie-back of wells to existing OGPP via hot tap tee assembly, Geographe tee or via the connection point at the base of the Thylacine platform
- Control of all new wells via extension of the existing electro-hydraulic (EH) control system linked to the Thylacine Platform and the OGP.

Beach is undertaking concept engineering to support the subsea developments. The subsea development will be optimised for recovery of gas from potentially multiple fields via new subsea installation and tie-back to existing OGPP (via hot tap tee assemblies and Geographe tee) or Thylacine A platform. The development concepts may require some brownfield modifications to existing production infrastructure at the hot tap tee (HTT) assembly, Geographe tee, Thylacine platform and the OGP.

The Project is designed to accommodate future tie back opportunities identified via future drilling campaigns, with the infrastructure to support these developments is likely to be similar to that required for the initial development. Any future development will be undertaken in accordance with the environmental legislative requirements in force at that time.

As described in this section, an objective of the OGV Project is to development new gas fields in VIC/P43 and VIC/P73 via existing Otway infrastructure, with production volumes therefore considered backfill to the existing production and ullage at OGP.

Production from existing fields (Thylacine, Geographe, Halladale-Black Watch–Speculant (HBWS), and Enterprise Fields) is processed at OGP, with the maximum production rate 205 TJ/day (i.e. nameplate capacity of the plant).

Forecast production from existing fields is naturally declining and expected end of economic field life (2P) is currently forecast for 2037. In an exploration success scenario, the combined production from development and exploration projects is forecast to reach facility nameplate capacity of 205 TJ/d and extend the end of field life from 2037 to 2045.

Production volumes are published in Beach's annual reserves report (June 2024) and are represented by 2P reserves of 357 PJ and 2C resources (La Bella and Artisan) of 92 PJ (Gross). As the drilling campaign includes exploration targets, the estimate of prospective resources has not been unpublished at the time of the OPP assessment.

The key characteristics of the Project are summarised inTable 3-1.

Table 3-1: Key Project Activities

	Description
Project Area	The Project Area is defined in Section 3.5
Key Project Stages	• Surveys (geotechnical and geophysical) • Drilling and completions • Installation and Commissioning • Operations and maintenance • Decommissioning
Proposed Wells	Up to 8 wells are anticipated to be drilled and completed (in success case) and one re-entered and completed as part of the initial drilling campaign. In summary: In summary, activities covered in this OPP include: • Re-entry and completion of Artisan 1 (VIC/P43) • Drilling and completion of La Bella 2 (VIC/P73) • Maximum of 5 additional wells in VIC/P43 expected to be within approximately 10 km of Artisan or hot tap tee locations Maximum of 2 additional wells in VIC/P73 expected to be within approximately 10 km of La Bella or HTT locations.
Subsea infrastructure	Installation of subsea infrastructure to connect gas discoveries (Artisan 1 and La Bella 2) and future connections of successful wells (from above drilling & completion campaigns) to the OGPP, Thylacine platform or including wellheads, flowlines, umbilicals, manifolds and skids

3.3 **Project Schedule**

Beach is planning an exploration and appraisal drilling and completions campaign commencing in 2025, installation of new subsea facilities commencing in 2028 with the earliest achievable date for commissioning and first gas in 2028 subject to corporate, joint venture and regulatory approvals. An indicative early project schedule is provided in **Error! Reference source not found.**.

Table 3-2: Project Schedule Summary

Project Stage	Indicative Timing (as of October 2024)
Exploration & Appraisal Drilling Campaign	Commencing Q2 2025
Well completion & Subsea Tree installation	Commencing Q4 2025
Installation of Subsea Infrastructure	Earliest commencement Q1-Q2 2028
Commissioning & RFSU	Earliest commencement Q2-Q3 2028
Future drilling and tie-backs	Within operating life of the Project
End of Field Life	2045
Decommissioning (wells and subsea infrastructure)	Decommissioning will be managed in compliance with Sections 572(3) and 270(3) of the OPGGS Act: (unless alternative arrangements are accepted)

3.3.1 Drilling and Completions Campaign

An OPP is needed for most new offshore petroleum development projects in Commonwealth waters. An 'offshore project' is defined in the OPGGS (Environment) Regulations as 'one or more activities that are undertaken for the purpose of the recovery of petroleum…".

As described in section 1.5.1 of the OPP, section 15 of Environment Regulations allows a proponent to use the OPP arrangements for exploration and appraisal activities. While an OPP must be accepted by NOPSEMA before the proponent can submit EPs for activities that make up an offshore project, this pre-requisite does not apply to exploration and appraisal activities such as exploratory drilling. As such, Beach has submitted an EP to NOPSEMA for the exploration and appraisal drilling activities.

The initial exploration and appraisal drilling campaign described in this OPP is part of the OGV Drilling and P&A Activities EP. Activities in the EP include exploration drilling and depending on well results, either P&A or temporary well suspensions **[PC302, PC309, PC194]**.

For the exploration and appraisal drilling and completion campaign, Beach is part of a consortium with other operators who are planning drilling and completions activities in the Otway Basin using a semi-submersible mobile offshore drilling unit (MODU). The commencement of the campaign is dependent upon the release of the MODU by another operator in north-west Australia and the and the sequencing of activities agreed by all the operators within the consortium. At this stage, the drilling campaign is likely to commence in Q2 of 2025 and well completions campaign is likely to commence in Q4 of 2025 to Q1 of 2026.

It is Beach's intention to undertake drilling activities at the beginning of the campaign and complete successful wells near the end of the campaign. This approach is consistent with Beach's "drill-to-keep" exploration and development strategy. thereby reducing the environmental impact associated with multiple MODU campaigns to develop individual offshore gas fields.

A decision to P&A or suspend an exploration or appraisal well will be made and carried out before the MODU is released from the well. Where the well is suspended, a subsequent decision to P&A or complete the well will be made and carried out as a follow-up activity before the MODU is released from the consortium. The MODU contract provides sufficient flexibility to achieve this objective.

In the event that the MODU is unable to undertake the follow up activity before being released from the consortium (or if the MODU becomes otherwise unavailable for any reason), and subsequent to that, the well becomes redundant, Beach commits to the timeframes for decommissioning of redundant wells as set out in NOPSEMA's Decommissioning Compliance Strategy 2024-2029. The design concept for the Project relies on existing Otway production assets to develop surrounding gas discoveries (refer section 3.2), therefore wells and infrastructure are considered part of the Otway production system categorised in NOPSEMA's Decommissioning Compliance Strategy 2024-2029. Redundant wells within a producing asset or production system must be P&A as soon as practicable:

- If a rig is contracted to undertake infill drilling or workovers within a field, it is NOPSEMA's expectation that suspended wells within the field are abandoned.
- Wells that have been suspended within a larger active production system, must be abandoned no later than 10 years from when it was suspended.

3.3.2 Development Activities

For the purpose of this OPP, the completion of exploration or appraisal wells with a subsea tree for future production is an activity which is undertaken for the purpose of the recovery of petroleum. Other activities that are planned for the purpose of the recovery of petroleum in this OPP include installation, operation and maintenance of subsea wells, flowlines and infrastructure [**PC302, PC309].**

Following acceptance of the OPP (expected in early 2025), Beach plans to submit EPs for the development activities, including well completions and suspension with a subsea tree, installation of subsea flowlines and infrastructure and operating of the subsea production.

The schedule for the Project (Table 3-2) assumes an approximate two-to-three-year period between well completions and subsea tree installation, and the subsequent construction of tie-ins and gas production. The preference for construction of subsea infrastructure (flowlines, umbilicals, manifolds, etc) is during summer months corresponding with Q1 to Q2 of 2028.

In the interim, wells will be regularly inspected in line with Beach's Well Integrity Standard and the accepted Well Lifecycle Management Plan (Corporate Management Systems, CDN/ID 19060820) documenting Beach's OEMS Standards for well life cycle management.

Further, as set out in Beach's accepted Well Lifecycle Management Plan (CDN/ID 19060820), if a decision is made to not proceed with development of a suspended or completed well (i.e. – connection for future production), such that the well becomes redundant, Beach will comply with section 270 of the OPGGSA for the permanent plug and abandonment of wells and acknowledges and commits to the timeframes for well decommissioning as set out in NOPSEMA's Decommissioning Compliance Strategy 2024-2029, specifically, redundant wells within Beach's Otway production asset well be P&A as soon as practicable:

- If a rig is contracted to undertake infill drilling or workovers within a field, it is NOPSEMA's expectation that suspended wells within the field are abandoned.

- Wells that have been suspended within a larger active production system, must be abandoned no later than 10 years from when it was suspended.

3.3.3 Future Drilling and Tie-backs

Future drilling programs and related tie backs to existing infrastructure will be developed based on the outcomes of the current exploration program.

3.3.4 Decommissioning

Decommissioning of wells and infrastructure installed as part of this Project will occur when it is no longer used (unless alternative arrangements are accepted) in accordance with sections 572(3) and 270 of the OPGGS Act.

3.3.5 Concurrent Activities

The Project is currently in the planning stage where there is uncertainty with regards to scheduling details for specific Project activities including the potential for concurrent and sequential activities. Activities such as the exploration and appraisal drilling and well completion are planned to commence in 2025 and subsea tree installation is likely to commence in 2028 (see Table 3-2). At this stage, activities are likely to be sequential, however, for the purpose of this OPP and credible concurrent activities, the installation of subsea infrastructure stage, and the future drilling and tie-backs stage may occur concurrently. The concurrent activities scenario from these stages is pipelay or diving/tie-in activities (10 to 20 days) may occur concurrently during MODU positioning (9 to 13 days) activities (which may be propulsion system or towed by vessels – see section 3.8.2). This scenario has the potential for up to five vessels operating in the Project Area at any one time. This scenario is considered the worst-case credible concurrent activities. Concurrent activities will be kept to a minimum and are unlikely to occur for more than 13 days.

Decommissioning of wells is expected to be performed progressively sequentially depending on existing well design and integrity, casing cement quality, and well condition and production status. The final P&A program for each well will be included in the WOMP which must be accepted by NOPSEMA prior to commencement of activity.

3.4 **Project Location**

The Project Area is located in the Otway Basin in offshore Commonwealth waters, approximately 17 km south of the Victorian mainland and 86 km west of Tasmania (King island) at its closest points in water depths ranging from 63 m to 160 m. The nearest regional centre of Geelong is approximately 140 km to the north east.

The Project Area is described in Section 3.5.

The locations of key existing and proposed initial development infrastructure are presented in Figure 1-1 and Figure 3-1.

3.5 **Project Area**

The Project Area (Figure 1-1and Figure 3-1) is within Commonwealth waters and is where all infrastructure and activities associated with the Project will be undertaken.

The Project Area is defined as a single combined area extending north and south of the existing Thylacine platform.

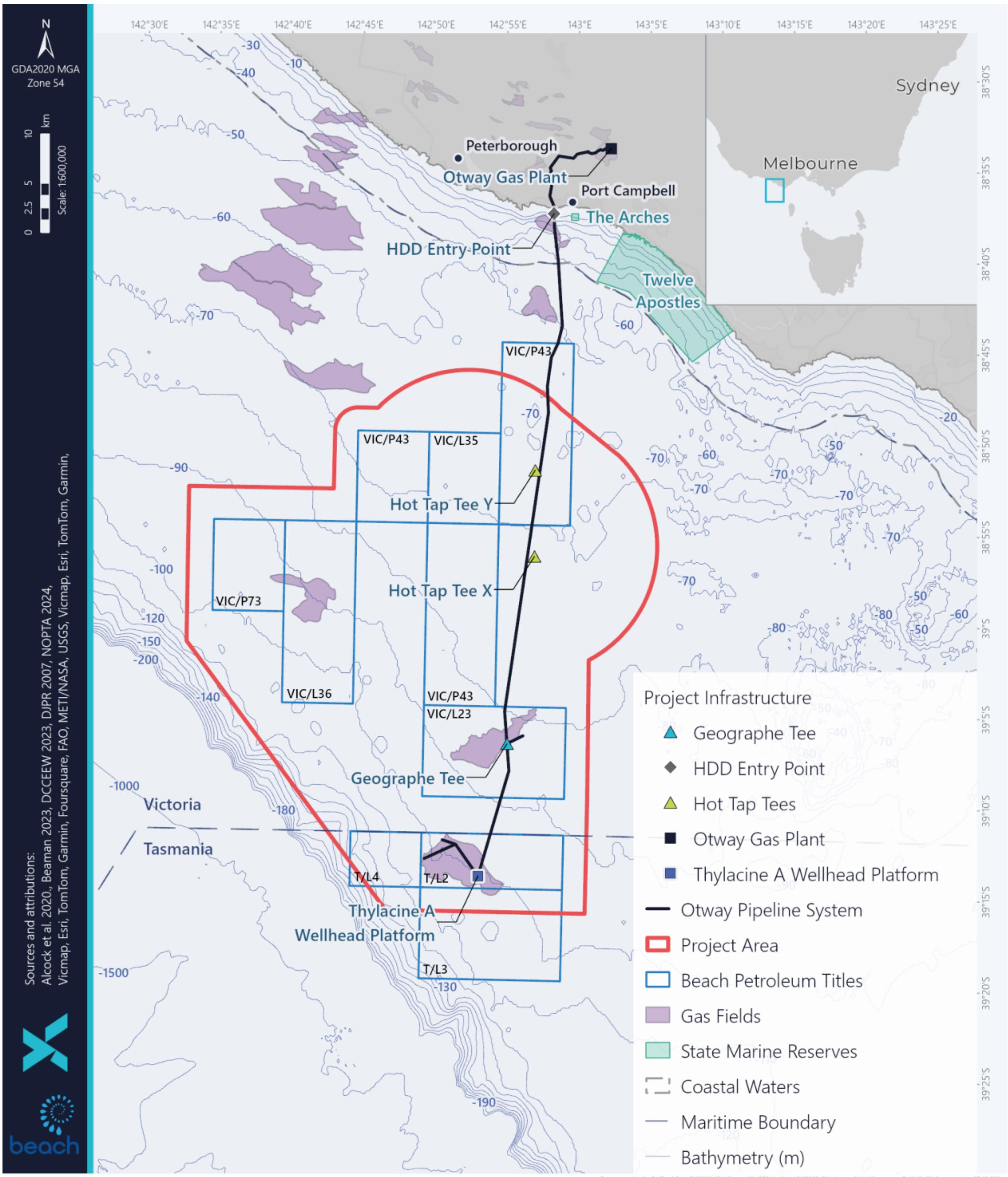
The Project Area located north of the Thylacine A platform includes the locations of gas discoveries (Artisan and La Bella) and exploration prospects within approximately 10 km of these discoveries and pipeline tie in points with the likely corridors (with buffer) for subsea connections.

Beach has taken a conservative approach and defined a Project Area (Figure 3-1) with buffer extents applied to inform the basis of the impact and risk assessment and provide flexibility to account for the early design phase and potential future developments.

The Project Area has been designed to not include the deeper waters off the continental shelf. In addition, since the Project has been refined it does not overlap any environmentally important features with the closest being the West Tasmanian Canyons Key Ecological Feature (KEF) situated approximately 9 km away.

The Project Area will accommodate a MODU for drilling and well completion activities and movement of all vessels around the offshore facilities during installation, commissioning, decommissioning and operations. Transit of vessels to and from the offshore locations is excluded from this OPP as this is outside the scope of the OPGGS Act and is regulated by maritime legislation, including the Commonwealth *Navigation Act 2012*.

Onshore support facilities required during construction, commissioning and operation will be located in existing ports. It is expected that the Project will utilise the onshore supply base facilities (Geelong and Portland) that are currently used to service Beach's existing Otway Basin operations.



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_S04_A.aprx, 01_WellLocations, P-UWS-132, brenna.waite, 27/10/2024

Figure 3-1: Project Area

3.6 **Hydrocarbon Composition**

The reservoir targets are gas within the Turonian Waarre Formation. Liquid condensate will form within the gas stream as temperature and pressure decrease when the gas is brought to the surface. The initial condensate gas ratio is expected to be up to 16 barrels per million standard cubic feet of gas.

Compositions for Thylacine, Artisan and La Bella gas are provided in Table 3-3 and Figure 3-2. Thylacine and La Bella are similar compositions, with Artisan having lower CO_2, higher methane and fewer heavy ends (lower condensate yield). These gas compositions are considered suitable analogues for all potential new fields within the Project Area.

Section 7.4.3.2 describes in further detail why Thylacine condensate is used as a suitable analogue for quantitative spill modelling.

Table 3-3: Gas Composition

Composition (mol%)	**Thylacine**	**Artisan**	**La Bella**
H_2S	0.00	0.00	0.00
CO_2	9.29	1.63	13.30
N_2	1.38	1.63	2.90
C1	81.13	94.79	75.43
C2	4.88	1.25	4.91
C3	1.61	0.36	1.81
iC4	0.29	0.07	0.32
nC4	0.39	0.08	0.35
iC5	0.15	0.02	0.13
nC5	0.11	0.01	0.10
C6	0.14	0.03	0.23
C7	0.23	0.03	0.29
C8	0.21	0.01	0.10
C9	0.06	0.01	0.07
C10	0.03	0.00	0.04
C11	0.02	0.01	0.02
C12+	0.08	0.07	0.00
Total	100.00	100.00	100.00

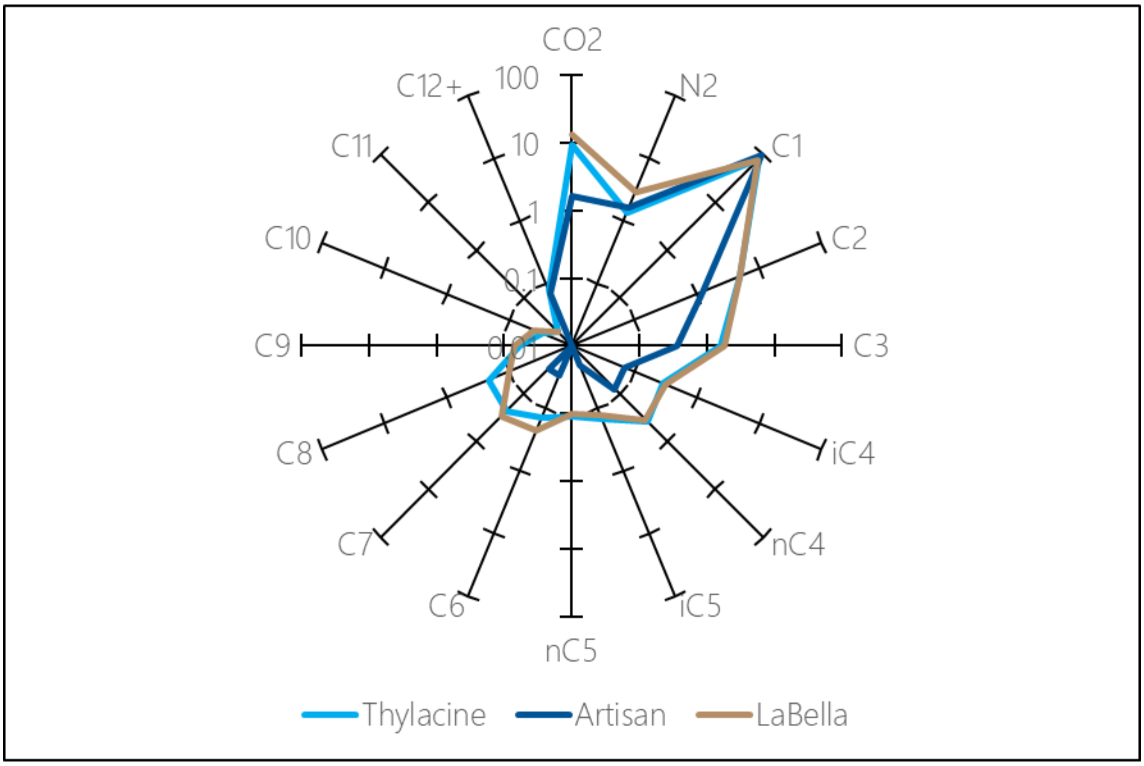


Figure 3-2: Gas Composition

3.7 **Project Infrastructure**

3.7.1 Existing Infrastructure

A key feature of the Project is the use of existing infrastructure to develop surrounding gas discoveries. A schematic of the key existing Otway Development infrastructure shown in Figure 3-3 and includes:

- Thylacine A Platform - a normally unmanned installation wellhead platform with four production wells
- Four subsea Thylacine wells, flowlines and infrastructure tied back to Thylacine A platform
- Geographe subsea facilities – subsea wells connected by flexible flowline directly into the OGPP with control and services provided via an umbilical from Thylacine A Platform and Monoethylene glycol (MEG) supplied directly from the MEG Service Line via an in-field umbilical.
- OGPP system:
  - Offshore section of DN500 raw gas pipeline from Thylacine A Platform (Platform) to the onshore OGP and a DN100 MEG Service Line supplying MEG and chemicals from the OGP for injection into the OGPP and Thylacine subsea flowlines.
  - The OGPP design for the Thylacine Otway development included two pre-installed hot tap tee (HTT) assemblies (HTT 'X' and HTT 'Y') to allow for future development of additional fields in the Otway Basin. There is also the potential to extend the Geographe infrastructure, which has additional capacity in relation to tie-in to the Subsea Valve Structure (SVS) and Tee, which sits adjacent to the OGPP.

Figure 3-3: Schematic Diagram of Existing Otway Infrastructure

3.7.2 Planned Infrastructure

The key infrastructure components of the Project are subsea and include wells, trees, flowlines, umbilicals, manifolds and skid structures.

3.7.2.1 Wells

Up to 8 wells are anticipated to be drilled and completed (in success case) and one re-entered and completed as part of the initial campaign. In summary the initial campaign includes:

- Re-entry and completion of Artisan 1 (VIC/P43)
- Drilling and completion of La Bella 2 (VIC/P73)
- Maximum of 5 additional wells in VIC/P43 (expected to be within approximately 10 km of Artisan or HTT locations)
- Maximum of 2 additional wells in VIC/P73 (expected to be within approximately 10 km of La Bella or HTT locations

Successful wells will have a wellhead, which provides means for hanging the production well casing and installing the subsea Christmas tree (or 'tree') and well control facilities. The tree enables reservoir fluids to flow from the well to the flowlines. It is also used to manage chemical injection and control production. The tree consists of a series of hydraulically operated valves, spools and instrumentation that are used to control and manage the production flow from a well and provide well shut-off mechanism. The tree includes a subsea control module (SCM). The SCM receives hydraulic and electrical signals from the topside facility and communicates this to a specific tree function. The hydraulic system operates with low pressure (LP), high pressure (HP) and chemical injection capabilities.

Trees are typically designed with open loop hydraulic systems with actuation fluid which will vent to sea via the SCM. Included in the system are accumulators which are mounted on the tree frame which are used to supply and open actuators fitted to each hydraulic valve (fail safe closed type). The hydraulic fluid used to fill the actuator open side (to compress a spring) will be vented to sea when it is closed.

3.7.2.2 Subsea System

The Artisan and La Bella gas discoveries and any successful wells from the initial and future drilling campaigns will be connected to the existing infrastructure by flowlines, umbilicals, manifolds and skid structures.

Beach is undertaking concept engineering to support the subsea developments and a base case and alternatives have been identified. Several options exist to tie-back new gas fields to the existing Thylacine and Geographe infrastructure including HTT X and Y on the OGPP, Geographe Tee and at the base of the Thylacine A platform.

A schematic of the base case for the subsea infrastructure of the Artisan tie-back is shown in Figure 3-4 and is representative of the La Bella and potential future tie-backs north of the Thylacine platform in the area of permits VIC/P43 and VIC/P73. The Artisan and La Bella flowline and umbilical routes are still in the early design stage with final routes to be confirmed within future EPs.

Flowlines will transport production fluids (gas and condensate) from the wellheads and manifolds to the pipeline or platform. This includes flowline end terminations to connect the flowline to other infrastructure.

Umbilicals will transfer power, electric and communication signals, hydraulic fluids and chemicals (such as MEG) to the wellheads. The umbilicals will connect to other infrastructure via umbilical termination assemblies.

Flowlines or umbilicals will not be trenched and may either be rigid or flexible. Localised placement of stabilisation material may be required to assure stability, primarily adjacent to well and structure tie-in locations.

Additional in-field subsea structures such as manifolds, skids, and distribution units will connect flowlines and umbilicals together and to the pipeline or platform tie-in points.

The total extent of seabed footprint required for the installation of seabed infrastructure for the initial development is estimated at approximately 74.95 km^2. This includes stabilisation support at tie in points if required. This total area is subject to refinement during the design process and drilling campaign outcomes however it represents a conservative approach of each potential exploration and appraisal well being tied back.

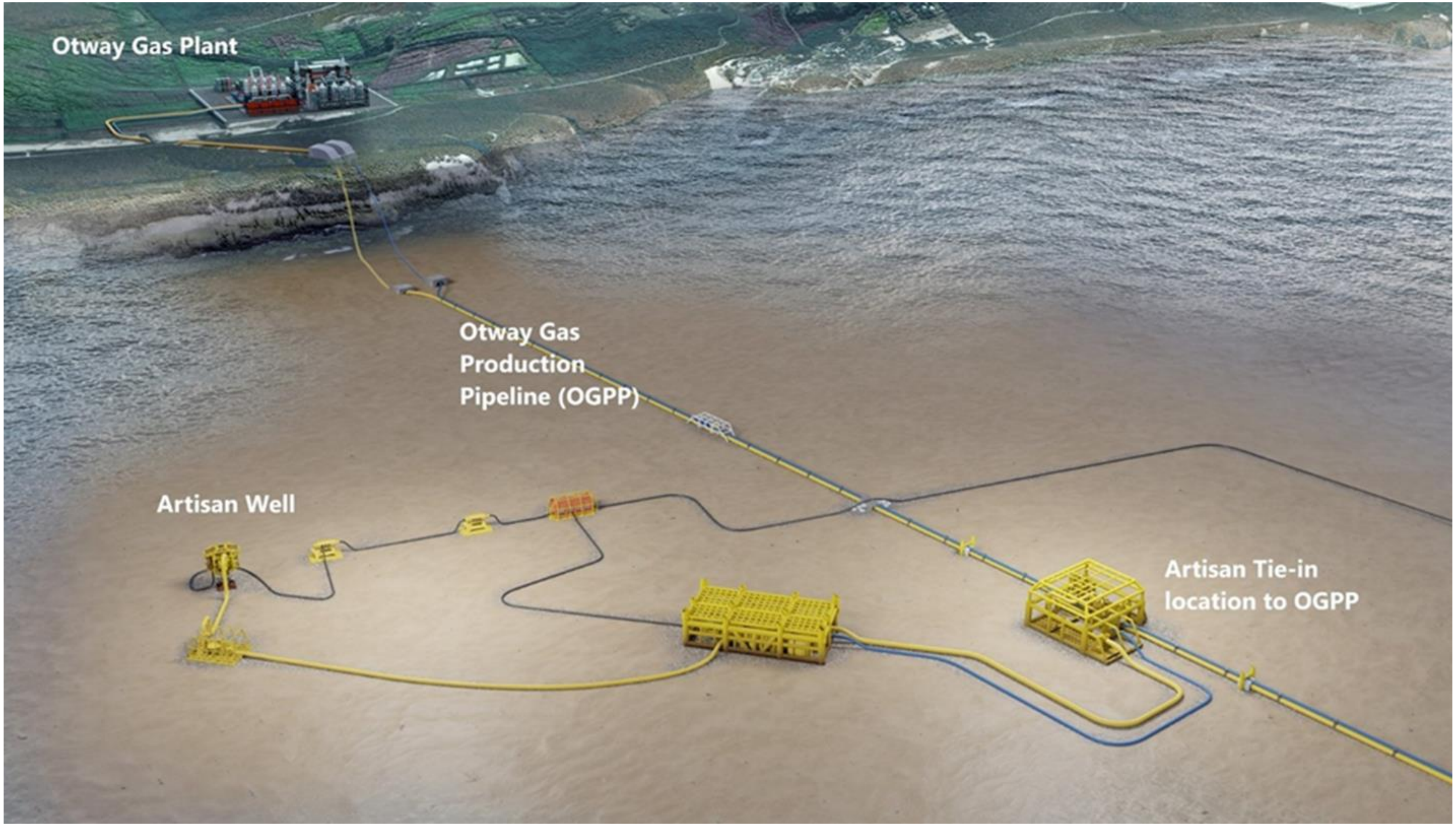


Figure 3-4: Schematic Diagram of Proposed Artisan Tie-back

3.8 **Description of Activities**

Activities associated with the Project are summarised in the sections below and are considered a base case of activities.

3.8.1 Surveys

Geotechnical and geophysical surveys may be required to assess the suitability of the seabed for drilling, infrastructure installation (including along the length of proposed flowline) and umbilical routes.

As detailed in the approved OGV Geophysical and Geotechnical Seabed Survey Environment Plan (Document Reference: V-1000-P1-MP-0011), surveys may be conducted over a total of approximately 200 days.

3.8.1.1 Geotechnical Survey

Geotechnical surveys may include techniques that involve using high-frequency sonar to provide high-resolution bathymetry and geophysical data, such as side-scan sonar, sub bottom profiler or multibeam echo sounder. Sonar generates high-frequency acoustic emissions that attenuate rapidly in the underwater environment. These geophysical surveys would be expected to take 10-20 days [PC236] to complete, depending on the length of the subsea system flowline routes.

Geotechnical surveys typically involve in-situ testing and piston/push sampling and coring. Following sampling, all equipment is withdrawn from the seabed. A small hole (<1 m^2) will remain, which will eventually collapse and infill with the movement of surface sediments in ocean current.

3.8.1.2 Geophysical Survey

Specific noise modelling from geophysical survey equipment was carried out to inform the risk assessment. The acoustic emissions will decrease rapidly due to the relatively high frequency of the acoustic emissions, with received sound levels estimated to be reduced to 160 dB re 1 µPa within 150 m.

3.8.2 MODU Positioning

A MODU will either mobilise to the required Project Area with its own propulsion system or be towed by vessels and anchored or connected to pre-laid anchors prior to commencing activities. Anchors may be pre-laid on the sea floor typically 1 month prior to the MODU arriving at the location.

The MODU will be moored with 8 or 12 anchors, with weight ranging from 15 to 30 MT each, resulting in an individual footprint of up to approximately 60 m^2 . A mooring analysis will be undertaken to determine specific mooring requirements for each well location. The mooring analysis will incorporate the results from the geophysical and geotechnical survey obtained prior to MODU mobilisation and which is subject to a separate EP (Offshore Gas Victoria Geophysical and Geotechnical Seabed Survey Environment Plan CDN/ID V-1000-P1-MP-0011).

Anchors are attached to the MODU by a chain or chain / wire system. The anchors will be positioned at approximately 2 km (ranging from 1.5 km – 2.1 km) from the MODU. The MODU is equipped with a thruster assisted mooring system to mitigate mooring fatigue in heavy sea states / poor weather conditions.

Transponders may be required to inform anchor positioning. The transponders for mooring are called ADAPS (Anchor Distance and Positioning) – they can be acoustically interrogated for GPS position and anchor orientation. They are affixed to the anchor so are deployed and recovered in the same timeframes as the anchor installation.

Each pre-laid anchor consists of:

- Anchor covering an area ~60 m^2
- Anchor chain including swivels and shackles. Typically, the anchor chain consists of 84–120 mm links. Approximately 1,000-1,200 m of chain is laid on the seabed with a pennant wire in the water column attached to a surface buoy. This equates to approximately 360 m^2 footprint per anchor based on the chain being approximately 300 mm wide.
- Surface buoy with a navigation light.

The pre-lay of anchors at the well locations is likely to take 9 to 13 days.

The total footprint for each anchor and chain will be less than 200 m^2. However, co-located wells sharing a common drill centre may use the same anchors with the MODU moving across to the new well location.

An array of long baseline and/or ultra-short baseline transponders for metrology and positioning may be installed on the seabed, within a radius of 500 m from the well locations. This positioning system is only expected to be used on selected wells and only if required.

Transponders, if used, will be moored to the seabed by a clump weight. Clump weights are typically made of cement or steel with a footprint of ~0.2 m^2. On completion of the positioning operation, transponders and associated equipment will be removed.

3.8.3 Drilling Method

The initial drilling campaign wells are planned to be drilled vertically. The wells will be drilled to depths of approximately between 2,000 m and 3,500 m beneath the seabed to intersect the reservoirs. Drilling is expected to be in the order of approximately 30 to 40 days duration for each well.

While not currently planned, where there is high inclination wells or wells with extended reach requirements in the future, these wells may require directional drilling to depths of up to approximately 4,500 m beneath the seabed. Drilling of these wells is expected to be in the order of approximately 30 to 40 days duration for each well.

The drilling process will use standard offshore drilling methods with the wells drilled in sections which decrease in diameter at increasing depths until the target reservoir is reached. Protective steel casing, supported by the wellhead, is inserted into the wells and cemented into place to isolate each section from subsequent sections and provide structural support and stability to the well.

In the process of drilling, drilling fluids (also known as drilling muds) will be used to lubricate and cool the drill bit, maintain well bore stability, and remove drill cuttings (rock fragments) from the well sections as they are drilled.

It is envisaged that water-based drilling fluid (WBDF) will be appropriate to drill and complete the wells within the Project Area, and that up to approximately 1,500 m^3 of WBDF per well will be discharged to the marine environment.

Synthetic based drilling fluids (SBDF) may be required in the future for high inclination wells or wells with extended reach requirements. In the unlikely scenario that SBDF is required, the potential discharge volumes will be minimised and be up to approximately 100 m^3. There will be no bulk discharge, with all SBDF remaining at the end of the well either being reused on the next well, passed onto the next operator or returned to the vendor for reprocessing or appropriate disposal. Management of SBDF if required will be detailed in the relevant activity specific Environment Plans.

Table 3-4 presents the types of drilling fluids and their typical components proposed to be used for the different sections of each well.

Drilling fluids and cuttings will be discharged at the seabed during drilling of the upper well sections as is standard industry practice due to the wellhead not yet being installed. The drilling fluids and cuttings from the lower sections will be circulated to the MODU, with fluids separated for recycling and cuttings discharged overboard. It is expected that up to approximately 600 m^3 of drill cuttings per well will be discharged.

Cementing of the casing may result in the release of small amounts of cement (up to approximately 50 m^3 per well) when the cement mixture is circulated to the seabed during grouting or when surplus fluids require disposal after cementing operations.

Table 3-4: Drilling Fluid Types and Typical Components (Indicative Based on Standard Otway Basin Well Design)

Well Selection Diameter (inches)	Drilling Fluid Type and Typical Main Components
36	Seawater and prehydrated gel sweeps (i.e. seawater to which high viscosity prehydrated bentonite has been added).
26	
17.5	WBFD - drilling fluids in which seawater is the major component of the liquid phase and to which bentonite clay, barite, brine and/or gellants (such as guar gum or xanthum gum) have been added
12.25	
8.5	
Future wells depending on well profile (intermediate and/or production hole sections)	SBDF - drilling fluids in which synthetic oil is the base fluid with bentonite clay, barite, fluid-loss control agents, lime, aqueous chloride, bridging agents and emulsifiers added

3.8.3.1 Blow-out Preventor Installation and Function Testing

After completion of the top-hole sections, a blow out preventer (BOP) is installed onto the wellhead. The BOP consists of a series of hydraulically operated valves and sealing mechanisms (annular preventers, ram preventers and blind shear rams) that are used to close in the well should a loss of well control situation arise. The annular preventers and ram preventers are used to shut in around various tubulars and regaining hydrostatic overbalance using the MODU's high pressure circulating system. The blind shear rams are designed to shear the pipe and seal the well.

Once the BOP is installed, function and pressure tests are undertaken in accordance with industry standards and the drilling contractor's maintenance system. Function testing involves activating the hydraulic control system aboard the MODU and is generally undertaken every seven days. Pressure testing is undertaken to verify seals on the BOP stack and is undertaken every 21-days. The tests discharges approximately 2 m^3 of control fluid to the marine environment. This fluid is water-soluble and readily disperses in the receiving waters after discharge from the BOP.

3.8.3.2 Formation Evaluation

During drilling, the formation may be evaluated to determine the presence and quantity of hydrocarbon within the target reservoir. This information is gathered real-time from 'logging while drilling' techniques or by running wireline tools into the well.

'Logging while drilling' and wireline logging involve the use of downhole instruments such as sonic and resistivity sensors, low-level radioactive sources, magnetic resonance imaging, coring, and formation pressure/sampling tools.

There are no planned emissions or discharges during formation evaluation. All instruments are deployed directly down hole with no exposure to the marine environment.

3.8.3.3 Vertical Seismic Profiling

While vertical seismic profiling (VSP) is not expected to be required for the initial drilling campaign, VSP may be performed at some stage in the Project, such as during future drilling campaigns within the in-field development area. VSP may also be performed on a targeted basis during operations. The use of VSP in these instances will be through deployment of a single small sound source from the MODU or vessel in the water column while receivers are positioned at specific depths downhole within the well.

VSP provides a seismic image of the geology in the immediate vicinity of the well, and typically takes approximately eight to 24 hours per well. Beach Energy expects a maximum of 2 VSP events.

VSP noise is not continuous. Each discharge of the seismic source generates a short, discrete, low frequency sound impulse. Seismic impulses during VSP are typically much lower than those generated during typical marine seismic surveys .

3.8.4 Completions

Well completion is the process of preparing a drilled well for production, either immediately following drilling or via re-entry into an existing suspended well. It involves:

- Installation of the sand face completion, typically a production liner or sand screen across the producing reservoir interval
- Wellbore cleanup where the drilling fluid is displaced from the well and replaced with a filtered completion fluid, typically brine
- Evaluation of the cement bond for barrier and/or zonal isolation confirmation
- Perforation of cemented production casing or liner with explosive charges to create communication from the reservoir into the wellbore

- Installation of the upper completion consisting of the production tubing, tubing hanger, surface-controlled subsurface safety valve (SSSV) and production packer, and may also include installation of downhole monitoring capability and flow control equipment
- Installation of a production tree (an assembly of valves, spools, and fittings used to regulate hydrocarbon flow within a well) on the existing wellhead.

In the case of a new well the completion would be performed by the MODU immediately after drilling operations have concluded. A well re-entry operation would require the mobilisation of MODU to the existing well and removal of downhole barriers prior to commencing completion operations.

A re-entry operation may also entail a drilling element to either deepen or sidetrack the well to access undamaged or alternative reservoir targets or increase the reservoir interval available to production.

Well completion is expected to take in the order of approximately 30 to 40 days duration for each well.

Discharge of completion fluids may occur as part of wellbore clean-up during completions. During the clean-up process, the completion fluids (consisting of completion brine and any formation water or condensate present in the wellbore) are circulated back to the MODU for treatment prior to discharge. Discharge may also include any excess completion brine remaining in the MODU tank system discharged to sea as per standard operating procedures.

If there is the potential for hydrocarbons to be present, the completion fluids will be tested and discharged only if the oil in water content is below 30 ppm. Any fluid not meeting this criterion will be stored in tanks onboard the MODU for later onshore disposal.

Well cleanup is performed after the well has been completed and is the process of removing well construction fluid from the well and bringing reservoir fluid (oil, condensate and/or gas) to surface. The objective of this activity is to remove well construction fluid from the well, and if necessary, undertake production testing to evaluate the reservoir potential and understand reservoir fluid properties.

The well construction fluid is typically a mixture of completion fluid (completion brine and any formation water or condensate present in the wellbore) and underbalance/low density fluid (base oil, diesel or nitrogen), remnants of drilling mud and loss-circulation materials. Depending on the formation and well construction process there could also be solids such as formation and perforating debris. As the well construction fluid exits the well, reservoir fluid becomes more prominent in the flow stream consisting of hydrocarbons and native groundwater present in the formation.

In the case of well unloading being undertaken on the MODU, the various flow stream mediums are separated (gas, oil, water) with the flammable components sent to the flare and burnt off. The non-flammable components, including any produced formation water or completion brine, will be discharged to the marine environment via the well test water filtration treatment package or stored in tanks and disposed onshore.

Unloading of well construction fluid to the MODU would be performed up to ~65 MMscf of gas per day being flared for up to 48 hours depending on the well geometry and objectives of the unload and testing. Gas is flowed to the flare via a dedicated gas line whilst high efficiency burners will be used that minimise the risk of fallout to ocean and enhance smokeless combustion of liquids.

In the case of a rig-based unloading operation undertaken on the MODU, the various flow stream mediums are separated (gas, oil, water) and either burnt off via a flare boom or stored in tanks for treatment prior to disposal overboard or onshore. Well testing may be undertaken for up to 48 hours depending on the well geometry, the objectives of the clean-up and the test operation.

Unloading a well of well construction fluid to the MODU would be performed at up to approximately 65MMscf of gas per day being flared for between one and two days per well. Gas is flowed to flare via a dedicated gas line whilst high efficiency burners will be used that minimise the risk of fallout to ocean and enhance smokeless combustion of liquids.

The majority of fluids returned from the wellbore and formation are flammable and will be sent to the flare and burnt off. Non-flammable fluids, including any produced formation water or completion brine initially present in the wellbore, will be discharged to the marine environment via the well test water filtration treatment package.

In some operations, there may be applications it is necessary to bleed off formation fluids (gas) direct to atmosphere. This can be performed by the MODU degasser (mud gas separator) or in some situations a dedicated “bleed off package” may be required. In such instances, gas is cold vented rather than flared. This may be required during abandonment and intervention operations when gas which is present in the wellbore needs to be removed, such as when performing a leak off test on a downhole device (barrier) or when displacing gas to fluid to perform a well re-entry, intervention or abandonment operation. Cold venting is considered an appropriate method of reservoir gas emission in instances when the gas volume and the rate of emission is typically significantly lower than which would be burnt at flare during a well unload and test.

Total discharge volume of completion fluids from well completion, unloading and testing will be up to approximately 300 m^3. Approximately 100 bbls (16 m^3) of produced water may be generated and discharged per well as part of this total volume, which will be treated to reduce the oil in water content to below 30 ppm oil in water content prior to overboard discharge. Fluid not meeting this criterion will be stored in tanks for later onshore disposal. This low volume of 16 m^3 is due to the low formation water content in formation gas.

3.8.4.1 Disposal of Bulk Powders

Beach participates in the bulk transfer working group appointed by the Drilling Industry Steering Committee (DISC) to assess the options for removing excess dry bulk products from the MODU at the end activities. Beach is committed to continuing to explore safe, feasible options that result in overall environmental benefit to manage the excess bulk including bringing the excess bentonite, barite, and cement that is not used at the end of the campaign back to shore for disposal. Beach will follow Australian industry practice at the time the bulk needs to be managed, with environmental assessment to be performed to supplement the decision.

3.8.5 Facilities Installation and Commissioning

3.8.5.1 Installation

Subsea infrastructure will be transported to site and installed by Installation Support Vessels (ISVs) equipped with remotely operated vehicles (ROVs). A dedicated pipelay vessel or multipurpose service vessel may be required for long flowlines or umbilicals.

Diving may be required for limited activities such as tie-in to the existing OGPP hot tap tee assemblies, which are equipped with diver connections only. Such activities will be undertaken from a dive support vessel using saturation diving.

Flowlines and umbilicals will be laid directly onto the seabed within defined corridors, with no trenching required, and will be designed to be inherently stable. Localised placement of stabilisation mattresses, gravity weights, or small rock anchor structures may be required to assure stability adjacent to well and structure tie-in locations. Generally, stabilisation mattress are used for the flowlines, while gravity weights or anchor piles are used for OGPP and the hot tap tee locations to mitigate the lateral movement of these structures. Stabilisation mattresses and gravity weights are lowered over the flowline from a vessel and typically cover an area of 18 m^2. Rock anchor structures are generally installed by divers using a small installation frame. Once installed, the rock anchor sits above the flowline and has minimal impact on the seafloor. The combined footprint is included in the total disturbance footprint of 74.95 km^2.

Depending on the scope and length of the flowlines and umbilicals, the installation could take in the order of approximately between 10 to 20 days duration per well tieback.

3.8.5.2 Commissioning

It is anticipated that the majority of the commissioning activities will take place onshore, with only limited commissioning activities occurring within the Project Area.

Once installation is complete, subsea infrastructure will be integrity tested by hydrotesting from the vessel to verify system leak integrity before the vessel leaves the field. Flowlines are filled with hydrotest fluid (including MEG) and subjected to test pressures that will meet design code requirements, typically significantly above any pressures likely during operation.

The hydrotest fluid will comprise filtered seawater with MEG, corrosion inhibitor, oxygen scavenger and biocide additives. The chemical additives are required to avoid metal corrosion, prevent bacterial growth and the accumulation of scale on internal surfaces. The hydrotest fluid volume is typically 120% of the flowline volume, with the longest flowline for the Artisan and La Bella tie back base case being ~23 km. These fluids will either be flowed back to the Otway Gas Plant for processing through existing facilities or discharged to the marine environment.

3.8.6 Operations

Activities associated with production operations include:

- Hydrocarbon extraction and export;
- Inspection, maintenance and repair; and
- Well intervention.

3.8.6.1 Hydrocarbon Extraction and Export

Reservoir fluids will flow via the subsea infrastructure to the existing OGPP for export to OGP. Control of the subsea system is via the umbilical(s) which transport electrical power, hydraulic fluids and chemicals to the required subsea locations.

The hydraulic fluid used is typically glycol-based (distinct from MEG used as a hydrate inhibitor) and used to actuate subsea valves. The system is open so there will be a small volume released each time the valve is actuated. Based on the existing Otway Development, it is estimated about 4 m^3 per year will be discharged to the marine environment.

Chemicals used for injection into the wells include hydrate inhibitor (likely MEG or methanol) and scale inhibitor. These fluids operate in a closed loop system, with no planned discharges to the marine environment.

3.8.6.2 Inspection, Maintenance and Repair

Inspection, maintenance and repair activities are ongoing activities to ensure the reliability and performance of equipment. An as-built survey will be undertaken on completion of infrastructure installation with further inspections on a risk-based frequency. Depending on the scope, each campaign could take in the order of approximately 30 days.

Inspections are undertaken by a ROV from a vessel and may include but are not limited to:

- Tree valve and equipment assessments
- Cathodic protection surveys and anode replacement
- Fluid leak detection
- General visual inspections for damage and missing items, fishing and anchoring interactions
- Marine growth and fouling
- Seabed scouring and flowline/structure freespans
- Wall thickness measurements

Maintenance and repair activities are typically part of regular inspection activities but may also be required in response to inspection results. These activities are undertaken by ROV or divers from an appropriate vessel. Typical maintenance and repairs undertaken which may have an environmental impact include:

- Tree control module and/or choke replacement
- Wet gas flowmeter replacement
- Acoustic sand detector replacement
- Anode replacement
- Cathodic protection system maintenance
- Flowline and umbilical repairs
- Flowline and umbilical stabilisation

- General subsea infrastructure servicing including leak testing
- Marine growth removal
- Removal of fishing nets or other marine debris

3.8.6.3 Well Intervention and Workovers

If required, well interventions will be conducted from either a MODU or a light well intervention vessel. Well interventions may be required to:

- Evaluate well condition or performance
- Undertake well servicing operations such as to function or remediate downhole valves, remove obstructions, stimulate the well and shut-off or access producing zones
- Restore well integrity
- Suspend or prepare the well for abandonment

Intervention operations include activities such as:

- Slickline / wireline / coil-tubing operations
- Well testing and flowback
- Well stimulation (acidizing, hydraulic fracturing)
- Subsea tree replacement

The most likely requirement for well intervention for the Project would be slickline and/or wireline operations.

Subsea well intervention and servicing occurs by accessing the wellbore via the tree. This would be managed either by utilising a MODU BOP and marine riser, an Emergency Disconnect Package (EDP) / Lower Marine Riser Package (LMRP) system, or a light well intervention system.

An intervention takes place within the upper well completion and can often involve access to the sand face completion. Specific types of tools can be deployed down the well, conveyed by slickline, wireline or coil tubing to achieve the operation objectives.

A workover typically refers to the replacement of the well upper completion. Workovers may be required to:

- Restore well integrity not possible via other intervention methods
- Restore production and/or flow control functionality not possible via other intervention methods
- Isolate and/or access alternative reservoir targets not possible via other intervention methods
- Replace a subsea tree

Workovers are not anticipated to be required for the Project, If required they would result from an unplanned event.

The frequency of well intervention and workover activities depends on well performance, objective criticality, MODU/vessel availability and regulatory requirements with an anticipated frequency for the Project of up to one well worked over every seven years. The duration for workovers is up to ~30 days.

Note there may be a potential requirement to cold vent formation gas during intervention and workover operations.

3.8.7 Decommissioning

Beach acknowledges that planning for decommissioning should commence at the earliest stage of project development. This section provides information on the decommissioning of property that will require removal once it is of no further use.

Once production has ceased, wells will be shut-in and monitored as part of the IMR program. P&A of wells and removal of subsea infrastructure described within this OPP will occur as either a standalone campaign or as part of a wider decommissioning campaign. Decommissioning of subsea infrastructure is expected to take up to approximately 30 days per tie-back, with P&A of wells estimated at up to approximately 30 days per well.

The base case for decommissioning will involve the complete removal of all infrastructure and includes:

- Displacement of hydrocarbons in manifolds, flowlines and umbilicals with a displacement fluid such as treated seawater to the existing infrastructure or a support vessel, followed by depressurisation. This fluid will be treated to remove hydrocarbons and discharged to the marine environment, with volumes in the order of those estimated for commissioning and detailed in activity specific EPs.
- Disconnection and removal of production manifolds and subsea structures
- Disconnection and removal of umbilicals
- Disconnection and removal of flowlines
- Retrieval of any flowline stabilisation equipment such as mattresses where possible
- Cutting of rock anchors or piles level with seabed
- Plugging and abandonment of wells

Well P&A procedures are designed to isolate the well and prevent the release of well fluids to the marine environment. During abandonment, cement and/or mechanical plugs may be set within the well to install a permanent reservoir and surface barrier. P&A includes activities such as:

- Installation of a temporary isolation plug in wellbore
- Removal of tree

- Installation of BOP
- Isolation of all reservoir and production zones with cement plugs
- Setting of permanent cement plug just below the mudline
- Removal of BOP stack
- Cutting of conductor below the mudline and recovery to MODU

Discharges to the marine environment will be limited to cement dust, cement contaminated water, excess dry cement (due to cement job for P&A operations) and annulus fluid released during conductor cutting, and those associated with MODU and vessel operations (Sections 3.8.8.1 and 3.8.8.2). There may be a potential requirement to cold vent formation gas during P&A operations (refer to Section 3.8.6.3).

Further information on decommissioning and how Beach will demonstrate compliance with the requirements of the OPPGS Act are provided in Section 9 of the OPP.

3.8.8 Support Operations

Support operations associated with the Project will include the use of MODUs, vessels, helicopters and ROVs with requirements varying depending on the Project stage (Table 3-5).

Table 3-5: Support Operations for each Project Stage

Support Type	**Drilling and Completions**	**Installation and Commissioning**	**Operations**	**Decommissioning**
MODU	✓		✓	✓
Helicopter	✓	✓	✓	✓
ROV	✓	✓	✓	✓
Anchor Handling Tug Support	✓		✓	✓
Supply / Support Vessel	✓	✓	✓	✓
Pipelay/Multipurpose service		✓		✓
Installation support		✓		✓
Inspection, Maintenance, Repair Vessel			✓	
Dive Support Vessel		✓	✓	✓

3.8.8.1 MODU Operations

The semi-submersible MODU most likely to be used for drilling, well intervention and workover, and plug and abandonment operations. The MODU is expected to accommodate ~170 workers and will be equipped with marine–standard catering and ablution facilities. Capacity for fuel oil is expected to be up to ~3500 m^3 and it will use ~15 m^3 of diesel per day.

Environmental aspects include:

- Bunkering / bulk transfer of fuel, chemicals, and supplies
- Transfer of waste to supply vessels
- Bilge water discharge
- Sewage, greywater and food waste discharge
- Cooling water, bilge and reverse osmosis (RO) brine discharge

The MODU will likely be mobilised from the previous operator’s location to the Project Area using one or two vessels with a third vessel providing support. Essential personnel will remain on the MODU during mobilisation, with the remainder to transit to the vessel by helicopter once moored on location.

While on location, a temporary exclusion zone will be gazetted in accordance with the OPGGS Act (500 m radius around the drill rig). The purpose of the exclusion zone is to maintain a safe distance between the drilling campaign areas and fishing boats and other vessels that may operate in the area.

A representative semi-submersible MODUs is shown in Figure 3-5.

Figure 3-5: Representative Semi-submersible MODU

3.8.8.2 Vessel Operations

Table 3-6 summarises the expected vessel types, numbers and specifications for each stage of the Project. Examples of vessel types are shown in Figure 3-6 to Figure 3-10. Vessels will use dynamic positioning (DP) to maintain position while undertaken activities. No vessel anchoring will take place unless in an emergency situation.

Typically, three vessels would operate in the Project Area at any one time, however, this could increase to five if, for example, pipelay and diving/tie-ins are undertaken at the same time as MODU positioning. Simultaneous operations will be kept to a minimum and are unlikely to occur for more than 13 days.

Table 3-6: Summary of Typical Support Vessel Requirements

Vessel Type	**Duration**	**Purpose**	**Typical POB per vessel**
Anchor Handling Tug Support Vessel (Figure 3-6)	9-13 days per well location	Up to three vessels could be used to lay anchors and tow the MODU into position.	15
Supply/Support vessel (Figure 3-7)	As required for all stages of the Project	Throughout all stages, support vessels will transport fuel, stores, waste and specialist supplies such as cement and drilling fluids to the MODU / vessels operating in the Project area. Whilst drilling one support vessel will always be with the MODU.	30
Pipelay and multipurpose service vessel (Figure 3-8)	~10-20 days per tie-in for Installation and Commissioning stages and the same for Decommissioning	Installation and decommissioning of the flowlines and umbilicals	120-160
Installation Support Vessel and/or Dive Support Vessel (Figure 3-9)	~10-20 days per tie-in for Installation and Commissioning stages and the same for Decommissioning	Installation and commissioning of subsea infrastructure and decommissioning activities	120
Inspection Maintenance and Repair vessel (Figure 3-10)	Approximately 1 month per IMR activity	Inspections, maintenance and repair campaigns are expected to be conducted annually for the life of the field.	30

Figure 3-6: Example of an Anchor Handling Tug

Figure 3-7: Example of a Supply Vessel

Figure 3-8: Example of a Pipelay/Multipurpose Service Vessel

Figure 3-9: Example of an Installation Support Vessel/Dive Support Vessel

Figure 3-10: Example of an Inspection, Maintenance, Repair Vessel

3.8.8.3 Helicopters

Helicopters are the primary form of transport for personnel to be transported to and from the MODU and may be used for installation and construction vessel transfers. It is also the quickest and preferred method to evacuate personnel in an emergency.

During drilling activities it is expected that there will be 5-8 round trips per week from the mainland to the MODU for crew changes and urgent supply needs. Helicopters will not be required during the operations stage.

Refuelling of helicopters does not usually take place offshore.

3.8.8.4 Remotely Operated Vehicles (ROV) and Autonomous Underwater Vehicles (AUV)

ROV and AUV operations may be conducted throughout all Project stages. ROVs and AUVs may also be used in an unplanned event such as a loss of well control.

ROVs and AUVs are not likely to be required to park or moor on the seabed during planned / routine activities.

3.8.8.5 Diving

Saturation and air diving operations may be conducted as part of installation, commissioning, operations (inspections, maintenance and repair), and decommissioning. Diving may also be used in an unplanned event such as a loss of containment from a flowline.

There are no emissions or discharges expected from diving activities other than those generated by the vessel.

3.9 **Assessment of Alternatives**

3.9.1 Overview

The OPGGS (Environment) Regulations (7(2)(f)) require that the OPP describe any feasible alternatives to the Project or to an activity that is part of the Project, including:

- A comparison of the environmental impacts and risks arising from the Project or activity and the alternative; and
- An explanation as to why the alternative was not preferred.

This section of the OPP presents feasible alternatives which have been considered for the Project concept and design. It provides an overview of the advantages and disadvantages of each feasible alternative with an emphasis on environmental impacts and risks.

For the purposes of the OGV OPP, a feasible alternative is one that is available and reasonably capable of being carried out after taking into consideration cost, existing technology and logistics in light of overall project purposes. As per NOPSEMA's *Offshore Project Proposal Content Requirements* (NOPSEMA 2024) the selection of the preferred Project concept also considers economic, social and engineering factors as part of the selection process.

3.9.2 Methodology

Feasible alternative design concepts were identified by Beach and summarised in Section 3.9.3.

Initial concepts were reviewed with those not carried through for alternative analysis assessment detailed in Section 3.9.4.

Concepts carried through for alternative assessment are detailed in Section 3.9.5 along with a high-level comparison of activities associated with each.

The alternative assessment for each concept is undertaken by focusing on the following two steps:

- Undertake a comparative assessment of the alternative concepts against environmental criteria to identify the concept with the least environmental impact.
- Further assess each alternative concept against the other focus areas (lifecycle, environmental impacts, economics, health & safety, technical feasibility) to justify the final selected concept.

Each of the above focus areas were assessed against criteria, as detailed in Table 3-7, in a workshop attended by subject matter experts for potential concepts that were considered to be technically and commercially feasible.

A decision matrix was used to rate each criteria based on a predetermined quality Likert scale (Table 3-8). Due to the potential large variation between options a 5-point scale was considered appropriate. The matrix was used to assess the environmental, social and economic impacts and risks of each concept with the range consisting of 1 (very good) through to 5 (very poor).

Where there was no material difference between all the provided options, each criteria was given a score of 3 (neutral). If criteria were not considered relevant, they were given a score of N/A (not applicable).

A total score has been provided for environmental criteria which represents all potential project drivers (Table 3-11). The option with the lowest score is considered the preferred environmental option. A total score for other focus areas has also been calculated (Table 3-11). Unless engineer or economic factors negate it, the concept with the combined lowest score has been carried through for impact and risk evaluation.Following the selection of the preferred design concept the above procedure was repeated for design and activity options (Section 3.9.6) for the Project which include:

- MODU type
- Completion fluids unloading
- Hydrotest discharge

Table 3-7: Assessment Criteria used in Alternatives Analysis

Aspect		Criteria
Environment	Physical presence	Interaction with other users
		Seabed Disturbance
		Interaction with marine fauna
	Emissions	Light
		Underwater noise emissions
		Atmospheric/ GHG emissions
	Discharges	Planned discharges: • Drill cutting and fluids • Cement • Commissioning and operational fluids • Routine operational wastes from vessels • Bulk powders including cement, bentonite and barite
		Unplanned discharges: • Hazardous and non-hazardous materials • Hydrocarbons and chemicals
	Introduction of invasive marine species	Invasive marine species (IMS)
Other Focus Area	Lifecycle environmental impacts	Consideration of relative life-of-field impact spanning infrastructure construction and presence, production operations and abandonment legacy impacts
	Economics	Economic viability
	Health & Safety	Health & safety standards and legislation
	Technical	Technical feasibility plus ability to operate and maintain infrastructure

Table 3-8: Quality Scale for Alternative Concepts / Options

Score	Description
1	Very good
2	Good
3	Neutral
4	Poor
5	Very poor

3.9.3 Identification of Concept Alternatives

Beach initially considered 4 different concepts during the alternative analysis comparative assessment process (Table 3-9). This assessment identified the benefits, impacts and potential risks that corresponded with each development concept. A summary of each concept is provided in Table 3-9.

Concept 4 – No development, was reviewed during early screening and was determined not to be commercially or economically viable as detailed in Section 3.9.4.

Table 3-9: Summary of Concept Alternatives

Development Concepts	**Summary**
Concept 1 - Subsea tie-back to existing facilities	Subsea tie-back to existing facilities via the shortest suitable routes between fields and tie-ins, featuring either hub and spoke or daisy chain subsea architecture arrangement for initial development with well tiebacks direct to pipeline tie in points.
Concept 2 - Well-head platform with dry trees	Unmanned fixed offshore platform / well head platform (WHP), with dry tree wells (surface well heads), to enable treatment of reservoir fluids for export via existing sub-sea infrastructure and OGPP to onshore OGP.
Concept 3 - Floating production facility	Subsea wells feeding into a manned offshore floating production facility (either floating production storage and offloading (FPSO) or floating liquefied natural gas (FLNG)) with appropriate anchor layout over the fields with the offloading of processed gas via shuttle tankers.
Concept 4 - No development	No development.

3.9.4 Concepts not carried through for assessment (Concept 4 – No Development)

Not undertaking the Project was an alternative considered by Beach during early screening and was discounted as if the Project does not go-ahead, then gas production from Beach's Otway assets will decline and the gas pools will become stranded with considerable commercial and economic impacts for Beach and the broader community.

The Project is being undertaken to replace existing production at the OGP from the Otway Basin and ultimately to deliver natural gas to the east coast gas market. Importantly, this gas will help arrest a predicted gas shortfall in Victoria and is therefore critical to ensure Victoria's energy security.

In March 2024 the Australian Energy Market Operator (AEMO) published the Victorian Gas Planning Report update (AEMO 2024) which found that Victorian production continues to decline, with large forecast reductions from 2024 to 2026. The total available gas supply is forecast to reduce by 48% over the outlook period, from 297 petajoules (PJ) in 2024 to 154 PJ in 2028. This will impact negatively on the reliability of the gas supply system and ability to meet daily peak supplies.

The Victorian economy is heavily reliant on gas. It is utilised for electricity generation, and for manufacturing, construction, agricultural and chemical industries with Victorian households having the highest natural gas usage in Australia. Victoria accounts for ~50% of gas demand in south-eastern Australia. It is vitally important to the viability of Victorian industries and residents that gas supplies are adequate and price volatility is suppressed. The ongoing supply from the Project will contribute not only to individual and community well-being but will support businesses and industry to maintain a competitive economy.

Demand is expected to continue in Victoria and the south-eastern states particularly because of the decline in coal consumption with the closure of coal-fired power stations with peak gas demand records being broken and will likely increase.

Existing southern gas reserves are in decline, and more development is required in the southern states from 2024 to ensure that all demand is met. AEMO has forecast that if Victoria wishes to accelerate the closure of its coal-fired power stations, more peaking gas-powered generation (gas needed during periods of high demand) will be needed to ensure the reliability of supply. As Australia transitions to a low emissions economy underpinned by renewable energy, natural gas will play a critical role by efficiently supporting the intermittency of solar and wind energy and future renewable technologies whilst assisting in the continued development of an internationally competitive economy. The role of gas is illustrated in Figure 3-11.

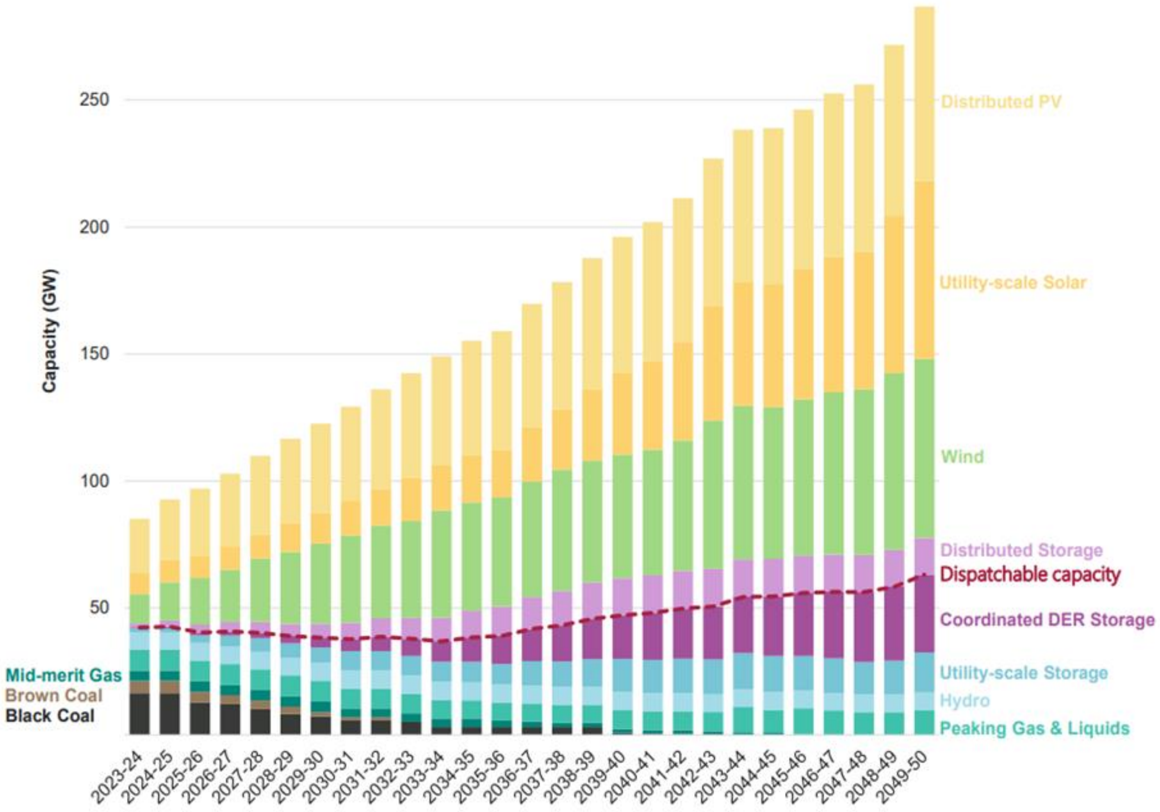


Figure 3-11: Forecast National Energy Market capacity to 2050, Step Change scenario (AEMO 2022 Integrated System Plan)

The *Victorian Climate Change Act 2017* establishes a long-term emissions reduction target for Victoria of Net Zero by 2050. The legislation requires 5-year interim targets to track the state's progress. From 2021, Adaptation Action Plans are required for key Victorian systems that may be vulnerable to climate change impacts. The legislation also requires periodic reporting to ensure transparency and accountability to the community.

The role of new gas investments within this geopolitical context is part of the transition toward lower emissions technologies and energy sources. Otway gas will play a role in reducing Victoria and Australia's emissions footprint. The development of more natural gas supplies is seen as critical in reducing Australia's emissions footprint. The Integrated System Plan (ISP), which models electricity generation up to 2050 in the National Electricity Market (NEM), was updated in June 2024 by AEMO. In the ISP most aggressive 'Step Change' scenario, it forecasts 15 GW of gas-powered generation to ensure the NEM remains resilient under a range of power system and extreme weather events. The ISP states that "electricity from gas-powered generation is forecast to continue its important role in the

NEM. After coal-fired generators retire, gas will be needed to support energy supply during periods of renewable drought and of extreme peak demand (AEMO, Integrated System Plan June 2024).

3.9.5 Concepts carried through for assessment

Beach has previously assessed the facility type and functionality for the nearby proposed Trefoil Project in Bass Strait. These learnings on technically and commercially feasible options were applied to the screening of development options for this Project in addition to factors specific to the Otway Development. Particularly considering the presence of existing subsea infrastructure and the relatively small number of additional potential wells.

The three alternative development concepts (as described in Table 3-9) carried forward for assessment were:

- Subsea tie-back to existing facilities (Concept 1);
- Well-head platform with dry trees (Concept 2); and
- Floating production facility (FPSO or FLNG) (Concept 3).

Table 3-10 provides a high-level comparison of activities associated with each concept used to identify potential risks and impacts of each concept.

Using the assessment criteria, as detailed in Section 3.9.2, Table 3-11 provides a high level summary of the impacts and risks (or lack of) for each of the three concepts carried forward for assessment. It also provides a summary of scores assigned to each criteria. Environmental, other focus areas, and total scores are summarised detailing which concept or option is carried forward for full detailed assessment within the OGV OPP.

Table 3-10: Comparison of Activities Associated with Proposed Concepts

	Concept 1 – Subsea tie-back to existing facilities	**Concept 2** – Wellhead platform with dry trees	**Concept 3** – Floating production facility
Infrastructure	Subsea wells and infrastructure connected to existing OGPP.	Dry tree wells and WHP connected to existing OGPP.	Subsea wells and infrastructure connect with floating production facility (either FPSO or FLNG)
Activities			
Surveys	Required for MODU anchor locations plus well and subsea infrastructure locations.	Required for MODU anchor locations plus subsea infrastructure and WHP locations.	Required for MODU anchor locations plus wells, subsea infrastructure, and floating production facility anchor locations.
Drilling and Completions	Anchored MODU to drill and complete wells at well locations.	Anchored MODU to drill and complete wells at well locations.	Anchored MODU to drill and complete wells at well locations.
Installation and Commissioning	Use of ISV to install and connect wells to existing OGPP.	Use of ISV to install and connect wells to existing OGPP.	Use of ISV to install and connect wells to floating production facility.

	Subsea infrastructure integrity tested with hydrotest water discharged to marine environment.	Subsea infrastructure integrity tested with hydrotest water discharged to marine environment.	Subsea infrastructure integrity tested with hydrotest water discharged to marine environment.
Operations	IMR undertaken by vessel for subsea wells and infrastructure. Well interventions conducted from either a MODU or a well intervention vessel.	IMR undertaken by vessel for subsea wells and infrastructure. Operation and maintenance of WHP. Well interventions conducted from a MODU or well intervention vessel.	IMR undertaken by vessel of subsea wells and infrastructure. Operation and maintenance of floating production facility (either FPSO of FLNG) Shuttle tankers required for offload of processed gas. Well interventions conducted from either a MODU or a well intervention vessel.
Decommissioning	MODU required for well P&A. Vessel to remove subsea infrastructure.	MODU required for well P&A. Vessel to remove subsea infrastructure. Decommissioning of WHP and removal via heavy-lift vessel, floating cranes, barges	MODU required for well P&A. Vessels to remove subsea infrastructure and floating production facility including anchor array. Floating production facility ceases operations and sails to new location or to shipyard for decommissioning.

Table 3-11: Comparative Assessment of Development Concepts

Focus Area		**Criteria**	**Concept 1** - Subsea tie-back to existing facilities	**Score**	**Concept 2** - Wellhead platform with dry trees	**Score**	**Concept 3** - Floating production storage offloading facility	**Score**	**Summary**
Environmental	Physical Presence	Interaction with other users	Potential interaction with marine stakeholders restricted to construction, interventions, IMR & decommissioning. No permanent surface facilities, therefore, no risk of surface collision during operations. Petroleum Safety Zone (PSZ) around wells and subsea infrastructure restricting access to area.	**1**	Potential interaction with marine stakeholders during construction, interventions, IMR & decommissioning. WHP is a permanent structure with associated PSZ, close to existing shipping lanes therefore increased risk of interactions / collision with other vessels. Increased IMR and decommissioning activities with associated vessels required compared to Concept 1.	**4**	Potential interaction with marine stakeholders during construction, interventions, IMR & decommissioning. FPSO / FLNG is a permanent floating structure with associated PSZ, including subsea wells and anchor spread. FPSO / FLNG close to existing shipping lanes therefore increased risk of interactions / collision with other vessels. Increase in vessel traffic from shuttle tanker movements. Increased IMR and decommissioning activities with associated vessels required compared to Concept 1 and 2.	**5**	Concept 1 score is lowest in relation to the interaction with other users due to the lack of permanent surface structures, reducing the impact and risk to other marine traffic. Both concepts 2 and 3 have permanent surface installations. Concept 3 may have a significantly larger PSZ, excluding other marine users for the duration of the project, due to the extent of the permanent anchor spread required for the floating facilities. Concept 3 will also result in additional vessel traffic than from shuttle tankers increasing risk of interactions with other marine users.
		Seabed disturbance	Footprint of subsea wells and flowlines used for tie-in to existing OGPP minimal. Anchor placement for MODU during installation and decommissioning is temporary.	**1**	Footprint of dry trees and flowlines used for tie-in to WHP and existing OGPP minimal. Anchor placement for MODU during installation and decommissioning is temporary. WHP permanently positioned on seabed for duration of the Project.	**4**	Footprint of subsea wells and flowlines used for tie-in to the floating facility minimal. Anchor placement for MODU during installation and decommissioning is temporary. Permanent anchor spread for floating facility for duration of the Project.	**5**	Concept 1 score is lowest in relation to seabed disturbance. All concepts would have minimal disturbance from subsea wells and flowlines. Both concepts 2 and 3 would have the potential for greater, longer-term seabed disturbance from the installation and decommissioning of a WHP and for the floating facility anchor spread, (which scores highest) which would be present throughout the duration of the Project.
		Interaction with marine fauna	Potential for vessel interaction with marine fauna restricted to construction, interventions, IMR & decommissioning. No permanent surface facilities.	**1**	Potential for vessel interaction with marine fauna restricted to construction, interventions, IMR & decommissioning. Potential impact (displacement and noise) to marine fauna from WHP for the duration of the Project.	**4**	Potential for vessel interaction with marine fauna during construction, interventions, IMR, decommissioning plus shuttle tanker movements for the duration of the Project. Potential impact (displacement and noise) of marine fauna from permanent floating facility, including anchor spread, for the duration of the Project.	**5**	Concept 1 score is lowest in relation to interaction with marine fauna due to the lack of surface facilities. Concept 2 and 3 score higher due to the physical presence of surface facilities. Concept 3 scores the highest due to the increase in vessel traffic as a result of regular shuttle tankers required to offload processed gas.
	Emissions	Light emissions	Temporary light emissions restricted to construction, interventions, IMR & decommissioning activities. No permanent surface facilities.	**1**	Temporary light emissions during construction, interventions, IMR & significant WHP decommissioning activities. Light emissions from permanent surface facilities (unmanned) for the duration of the Project.	**4**	Temporary light emissions during construction, interventions, IMR & significant decommissioning activities. Light emissions from permanent surface facilities (manned) for the duration of the Project.	**5**	Concept 1 scores lowest in relation to light emissions due to the lack of surface facilities during the operational phase of the Project. Concept 3 scores higher than Concept 2 as the FPSO / FLNG would be a manned surface facility which would likely be larger and require a greater degree of safety / working lights than an unmanned WHP.
		Underwater noise emissions	Potential for underwater noise emissions largely restricted to construction, interventions, IMR & decommissioning activities. No permanent surface facilities with minimal noise associated with subsea well operations.	**1**	Potential for underwater noise emissions from construction (including WHP installation), interventions, IMR & significant decommissioning activities. WHP is an unmanned permanent structure for the duration of the Project with associated onboard noise.	**4**	Potential for underwater noise emissions from construction (including floating facility anchor installation), interventions, IMR & significant decommissioning activities. Floating facility is a manned permanent facility with associated onboard noise. Increased underwater noise due to a MODU and associated support vessels being required for well interventions.	**5**	Concept 1 scores lowest in relation to underwater noise emissions due to the lack of surface facilities during the operational phase of the Project. Concept 3 scores higher than Concept 2 as the FPSO / FLNG would be a manned surface facility which would likely require increased operational noise in comparison to an unmanned WHP.

		Atmospheric / GHG emissions	Atmospheric emissions during construction, interventions, IMR & decommissioning phases.	1	Atmospheric emissions during construction, interventions, IMR & decommissioning phases. Unmanned WHP present for the duration of the operational phase will result in continuous long-term atmospheric emissions from power generation and processing.	4	Atmospheric emissions during construction, interventions, IMR & decommissioning phases. Manned floating facility present for the duration of the operational phase will result in continuous long-term atmospheric emissions from power generation and processing. Additional atmospheric emissions from shuttle tankers for the duration of the Project required to offload processed gas.	5	Concept 1 scores the lowest in relation to atmospheric / GHG emissions due to the lack of surface facilities during the operational phase of the Project. Concept 2 and 3 score higher due to the presence of surface facilities which produce continuous emissions throughout the operational phase. Concept 3 scores higher as it is a manned surface facility which results in increased operational emissions plus the increase in vessel traffic from shuttle tankers required to offload processed gas.
	Discharges	Planned discharges	Planned discharges during construction, interventions, IMR & decommissioning from support vessels and MODU. Control fluid, IMR and hydrotest discharges from subsea infrastructure during operations.	1	Planned discharges during construction, interventions, IMR & decommissioning from support vessels and MODU. Control fluid, IMR and hydrotest discharges from subsea infrastructure during operations. Possible cooling water and produced formation water from unmanned WHP which is present for the duration of the operational phase of the Project.	4	Planned discharges during construction, interventions, IMR & decommissioning from support vessels and MODU. Control fluid, IMR and hydrotest discharges from subsea infrastructure during operations. Moderate planned emissions/discharges associated with normally manned floating production facility operations. Potential planned emissions from shuttle tankers required for the duration of the operational phase of the Project required to offload processed gas.	5	Concept 1 scores lowest in relation to planned discharges due to the lack of surface facilities during the operational phase of the Project. Concept 2 and 3 score higher due to the presence of surface facilities and their associated discharges throughout the operational phase. Concept 3 scores higher due to the presence of a manned surface facility plus shuttle tankers which results in increased planned discharges during the operational phase.
		Unplanned discharges	Potential for unplanned discharges during construction, interventions, IMR & decommissioning from support vessels and MODU. Low risk of loss of containment from subsea infrastructure (wells and/or flowlines).	1	Potential for unplanned discharges during construction, interventions, IMR & decommissioning from support vessels and MODU. Low risk of loss of containment from subsea infrastructure (wells and/or flowlines). Small liquid hydrocarbon volumes planned to be maintained/stored on WHP for the duration of the Project.	4	Potential for unplanned discharges during construction, interventions, IMR & decommissioning from support vessels and MODU. Large liquid hydrocarbon volumes maintained/stored on floating facility with low risk of unplanned discharges. Risk of spills during offloading to shuttle tankers for duration of operational phase of the Project. Increased risk of spills from greater vessel presence (shuttle tankers) during the operational phase of the Project.	5	Concept 1 scores lowest in relation to unplanned discharges due to the lack of surface facilities during the operational phase of the Project. Concept 2 and 3 score higher due to the presence of surface facilities which store hydrocarbons. Concept 3 scores higher as it has a larger storage capacity plus increased risks resulting from offloading of processed gas to shuttle tankers.
	Introduction of invasive marine species	Invasive marine species (IMS)	IMS risk associated with vessels used during construction, interventions, IMR & decommissioning activities only.	1	IMS risk associated with vessels used during construction, interventions, IMR & decommissioning activities. Increased risk of introduction of IMS from WHP due to overseas manufacture. Presence of WHP structure suitable for colonisation.	4	IMS risk associated with vessels used during construction, interventions, IMR & decommissioning activities. Increased risk of introduction of IMS from floating facility due to overseas manufacture. Presence of floating facility and anchor spread suitable for colonisation. Increased risk of introduction of IMS from visiting shuttle tankers from overseas locations.	5	Concept 1 scores lowest in relation to IMS due to the lack of surface facilities and possible colonisation surfaces during the operational phase of the Project. Concept 2 and 3 score higher due to the presence of surface facilities which provide a surface for possible colonisation. Concept 3 is scored higher due to the anchor spread plus increased risks resulting from offloading of processed gas to shuttle tankers transiting from oversea locations.
Other Focus	Lifecycle environmental impacts	Consideration of relative life-of-field impact	Concept footprint is minimal, localised and benefits from utilising existing subsea infrastructure, with limited new subsea infrastructure required for tie-in.	1	Concept footprint is moderate, localised and includes installation of new WHP and associated infrastructure.	4	Concept footprint is minimal, localised and includes anchor mooring spread for floating facility.	5	Concept 1 scores lowest in relation to the lifecycle environmental impacts due to the lack of surface facilities and limited planned discharges.

				Minimal planned discharges associated with unmanned WHP for the duration of the operational phase of the Project. Atmospheric emissions associated with this concept are significant.		Moderate planned emissions/discharges associated with normally manned floating production facility for the duration of the operational phase of the Project. Atmospheric emissions associated with this concept are significant.		Concept 2 and 3 score higher due to the presence of surface facilities which result in additional emissions/discharges. Concept 3 is scored higher due to the increased vessel movements as a result of offloading processed gas to shuttle tankers.
Economics	Economic viability	Costs associated with development include tie-in to an existing facility and utilise existing infrastructure.	**1**	Costs associated with installation, IMR and decommissioning of unmanned WHP. Costs associated with tie-in to WHP.	**4**	Cost associated with installation, IMR and decommissioning of manned floating production facility. Costs associated with operations of shuttle tankers for the duration of the operational Phase of the Project. Costs associated with tie-in to floating facility.	**5**	Concept 1 scores low in relation to the economics of the project due to the lack of surface facilities and associated costs for construction and installation. Concept 3 scores high due to the construction and maintenance costs associated with a manned surface facility and costs associated with shuttle tankers required to offload processed gas.
Health & Safety	Health & safety standards and legislation	Risks associated with support vessels and MODU during construction, interventions, IMR & decommissioning. No manned offshore facilities. Minimal IMR for subsea infrastructure.	**1**	Risks associated with support vessels and MODU during drilling and IMR plus major offshore construction and decommissioning of WHP. WHP will require periodic maintenance. As no accommodation on WHP frequent helicopter transfers required. Systems on the topsides therefore are likely to require more frequent IMR than a manned installation. Risk of vessel collision due to presence of WHP during the operational phase of the Project. Risk to personnel whilst temporarily manned during maintenance.	**4**	Risks associated with support vessels and MODU during drilling and IMR plus major offshore construction and decommissioning of floating facility anchor spread. Normally manned floating facility will require frequent vessel resupply transfers. Higher risk of vessel collision due to presence of a floating facility. Risk to personnel as permanently manned during all phases of operation.	**5**	Concept 1 scores lowest in relation to health and safety. The risks and considered significantly smaller than those associated with the surface facilities for concepts 2 and 3. Concept 3 scores high due to the presence of a manned floating facility and associated risks, plus considerably increase vessel operations resulting from shuttle tanker movements.
Technical	Technical feasibility	All processing via existing Otway Gas Plant. Subsea completions may be completed by either a MODU or the use of a light well intervention vessel.	**1**	Subsea completions may be completed by either a MODU or the use of a light well intervention vessel. Crews to visit the platform for periodic maintenance and inspections via helicopter. Significant construction associated with WHP. Increased IMR associated with the WHP compared with Concept 1.	**4**	Subsea completions may be completed by either a MODU or the use of a light well intervention vessel. Normally manned floating facility requires continuous IMR by onboard personnel. Significant construction associated with floating facility.	**5**	Concept 1 score lowest in relation to technical feasibility with the relatively simpler concept of the tie-in to existing infrastructure and lack of surface facilities. Concept 2 and 3 scores high due to the construction requirements for surface facilities which result in additional technical complexities. Concept 3 scores higher due to the major construction requirements of a floating facility and logistics involved with operating shuttle tankers throughout the operational phase of the Project.
Environmental Score			**9**		**36**		**45**	**Concept 1** is the simplest possible option, utilising existing infrastructure and subsea wellheads, with the shortest suitable routes between fields and tie-ins and therefore has the lowest environmental and social footprint when considered over the life of the development. Furthermore, it is the most economical, safe and feasible option and as such is the preferred choice. In comparison, Concepts 2 and 3 add complexity and cost in addition to potential increased environmental impact and risk.
Other Focus Areas			**4**		**16**		**20**	
Total Score			**13**		**52**		**65**	

3.9.6 Analysis of Preferred Concept Design / Activity Alternatives

Following the selection of the preferred concept (Concept 1 – Subsea tie-back to existing subsea facilities), alternative options were considered for the design and activities associated with this concept. The design was evaluated against planned and unplanned activities for elements requiring further assessment (Table 3-12). This section describes the key alternative elements that were considered and compared for Concept 1.

Design and activity elements for the Project include:

- MODU type
- Completion fluids unloading
- Hydrotest discharge

Within the following subsections each element and their associated alternatives are compared.

Table 3-12: Scoping for Design Alternatives for Concept 1 - Subsea Tie-back to Existing Facilities

Focus Area		**Criteria**	**Concept 1** - Subsea tie-back to existing facilities	**Design/Activity Alternative Analysis Required**
Environmental	Physical Presence	Interaction with other users	Potential interaction with other marine users restricted to when MODU and vessels undertaking activities. Type of vessel selected does not impact on the risk of interaction with other marine users. Type of MODU selected could impact on the risk of interaction with other marine users as some MODU types require less support vessels.	Yes – MODU type.
		Seabed disturbance	Subsea infrastructure seabed disturbance is as low as feasibly possible with limited new subsea infrastructure required for tie-in. Type of MODU selected could impact drilling and intervention seabed disturbance area.	Yes – MODU type.
		Interaction with marine fauna	Potential interaction with marine fauna restricted to when MODU and vessels undertaking activities. Type of vessel selected does not impact on the risk of interaction with marine fauna.	Yes – MODU type.
	Emissions	Light emissions	Light emissions restricted to when MODU and vessels undertaking activities. MODU and vessel types will have similar light emissions. Well unload and testing could impact light emissions.	Yes – MODU type.
		Underwater noise emissions	Minimal noise associated with subsea well operations. Underwater noise emissions restricted when MODU and vessels undertaking activities. All vessels will be DP as water depths are to deep for anchoring. Type of MODU selected could impact drilling and intervention underwater noise emissions.	Yes – MODU type.
		Atmospheric / GHG emissions	Atmospheric emissions restricted to when MODU and vessels undertaking activities. Type of MODU selected could impact atmospheric emissions. Well unload and testing could impact atmospheric emissions.	Yes – MODU type.

	Discharges	Planned discharges	Domestic liquid/solids waste discharges restricted to when MODU and vessels undertaking activities. Type of MODU selected could impact on domestic liquid/solids wastes discharges as some MODU types require less support vessels. BOP, drilling and completion fluid discharges are the same for all MODU types. Discharge of completion fluids options (MODU or OGP) could impact planned liquid discharges. Unloading and testing the well to the OGP is not intended, however, is provided for as a contingency in the event it is required for technical and feasibility reasons. Discharge of hydrotest fluids options (discharge to marine environment or OGP) could impact planned liquid discharges.	Yes – MODU type. Yes – Completion fluids discharge. Yes – Hydrotest discharge.
		Unplanned discharges	Low risk of loss of containment from subsea infrastructure (wells and/or flowlines). Vessels have similar risk of loss of containment. Type of MODU selected could impact on the risk of loss of containment.	Yes – MODU type.
	Introduction of invasive marine species	Invasive marine species (IMS)	IMS risk restricted to when MODU and vessels undertaking activities. Vessels have similar IMS risk. Type of MODU selected could impact IMS risk.	Yes – MODU type.

3.9.6.1 MODU Type

For Project activities where a MODU is required three options were considered as detailed within Table 3-13.

- Option 1 – Anchored MODU (or DP assist Anchored MODU). The MODU is towed into position and moored to the seabed with anchors. Approximately 8-12 anchors are required, which are tethered to the MODU with mooring lines.
- Option 2 – Dynamic Positioned (DP) MODU. The MODU uses DP to hold itself in position.
- Option 3 – Jack up MODU. The MODU is towed into position with its legs lowered to the seabed raising the MODU hull above sea level.

Table 3-13 details the environmental, social and economic impacts and risks of each option using the 5-point scale (Table 3-8) as per previous methodology.

Table 3-13: Comparative Assessment of Criteria for MODU Options

Focus Area		Criteria	**Option 1** – Anchored MODU (or DP assist Anchored MODU	Score	**Option 2** – DP MODU	Score	**Option 3** – Jack-up MODU	Score	Summary
Environmental	Physical presence	Interaction with other users	Temporary MODU presence and associated exclusion zone close to existing fishing and shipping lanes.	3	Temporary MODU presence MODU and associated exclusion zone close to existing fishing and shipping lanes.	3	Temporary MODU presence MODU and associated exclusion zone close to existing fishing and shipping lanes.	3	Whilst the anchor spread of Option 1 would impact a greater area, all 3 options will have a similar exclusion zone whilst the MODU is on site and operational. Therefore, it is considered that there are no material differences between options.
		Seabed disturbance	Seabed disturbance associated with temporary anchor spread used for MODU mooring. Flowlines and well sites present for the duration of the Project	2	Flowlines and well sites present for the duration of the Project	1	Seabed disturbance associated with jack-up legs lowered onto seabed. Risk of leg "punch-throughs" previously seen in similar operations in the Bass Strait. Flowlines and well sites present for the duration of the Project	5	Option 2 scores lowest in relation to seabed disturbance. Seabed disturbance will be limited to wells and flowlines only. Option 3 is scores high due to the risk of "punch-throughs".
		Interaction with marine fauna	Risk of marine fauna interaction associated with presence of MODU and support vessels	3	Risk of marine fauna interaction associated with presence of MODU and support vessels.	3	Risk of marine fauna interaction associated with presence of MODU and support vessels.	3	Whilst the anchor spread of Option 1 covers a slightly greater area the additional risk of interaction with marine fauna it is considered negligible with all 3 options considered to have similar risks.
	Emissions	Light emissions	Temporary presence of MODU on site during drilling and decommissioning phases with support vessels required.	3	Temporary presence of MODU on site during drilling and decommissioning phases with support vessels required.	3	Temporary presence of MODU on site during drilling and decommissioning phases with support vessels required.	3	Each MODU will spend a similar time on site during drilling and decommissioning phases.
		Underwater noise emissions	Minor noise emissions associated with occasional use of dynamic positioning thruster system to assist positioning during extreme weather events. Onboard machinery noise. Noise emissions associated with support vessels."	2	Significant noise emissions associated with continuous use of dynamic positioning thruster system to hold location. Onboard machinery noise. Noise emissions associated with support vessels.	5	Noise emissions associated with jack-up and jack-down operations. Onboard machinery noise. Noise emissions associated with support vessels.	1	Option 3 scores lowest in relation to underwater noise emissions. Whilst all options will have similar noise levels resulting from onboard machinery and support vessels there is no associated noise from DP. DP is known to generate increased underwater noise levels. Option 2 scores high due to the continuous use of DP for the duration of the time that the MODU would be on site.
		Atmospheric / GHG emissions	Emissions associated with MODU operations and power generation. Emissions associated with occasional use of dynamic positioning thruster system to assist with holding position in extreme weather events. Atmospheric emissions associated with support vessels.	2	Emissions associated with MODU operations and power generation. Emissions associated with continuous use of dynamic positioning thruster system to hold location. Atmospheric emissions associated with support vessels.	5	Emissions associated with MODU operations and power generation. Atmospheric emissions associated with support vessels.	1	Option 1 scores low in relation to atmospheric / GHG emissions. Whilst options 1 and 3 will have similar emission levels, it is expected that whilst on station Option 1 will require the occasional use of DP to hold position in extreme weather events. Option 2 scores high due to the continuous use of DP for the duration of the time that the MODU would be on site.
	Discharges	Planned discharges	Typical waste as expected from temporary drilling, commissioning and routine operations.	3	Typical waste as expected from temporary drilling, commissioning and routine operations.	3	Typical waste as expected from temporary drilling, commissioning and routine operations.	3	Similar planned discharges are expected from all options whilst the MODU is on site and operational.
		Unplanned discharges	Typical risks associated with drilling, commissioning and routine operations including accidental discharge of hazardous and non-hazardous material plus loss of containment.	3	Typical risks associated with drilling, commissioning and routine operations including accidental discharge of hazardous and non-hazardous material plus loss of containment.	3	Typical risks associated with drilling, commissioning and routine operations including accidental discharge of hazardous and non-hazardous material plus loss of containment.	3	Similar planned discharges are expected from all options whilst the MODU is on site and operational.

	Introduction of invasive marine species	Invasive marine species (IMS)	Risk of IMS introduction related to MODU travelling from overseas, anchor spread and seabed contact.	**4**	Risk of IMS introduction related to MODU travelling from overseas.	**2**	Risk of IMS introduction related to MODU travelling from overseas and seabed contact.	**5**	Option 2 scores lowest in relation to the risk of the introduction of invasive marine species. Options 1 will have no seabed contact limiting the possibility of an IMS being able to establish itself. Whilst both option 1 and 2 will have seabed contact anchor spreads are usually transported in dry conditions making it difficult for an IMS to establish. The legs of a jack-up MODU can remain wet whilst travelling between locations increasing the possibility of transporting an IMS.
	Lifecycle environmental impacts	Consideration of relative life-of-field impact	Temporary presence on site.	**N/A**	Temporary presence on site.	**N/A**	Temporary presence on site.	**N/A**	As MODU presence on site will be temporary, lifecycle environmental impacts are not considered applicable for this assessment.
Other Focus Areas	Economics	Economic viability	Moderate design. Generally, more expensive to contract than Option 3 but less than Option 2.	**4**	More expensive to contract Options 1 and 3 due to technical capabilities of DP.	**5**	Simple design. Generally, less expensive to contract than Option 1 or Option 2	**1**	Option 1 scores lowest in relation to economics. Jack-up rigs are of a relatively simpler design than anchored or DP MODUs. Option 2 scores high due to the technical capabilities of DP.
	Health & Safety	Health & safety standards and legislation	Success of historical operations in region.	3	No anchor handling risk. Risk of station keeping	**3**	Based on feasibility studies, safety risk exacerbated by inherent risk for rapid leg penetration (punch-through) as seen in similar operations in the Bass Strait.	**5**	Options 2 and 3 are considered to have no material difference between options considering health and safety, with operations for both MODU types well understood with standard industry practises. Option 3 scores high due to the risk of rapid leg penetration of the seabed (punch-through).
	Technical	Technical feasibility	Success of historical operations in region	1	MODU generally suitable for deeper water depths than those present in the Project Area.	**4**	Risk for rapid leg penetration (punch-through) as seen in similar operations in the Bass Strait. Water depths and metocean conditions may not be suitable	**5**	Option 1 scores lowest in relation to technical feasibility due the success of historical operations utilising this type of MODU in the region. Option 3 scores high due to the risk of rapid leg penetration of the seabed (punch-through).
Environmental Score				**25**		**28**		**27**	**Option 1** is the most suitable option for drilling operations for the Project. It has the lowest environmental and other focus score when considered against options 2 and 3. Methods for Option 1 are commonly used in the Otway region with impacts and risks well understood. Technically both the full DP and jack-up MODU are generally not suitable for the Otway region due to water depths, metocean conditions and the risk of punch through.
Other Focus Areas				**8**		**12**		**11**	
Total Score				**33**		**40**		**38**	

3.9.6.2 Completion Fluids Unloading Qualitative Assessment of Alternatives

Beach may utilise completion fluids as part of wellbore clean-up during completions. This fluid is placed in the well to facilitate final operations prior to initiation of production.

Two options were considered for the disposal of completion fluids for the Project which are:

- Option 1 - Wells cleaned up to MODU (Clean up to rig/MODU - CUTR)
- Option 2 - Wells cleaned up to plant (OGP) (Clean up to Plant – CUTP)

With Option 1, the completion fluids (consisting of completion brine and any formation water or condensate present in the wellbore) are circulated back to the MODU for treatment prior to discharge. The discharge may also include any excess completion brine remaining in the MODU tank system discharged to sea as per standard operating procedures. These discharges may result in a temporary decrease in water quality in the water column, however, the risks can be managed to an acceptable level.

If there is the potential for oil to be present, the completion fluids will be tested and discharged only if the oil-in-water content is below 30ppm. Fluid not meeting this criterion will be stored in tanks onboard the MODU for later onshore disposal.

With Option 2, the completion fluids are circulated back to the OGP via the OGPP for treatment prior to disposal, with this activity occurring post-installation and tie-in of subsea infrastructure.

Table 3-14 provides a comparison of criteria for each option as per previous methodology.

Table 3-14: Completions Fluids Unloading Qualitative Assessment of Alternatives

Focus Area		**Criteria**	**Option 1** – Wells cleaned up to rig/MODU (CUTR)	**Score**	**Option 2** – Wells cleaned up to the plant (CUTP)	**Score**	**Summary**
Environmental	Physical presence	Interaction with other users	No additional risk other than those identified for MODU Option 1.	3	No additional risk other than those identified for MODU Option 1.	3	No material difference between options
		Seabed disturbance	No additional risk other than those identified for MODU Option 1.	3	No additional risk other than those identified for MODU Option 1.	3	No material difference between options
		Interaction with marine fauna	No additional risk other than those identified for MODU Option 1.	3	No additional risk other than those identified for MODU Option 1.	3	No material difference between options
	Emissions	Light emissions	Short term flaring	4	No additional risk other than those identified for MODU Option 1.	1	Option 2 scores lowest in relation to light emissions as no flaring. Option 1 involves short-term flaring and increased light emissions.
		Underwater noise emissions	Temporary flaring noise.	4	Perforations runs.	1	Option 2 scores lowest in relation to underwater noise emissions as none expected. Option 1 involves short-term flaring and increased surface noise emissions with minimal in water impacts.
		Atmospheric / GHG emissions	No additional risk other than those identified for MODU Option 1.	3	No additional risk other than those identified for MODU Option 1.	3	No material difference between options
	Discharges	Planned discharges	Temporary and localised changes to water quality	4	No additional risk other than those identified for MODU Option 1.	1	Option 2 scores lowest in relation to planned discharges as there will be no discharges to the marine environment with this option.
		Unplanned discharges	No additional risk other than those identified for MODU Option 1.	3	No additional risk other than those identified for MODU Option 1.	3	No material difference between options
	Introduction of invasive marine species	Invasive marine species (IMS)	No additional risk other than those identified for MODU Option 1.	3	No additional risk other than those identified for MODU Option 1.	3	No material difference between options
	Lifecycle environmental impacts	Consideration of relative life-of-field impact	Temporary activity	**N/A**	Temporary activity	**N/A**	Temporary activity, therefore, lifecycle environmental impacts are not considered applicable for this assessment.
Other Focus Areas	Economics	Economic viability	Comparative low cost.	1	Comparative high cost.	5	Option 1 scores lowest in relation to economics. CUTR is the most viable economical viable option as: • costs can be shared between other operators. • cost associated with rig time and significantly less • reduced critical path rig time • elimination of deferred production risk from offshore production wells tied to subsea flowline whilst testing the new wells through the OGP.
	Health & Safety	Health & safety standards and legislation	Risk includes bringing HC to surface on the MODU and handling through a temporary processing facility	4	Common industry practice. Hydrocarbons will be flowed back to the OGP for processing through existing facilities.	2	Option 2 scores lowest in relation to health and safety as hydrocarbons will be flowed back to existing facilities. However, Option 1 is common industry practice.
	Technical	Technical feasibility	Common industry practice. Reduced technical risk by eliminating the requirement for coil hose, nitrogen pumping and additional wireline activities required for perforating.	1	Technically feasible but increased technical risk due to requirement for coil hose, nitrogen pumping and additional wireline activities required for perforating.	5	Option 1 scores lowest in relation to technical feasibility as is common industry practice and has a reduced technical risk.
Environmental Score				**30**		**21**	Whilst Option 2 scores slightly lower for combined environmental and social footprints, Option 1, is a commonly used method in the Otway region with impacts and risks well understood. The significant difference between the technical and economics of Option 1 compared with that of Option 2, offsets the differences between environmental criteria of the 2 options.
Other Focus Areas				**6**		**12**	
Total Score				**36**		**33**	

3.9.6.3 Hydrotest Fluid Discharge Qualitative Assessment of Alternatives

Beach will complete hydrostatic testing to determine the integrity of subsea infrastructure. Flowlines will be filled with inhibited seawater and subjected to test pressures that will meet design code requirements, typically significantly above any pressures seen during operation.

Two options were considered for the disposal of hydrotest discharges for the Project which are:

- Option 1 - Discharge to the marine environment
- Option 2 - Discharge to plant via OGPP

Table 3-15 provides a comparison of criteria for each option as per previous methodology.

Table 3-15: Hydrotest Fluid Discharge Qualitative Assessment of Alternatives

Focus Area		**Criteria**	**Option 1** – Discharge to marine environment	**Score**	**Option 2** – Discharge to plant via OGPP	**Score**	**Summary**
Environmental	Physical presence	Interaction with other users	No impact identified.	**3**	No impact identified.	**3**	No material difference between options
		Seabed disturbance	No impact identified.	**3**	No impact identified.	**3**	No material difference between options
		Interaction with marine fauna	No impact identified.	**3**	No impact identified.	**3**	No material difference between options
	Emissions	Light emissions	No impact identified.	**3**	No impact identified.	**3**	No material difference between options
		Underwater noise emissions	No impact identified.	**3**	No impact identified.	**3**	No material difference between options
		Atmospheric / GHG emissions	No impact identified.	**3**	No impact identified.	**3**	No material difference between options
	Discharges	Planned discharges	Temporary and localised changes to water quality	**4**	No impact identified.	**1**	Option 2 scores lowest in relation to planned discharges as there will be no discharges to the marine environment with this option.
		Unplanned discharges	Similar risk of unplanned discharge	**3**	Similar risk of unplanned discharge	**3**	No material difference between options
	Introduction of invasive marine species	Invasive marine species (IMS)	No impact identified.	**3**	No impact identified.	**3**	No material difference between options
	Lifecycle environmental impacts	Consideration of relative life-of-field impact	Temporary activity	**N/A**	Temporary activity	**N/A**	Temporary activity, therefore, lifecycle environmental impacts are not considered applicable for this assessment.
Other Focus Areas	Economics	Economic viability	No additional cost.	**1**	Potentially requires existing production from existing Thylacine/Geographe Fields to be taken offline. Added economic risk should production stay offline longer than planned.	**5**	Option 1 scores lowest in relation to economics as Option 2 would require existing facilities to pause production.
	Health & Safety	Health & safety standards and legislation	Common industry practice,	**4**	Common industry practice. Fluids will be flowed back to the Otway Gas Plant for processing through existing facilities.	**2**	Option 2 scores lowest in relation to health and safety as hydrocarbons will be flowed back to existing facilities. However, Option 1 is common industry practice.
	Technical	Technical feasibility	Technically feasible, common industry practice.	**3**	Technically feasible, common industry practice.	**3**	No material difference between options
Environmental Score				**28**		**25**	The qualitative assessment of each concept shows similar results with Option 2 – Discharge to plant having, having a very slightly lower environmental footprint. Similarly, Option 1 – Discharge to the marine environment has a slightly lower score for other focus areas. Both are commonly used methods in the Otway region with impacts and risks well understood. Therefore, for the purposes of this OPP, Beach Energy will carry both options through for assessment
Other Focus Areas				**8**		**10**	
Total Score				**36**		**35**	

4 Description of the Environment

The physical, biological, and socio-economic environment that may be affected by the Project is described in this section, together with the details of the particular relevant values and sensitivities of that environment.

The existing environment that may be affected by the Project is defined as the area where a change to ambient environmental conditions may potentially occur as a result of planned activities or unplanned events. It is noted that a change does not always imply that an adverse impact will occur; for example, a change may be required over a particular exposure value or over a consistent period of time for an adverse impact to occur.

Table 4-1 and Figure 4-1 detail the areas associated with the Project that are used to describe the environmental that may be affected. In addition to those zones, aspect-specific EMBAs are defined in the environmental impact evaluation sections (Section 5), including light EMBAs and noise EMBAs. Where relevant, these EMBAs are shown spatially within this chapter.

Table 4-1: Description of the Areas Used to Define the Existing Environment

Zones	Description
Project Area	The Project Area is within Commonwealth waters and is where all infrastructure and activities associated with the Project will be undertaken as detailed in Section3.5 The EPBC Protected Matters Search Tool (PMST) Report for the Project Area is provided in Appendix A.
Planning Area	The Planning Area is within Commonwealth, Victorian and Tasmanian waters and reaches Victorian and Tasmanian (King Island) shorelines (Figure 4-1). The Planning Area is based on a combination of the MDO (Diesel) Planning Area and Condensate Planning Area based on the spill modelling to the low thresholds as detailed in Section 7.4. for two separate release locations for conservatism. The PMST Report for the Planning Area is in Appendix B.

4.1 Regional context

The Project Area and Planning Area are within the South-east Marine Region, with the Project Area within the Western Bass Strait Shelf Transition and West Tasmania Transition Provincial bioregions (Figure 4-1). The bioregions are based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA v4.0) which is a spatial framework for classifying Australia’s marine environment into bioregions that make sense ecologically and are at a scale useful for regional planning (CoA 2005).

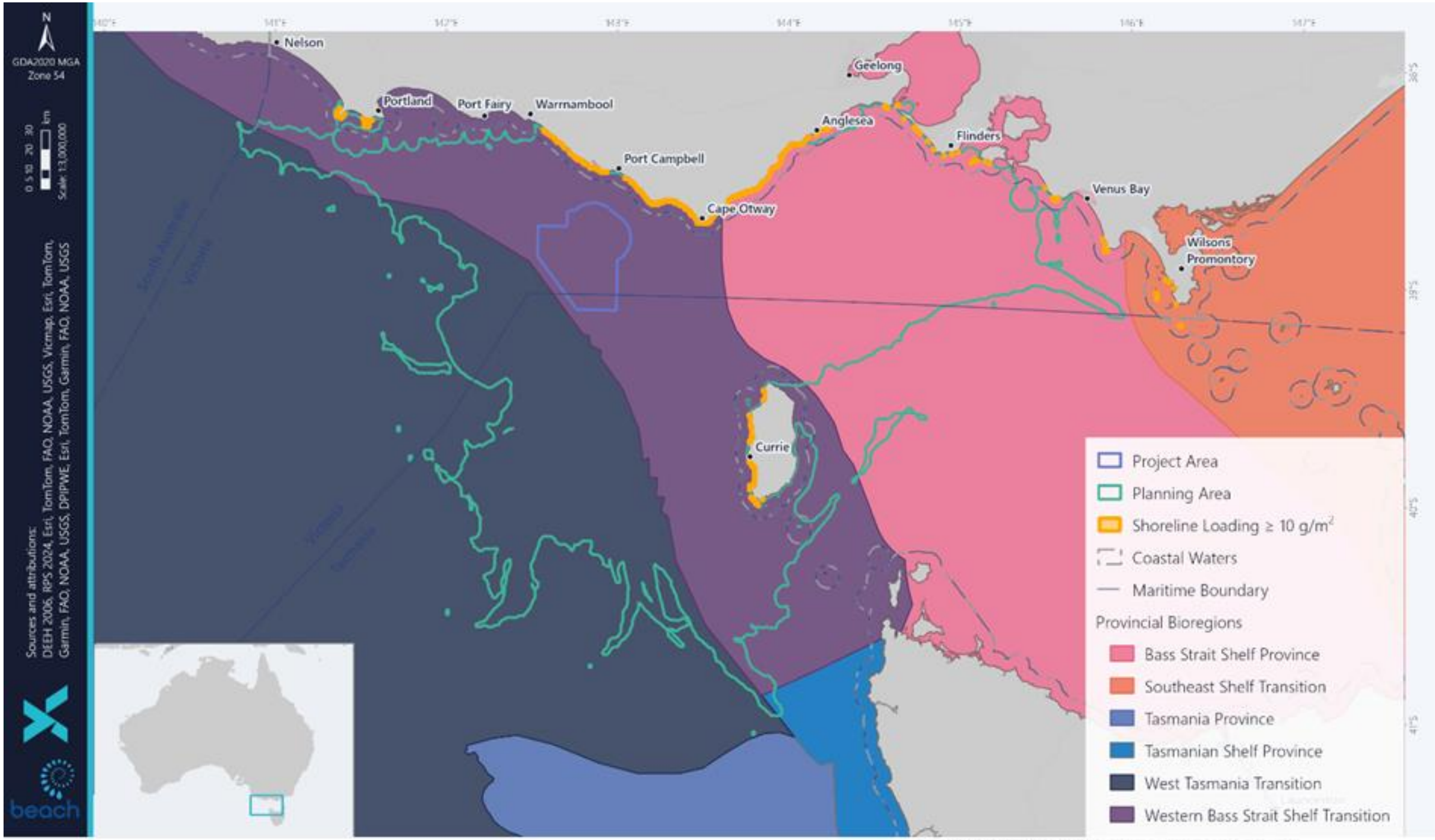


Figure 4-1: Provincial Bioregions within the Project Area and Planning Area

4.2 **Conservation Values and Sensitivities**

The following section details the conservation values and sensitivities identified within the Project Area and Planning Area identified from PMST Reports (Appendix A; Appendix B), reputable, peer-reviewed literature and relevant person consultation.

4.2.1 World Heritage Properties

No World Heritage Properties were identified within the Project or Planning Areas (Appendix A; Appendix B).

4.2.2 Australian Marine Parks

No Australian Marine Parks were identified within the Project Area (Figure 4-2).

Australian Marine Parks identified within the Planning Area (Appendix B) are presented in Table 4-2 and Figure 4-2. Australian Marine Parks identified in the PMST Reports due to the size of the grids used in the PMST but not actually intersecting the Planning Area are listed in the table with 'X'. Australian Marine Parks which intersect the Planning Area are discussed in the subsections below.

Table 4-2: Australian Marine Parks Identified within the Project and Planning Areas

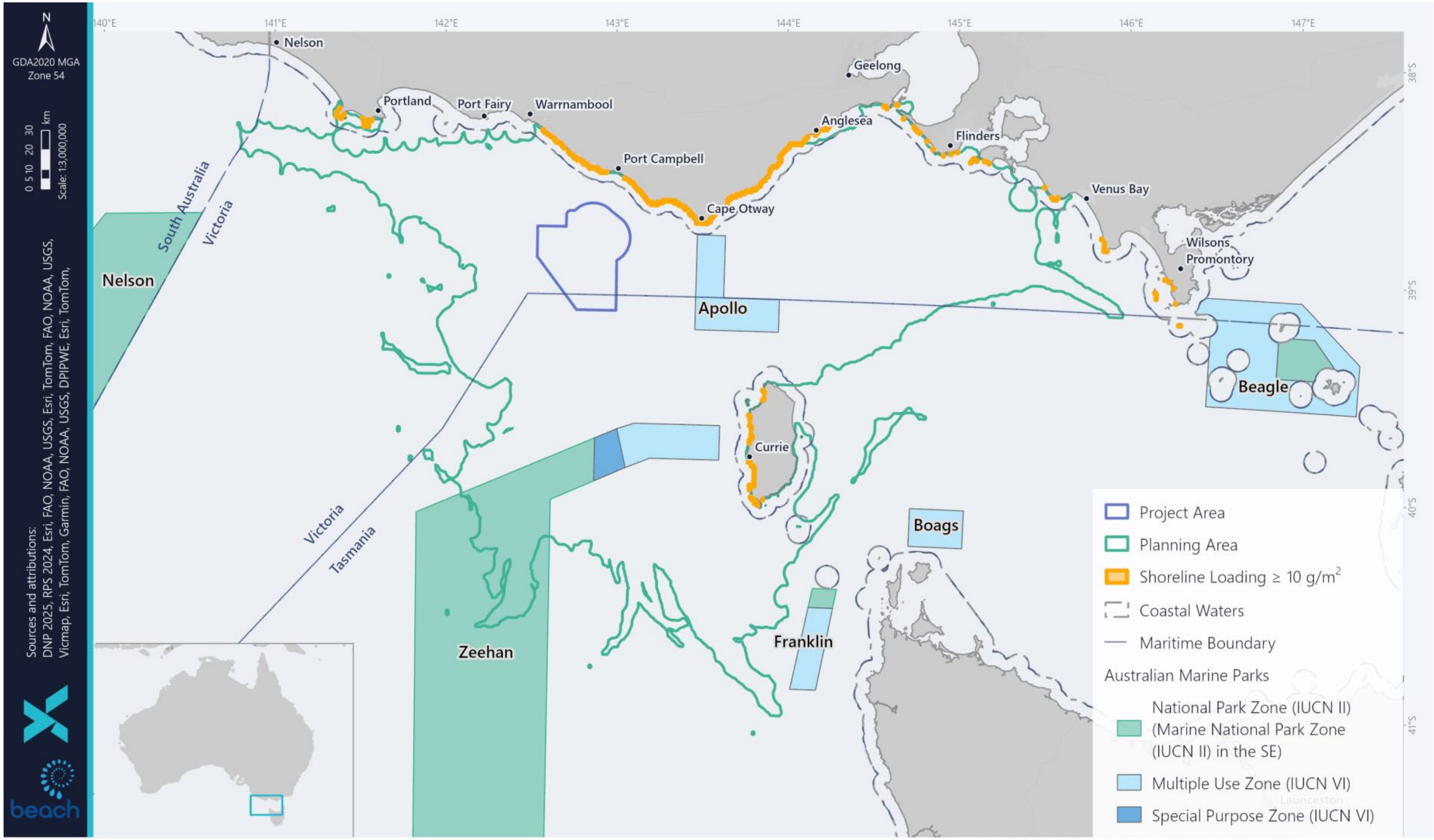
Australian Marine Park	Zone & IUCN Categories	Project Area	Planning Area
Apollo	Multiple Use Zone (IUCN VI)	-	✓
Franklin	Multiple Use Zone (IUCN VI) National Park Zone (IUCN II)	-	X
Zeehan	Multiple Use Zone (IUCN VI)	-	✓
	Special Purpose Zone (IUCN VI)	-	✓
	National Park Zone (IUCN II)	-	✓

The majority of AMPs within the Planning Area are classified as International Union for Conservation of Nature (IUCN) VI – Multiple Use Zone, in which a wide range of sustainable activities are allowed if they do not significantly impact on benthic (seafloor) habitats or have an unacceptable impact on the values of the area. Allowable activities include commercial fishing, general use, recreational fishing, defence, and emergency response. Some forms of commercial fishing, excluding demersal trawl, Danish seine, gill netting (below 183 m) and scallop dredging, are allowed, provided that the operator has approval from the Director of National Parks and abides by the conditions of that approval.

A section of Zeehan AMP within the Planning Area is classified as IUCN VI - Special Purpose Zone, which allows for limited mining and low-level extraction of natural resources. Permitted activities are similar to Multiple Use Zones; however, commercial fishing is not permitted.

Further, a section of the Zeehan AMP within the Planning Area is classified as IUCN II – National Park Zone, which provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible. Unauthorised activities include mining, offshore wind energy, CCS, commercial fishing, etc.

The South-east Marine Reserves are managed under the South-east Marine Parks Network Management Plan (DNP 2025).



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_S04_A.aprx, P100383_S00_04_MPAs, XWS-PER003, 24/02/2025

Figure 4-2: Australian Marine Parks within the Planning Area

4.2.2.1 Apollo AMP

The Apollo AMP is located off Apollo Bay on Victoria's west coast in waters 80 m to 120 m deep on the continental shelf. The reserve covers 1,184 km^2 of Commonwealth ocean territory (DNP 2013). The AMP encompasses the continental shelf ecosystem of the major biological zone that extends from South Australia to the west of Tasmania. The area includes the Otway Depression, an undersea valley that joins the Bass Basin to the open ocean. Apollo AMP is a relatively shallow reserve with big waves and strong tidal flows; the rough seas provide habitats for fur seals and school sharks (DNP 2013).

The major conservation values of the Apollo AMP (DNP 2013) are:

- ecosystems, habitats, and communities associated with the Western Bass Strait Shelf Transition and the Bass Strait Shelf Province and associated with the seafloor features: deep/hole/valley and shelf.
- important migration area for blue, fin, sei and humpback whales.
- important foraging area for black-browed and shy albatross, Australasian gannet, short-tailed shearwater and crested tern.
- cultural and heritage site - wreck of the MV City of Rayville.

4.2.2.2 Zeehan AMP

The Zeehan AMP covers an area of 19,897 km^2 to the west and south-west of King Island in Commonwealth waters surrounding north-western Tasmania (DNP 2013). It covers a broad depth range from the shallow continental shelf depth of 50 m to the abyssal plain which is over 3,000 m deep. The AMP spans the continental shelf, continental slope and deeper water ecosystems of the major biological zone that extends from South Australia to the west of Tasmania. Four submarine canyons incise the continental slope, extending from the shelf edge to the abyssal plains. A rich community made up of large sponges and other permanently attached or fixed invertebrates is present on the continental shelf, including giant crab (*Pseudocarcinus gigas*). Concentrations of larval blue wahoo (*Seriolella brama*) and ocean perch (*Helicolenus* spp.) demonstrate the role of the area as a nursery ground.

Rocky limestone banks provide important seabed habitats for a variety of commercial fish and crustacean species including the giant crab. The area is also a foraging area for a variety of seabirds such as fairy prion, shy albatross, silver gull, and short-tailed shearwater (DNP 2013).

The major conservation values for the Zeehan AMP (DNP 2013) are:

- examples of ecosystems, habitats and communities associated with the Tasmania Province, the West Tasmania Transition and the Western Bass Strait Shelf Transition and associated with the seafloor features: abyssal plain/deep ocean floor, canyon, deep/hole/valley, knoll/abyssal hill, shelf, and slope.
- important migration area for blue and humpback whales.
- important foraging habitat for black-browed, wandering and shy albatrosses, and great-winged and cape petrels.

4.2.3 National Heritage Places

No National Heritage Places were identified within the Project Area (Figure 4-3 ; Appendix A).

National Heritage Places identified within the Planning Area (Appendix B) are presented in Table 4-3 and Figure 4-3. National Heritage Places which overlap the Planning Area are described in the subsections below.

Table 4-3: National Heritage Places Identified within the Project Area and Planning Area

National Heritage Places	Class	Status	Coastal Component	Project Area	Planning Area
Great Ocean Road and Scenic Environs	Historic	Listed place	✓	-	✓
Point Nepean Defence Sites and Quarantine Station Area	Historic	Listed place	✓	-	✓
Quarantine Station and Surrounds (within Point Nepean Site)	Historic	Within listed place	✓	-	✓

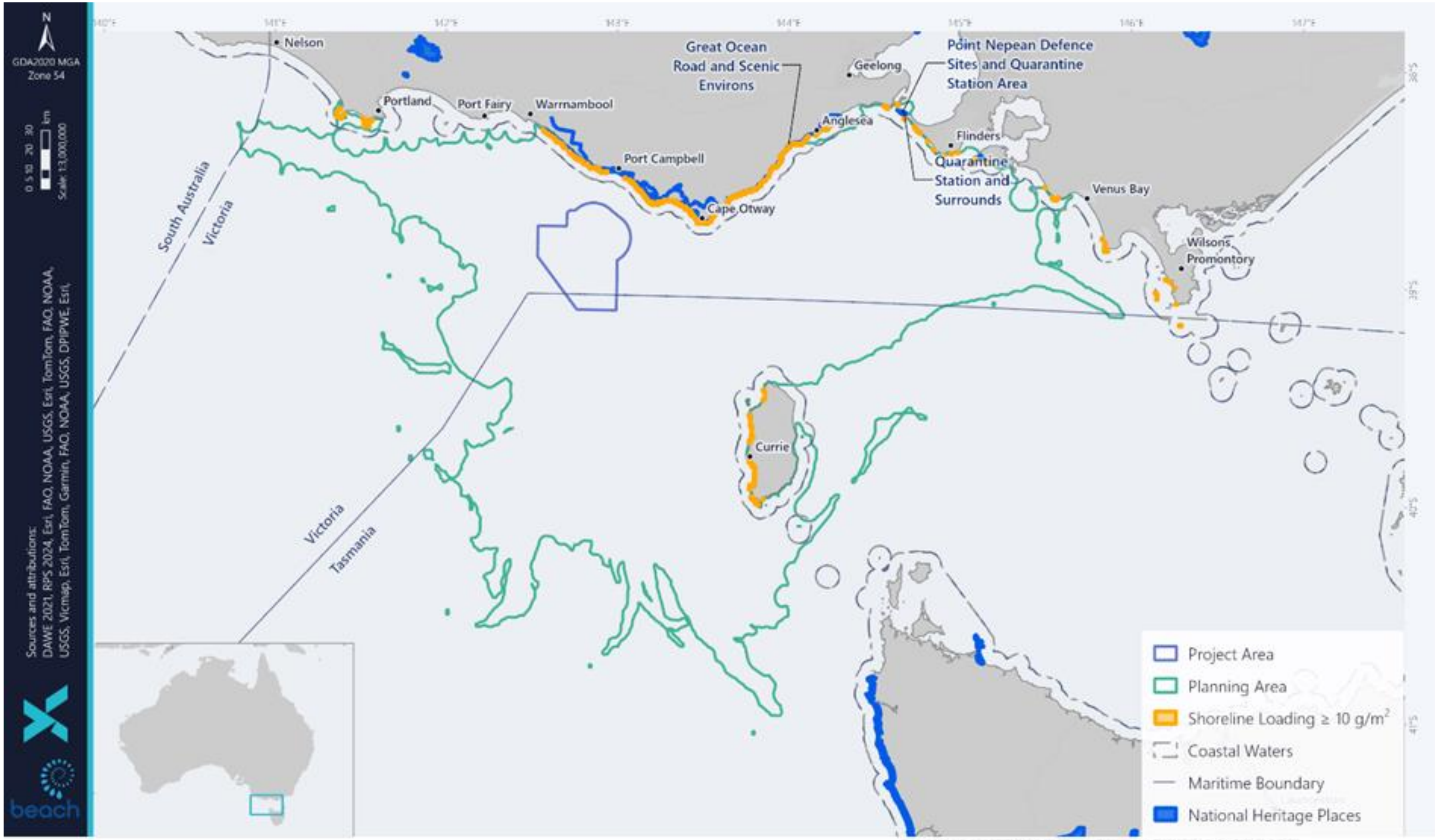


Figure 4-3: National Heritage Places within the Planning Area

4.2.3.1 Great Ocean Road and Scenic Environs

The Australian Heritage Council found the Great Ocean Road and its scenic environs road from Torquay to Allansford, a journey of 242 km, as a place of outstanding national heritage significance. Constructed by workers, including more than 3,000 returned servicemen, as a memorial to First World War servicemen, the Great Ocean Road is a significant reminder of the participation of Australian servicemen in the First World War, the Australian community's appreciation of their service, and the support provided for the welfare of servicemen and women upon returning to Australia.

The scenic environs include all views from the Great Ocean Road and Great Ocean Walk, including the Twelve Apostles, the Bay of Islands and Bay of Martyrs. The coastline from Lorne to Kennett River is among the world's most dramatic cliff and ocean scenery able to be viewed from a vehicle.

Along the length of the Great Ocean Road, the pullover points, and lookouts beside or nearby the road provide travellers with spectacular views of the coastline, hinterland, and Bass Strait seascape, framed only by cliffs, lighthouses and unencumbered by intrusive built structures. The place is also listed for its; outstanding rocky coastline, dinosaur fossil sites, geomorphological monitoring sites, its association with the pioneering landscape architect Edna Walling, and for the significance of Bells Beach to surfing.

4.2.3.2 Point Nepean Defence Sites and Quarantine Station Area including Quarantine Station and Surrounds

Point Nepean comprises approximately 520 ha at the western end of the Mornington Peninsula, along the southern coast of Port Phillip Bay. The coastline at Point Nepean is rocky with cliffs as well as Pleistocene and Holocene dunes. Ninety species of birds have been recorded at the site.

Point Nepean demonstrates the primary importance of coastal defence as well as Victorian and national quarantine processes. It contains the oldest surviving quarantine accommodation buildings in Australia which was established in 1852 after the discovery of gold which saw 100,000 migrants arriving to the region by sea.

4.2.4 Commonwealth Heritage Places

No Commonwealth Heritage Places were identified within the Project Area (Appendix A). One natural Commonwealth Heritage Place, Swan Island and Naval Waters, was identified in the Planning Area (Appendix B) however this is due to the size of the grids used in the PMST and does not actually overlap the Planning Area.

4.2.5 Maritime Archaeological Heritage

Shipwrecks over 75 years old are protected within Commonwealth waters under the *Underwater Cultural Heritage Act 2018* (Cth), in Victorian State waters under the *Heritage Act 1995* (Vic) and in Tasmanian waters under the *Historic Cultural Heritage Act 1995* (Tas). Some historic shipwrecks lie within protected zones of up to 800 m radius, typically when the shipwreck is considered fragile or at particular risk of interference. The primary purpose of the *Heritage Act 1995* (Vic) is to provide for the protection and conservation of the cultural heritage of the State and is administered by Heritage Victoria **[PC322].** In Tasmania, the Historic Heritage Section of the Parks and Wildlife Service is the government authority responsible for the management of the State's historic shipwrecks and other maritime heritage sites.

Within the Planning Area there is a 130 km stretch of coastline known as the 'Shipwreck Coast' because of the large number of shipwrecks present, with most wrecked during the late nineteenth century. The strong waves, rocky reefs and cliffs of the region contributed to the loss of these ships. More than 180 shipwrecks are believed to lie along the Shipwreck Coast (DELWP 2016a) and well-known wrecks include Loch Ard (1878), Thistle (1837), Children (1839), John Scott (1858) and Schomberg (1855).

The wrecks represent significant archaeological, educational, and recreational (i.e. diving) opportunities for locals, students and tourists (Flagstaff Hill 2015). There are 188 documented historic wrecks in the Planning Area, one of which (S.S. Alert) has a protection zone (Figure 4-4). The S.S. Selje, a Norwegian cargo ship, wrecked in 1929 is 688 m from the Project Area (Figure 4-4).

Beach commissioned a seabed site assessment for the Otway Basin Environmental Survey (Ramboll 2020; Appendix C). As part of the seabed site assessment a sub-bottom profiler was used to identify any buried objects. The penetration of the sub-bottom profiler was limited to a maximum of approximately 100 cm, with the average thickness of the sand patches being approximately 20-30 cm precluding burial of a shipwreck.

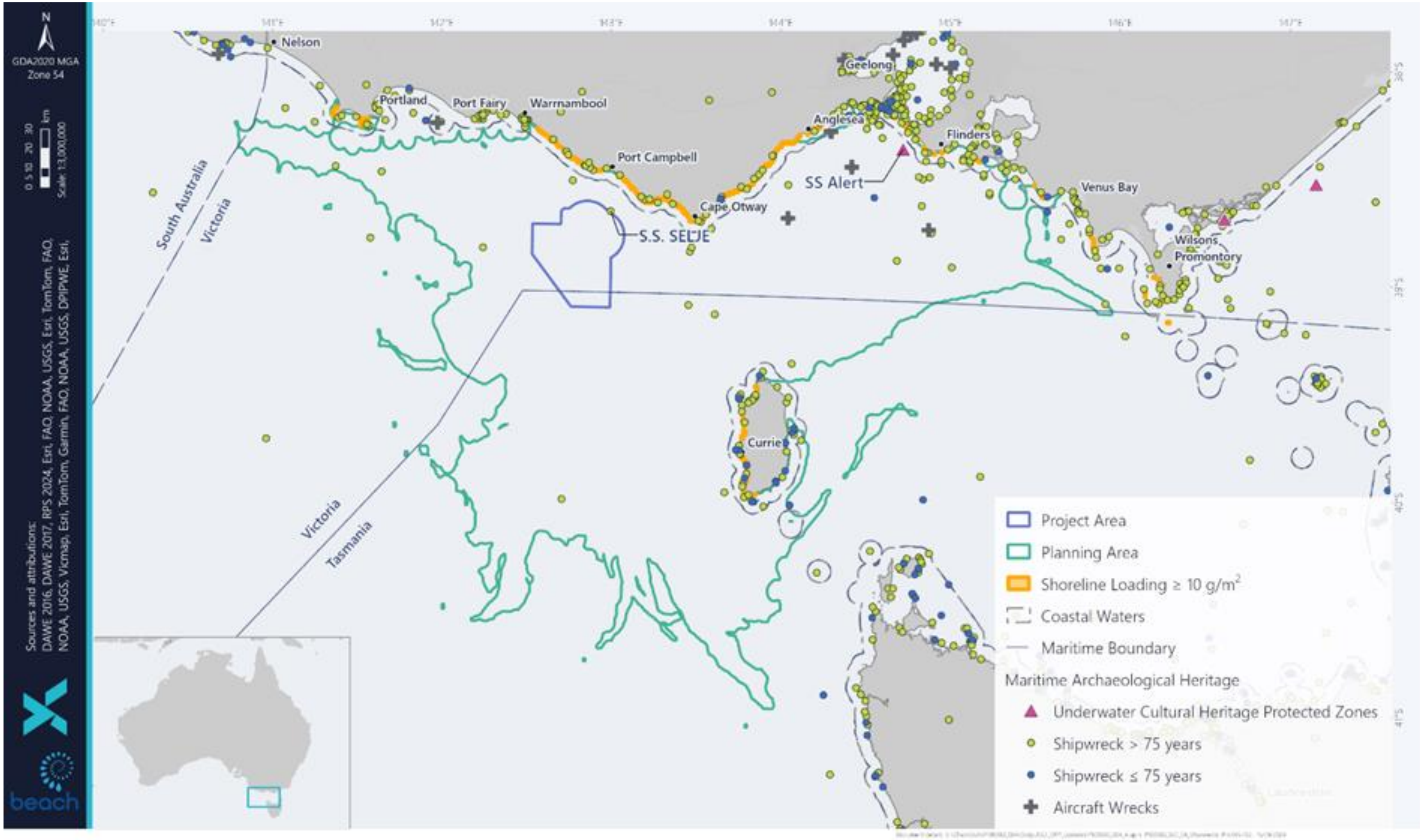


Figure 4-4: Maritime Archaeological Heritage within the Project and Planning Areas

4.2.6 Wetlands of International Importance

No Wetlands of International Importance were identified in the Project Area (Appendix A).

Wetlands of International Importance (Ramsar-listed wetlands) identified within the Planning Area (Appendix B) are presented in Table 4-4 and Figure 4-5. Wetlands identified in the PMST Report due to the size of the grids used in the PMST but not actually intersecting the Planning Area are listed in the table with 'X'. Wetlands of International Importance which intersect the Planning Area and have a coastal component which may be exposed to hydrocarbons from a spill event are described in the subsections below.

As defined in the OPGGS(E)R, particular relevant values and sensitivities include: the ecological character of a declared Ramsar wetland within the meaning of that Act. The ecological character and values of the overlapping Ramsar sites are described below and are from the Australian Wetlands Database (DCCEEW 2024b).

Table 4-4: Wetlands of International Importance within the Planning Area

Wetland of International Importance	Coastal Component	Project Area	Planning Area
Glenelg Estuary and Discovery Bay Wetlands	✓	-	X
Lavinia	✓	-	✓
Port Phillip Bay (Western Shoreline) and Bellarine Peninsula	✓	-	X
Western Port	✓	-	X

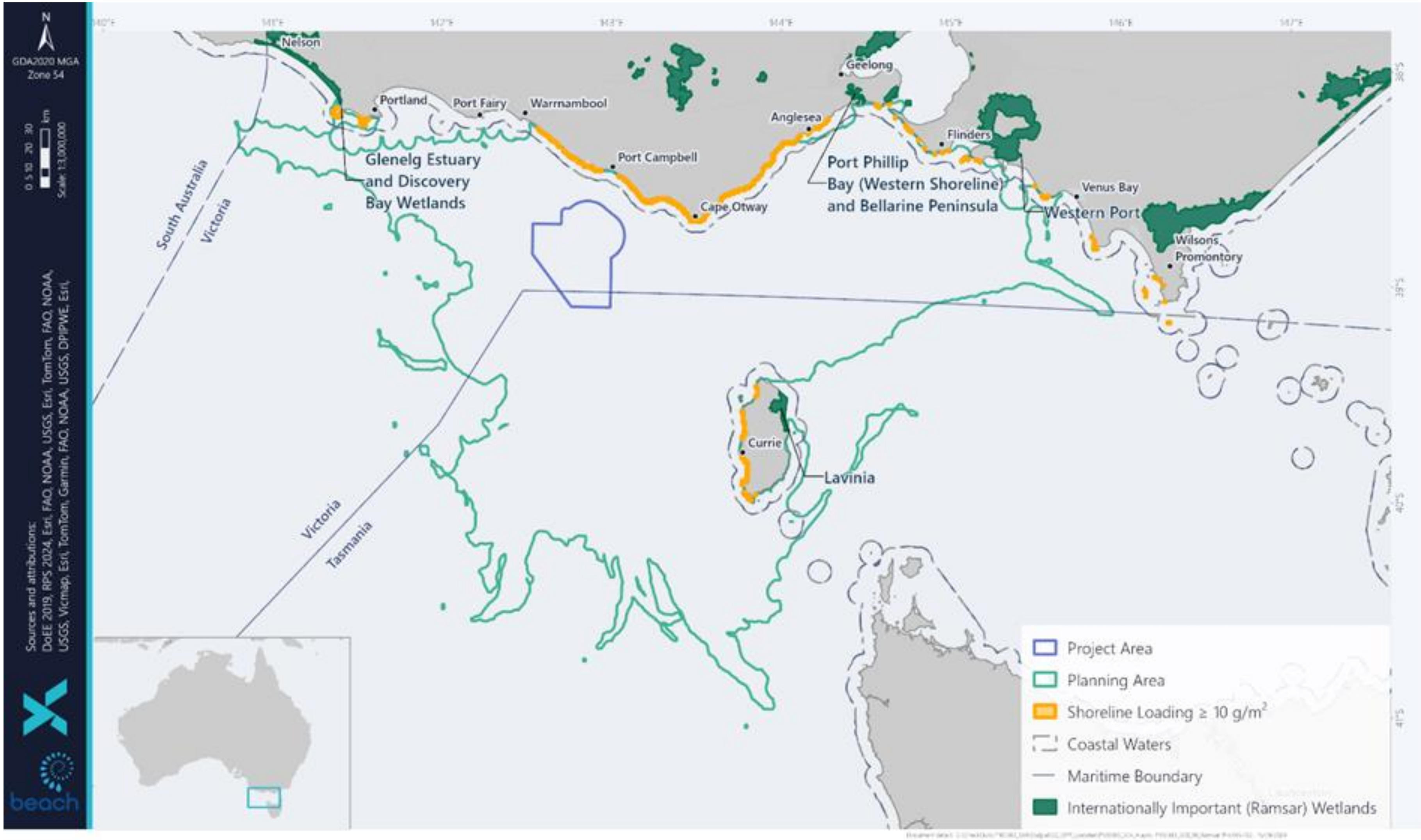


Figure 4-5: Wetlands of International Importance (Ramsar) within the Planning Area

4.2.6.1 Lavinia

The Lavinia Ramsar site is located on the north-east coast of King Island, Tasmania. The boundary of the site forms the Lavinia State Reserve, with major wetlands in the reserve including the Sea Elephant River estuary area, Lake Martha Lavinia, Penny's Lagoon, and the Nook Swamps. It is subject to the Lavinia Nature Reserve Management Plan (2000) (in draft).

The shifting sands of the Sea Elephant River's mouth have caused a large back-up of brackish water in the Ramsar site, creating the saltmarsh which extends up to 5 km inland. The present landscape is the result of several distinct periods of dune formation. The extensive Nook Swamps, which run roughly parallel to the coast, occupy a flat depression between the newer parallel dunes to the east of the site and the older dunes further inland. Water flows into the wetlands from the catchment through surface channels and groundwater and leaves mainly from the bar at the mouth of the Sea Elephant River and seepage through the young dune systems emerging as beach springs.

The Lavinia State Reserve is one of the few largely unaltered areas of the island and contains much of the remaining native vegetation on King Island. The vegetation communities include Succulent Saline Herbland, Coastal Grass and Herbfield, Coastal Scrub and King Island Eucalyptus globulus Woodland. The freshwater areas of the Nook Swamps are dominated by swamp forest. Nook Swamps and the surrounding wetlands contain extensive peatlands.

The site is an important refuge for a collection of regional and nationally threatened species, including the nationally endangered, Orange-bellied Parrot. This parrot is heavily dependent upon the samphire plant, which occurs in the saltmarsh, for food during migration. They also roost at night in the trees and scrub surrounding the Sea Elephant River estuary.

Several species of birds which use the reserve are rarely observed on the Tasmanian mainland, including the Dusky Moorhen, Nankeen Kestrel, Rufous Night Heron and the Golden-headed Cisticola.

The site is currently used for conservation and recreation, including boating, fishing, camping and off-road driving. There are artefacts of Indigenous Australian occupation on King Island that date back to the last ice age when the island was connected to Tasmania and mainland Australia via the Bassian Plain.

There are ten critical components and processes identified in the Ramsar site: wetland vegetation communities, regional and national rare plant species, regionally rare bird species, Kind Island scrubtit, Orange-bellied Parrot, water and sea birds, migratory birds, striped marsh frog and the green and gold frog. Elements essential to the site are the marine west coast climate, mild temperatures along with wind direction and speed. Sandy deposits dominant the site, inland sand sheets cover majority of the western area of the site (PWS 2000). Between these sand sheets and the eastern coast there is an important geoconservation feature, several sand dunes. The dunes impede drainage from inland causing extensive swamps, lakes and river reflections. Terrestrial vegetation communities are important in providing the overall structure by buffering and supporting habitat (PWS 2000). Wetland vegetation in the Ramsar site include swamp forest and forested peatlands are rare and vulnerable in the region. Along with other types the vegetation, the wetland provides support and provides habitat for rare flora and fauna highlighting the significance of the wetlands. Six wetland associated species have been recorded within the site. Rare bird and frog species are dependent on the wetland habitat along with ten migratory birds and other water and sea birds. Benefits provided by the Lavinia Ramsar site include aquaculture (oyster farming), tourism, education, and scientific value.

There has been considerable damage caused to the saltmarsh community by vehicle disturbance in the Sea Elephant Estuary and the coastal strip (PWS 2000). Vegetation clearance in parts of the catchment upstream as contributed to altered water balance due to less evapotranspiration of rainfall and build-up of the groundwater. There are threats to flora and fauna by invasive weeds and fungus. Although aquaculture plays a role in the Lavinia benefits risk from inputs of nutrients from feeding and occasional opening of the barred estuary for tidal flushing although with farm vehicles disturbance can impact the site.

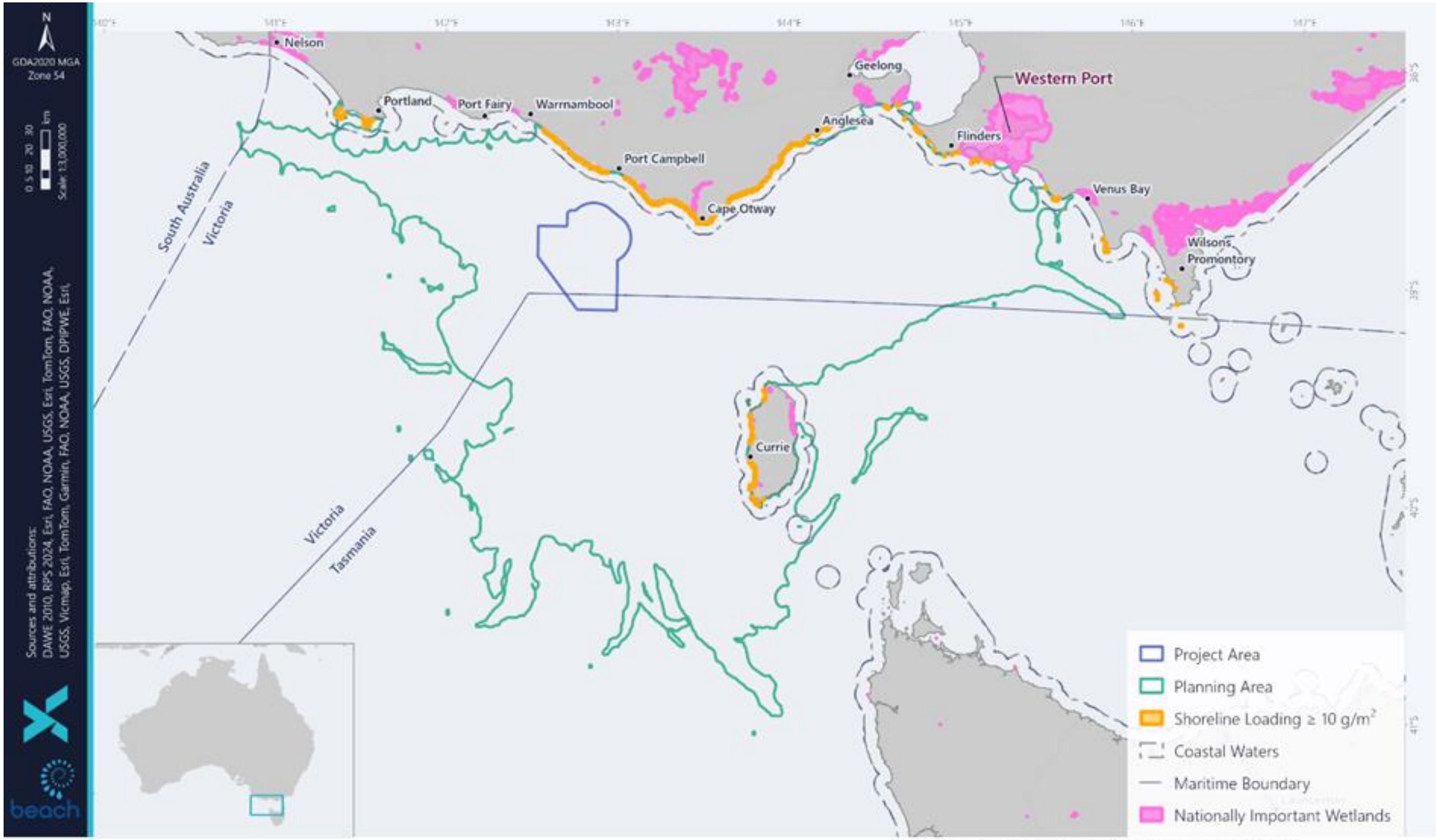
4.2.7 Nationally Important Wetlands

No Nationally Important Wetlands were identified in the Project Area (Appendix A).

Nationally Important Wetlands identified within the Planning Area (Appendix B) are presented in Table 4-5 and Figure 4-6. Wetlands identified in the PMST Report due to the size of the grids used in the PMST but not actually intersecting the Planning Area are listed in the Table with 'X'. Nationally Important Wetlands which intersect the Planning Area and have a coastal component which may be exposed to hydrocarbons from a spill event are discussed in the subsections below. Information provided on these wetlands is from the DCCEEW Directory of Important Wetlands in Australia.

Table 4-5: Nationally Important Wetlands Identified within the Planning Area

Nationally Important Wetland	State	Coastal component	Project Area	Planning Area
Aire River	VIC	-	-	X
Bungaree Lagoon	TAS	-	-	X
Lake Connewarre State Wildlife Reserve	VIC	✓	-	X
Lake Flannigan	TAS	-	-	X
Lavinia Nature Reserve	TAS	✓	-	X
Lower Aire River Wetlands	VIC	✓	-	X
Mud Island	VIC	✓	-	X
Pearshape Lagoons (1-4)	TAS	-	-	X
Princetown Wetlands	VIC	✓	-	X
Swan Bay & Swan Island	VIC	✓	-	X
Western Port	VIC	✓	-	✓



Sources and attributions:
DAWE 2010, RPS 2024, Esri, FAO, NOAA, USGS, Esri, TomTom, FAO, NOAA,
USGS, Vicmap, Esri, TomTom, Garmin, FAO, NOAA, USGS, DPIPWE, Esri,

Figure 4-6: Nationally Important Wetlands within the Planning Area

4.2.7.1 Western Port

Western Port is a large bay with extensive intertidal flats, mangroves, saltmarsh, seagrass beds, several small islands and two large islands.

Western Port is a high value wetland for its ecological, recreational, tourist, scientific, educational, cultural, and scenic features. It is a very good example of a saltmarsh-mangrove-seagrass wetland system.

Western Port is of high value for its avifauna and flora. The bays seagrass flats are nursery grounds for King George Whiting and other species of fish and many birds depend on these areas. Many sites in Western Port are of special significance as breeding, roosting, or feeding sites for waterbirds, including migratory waders.

4.2.8 Victorian Protected Areas – Marine

Victoria has a representative system of marine protected areas consisting of 13 Marine National Parks and 11 Marine Sanctuaries established under the *National Parks Act 1975* (Vic).

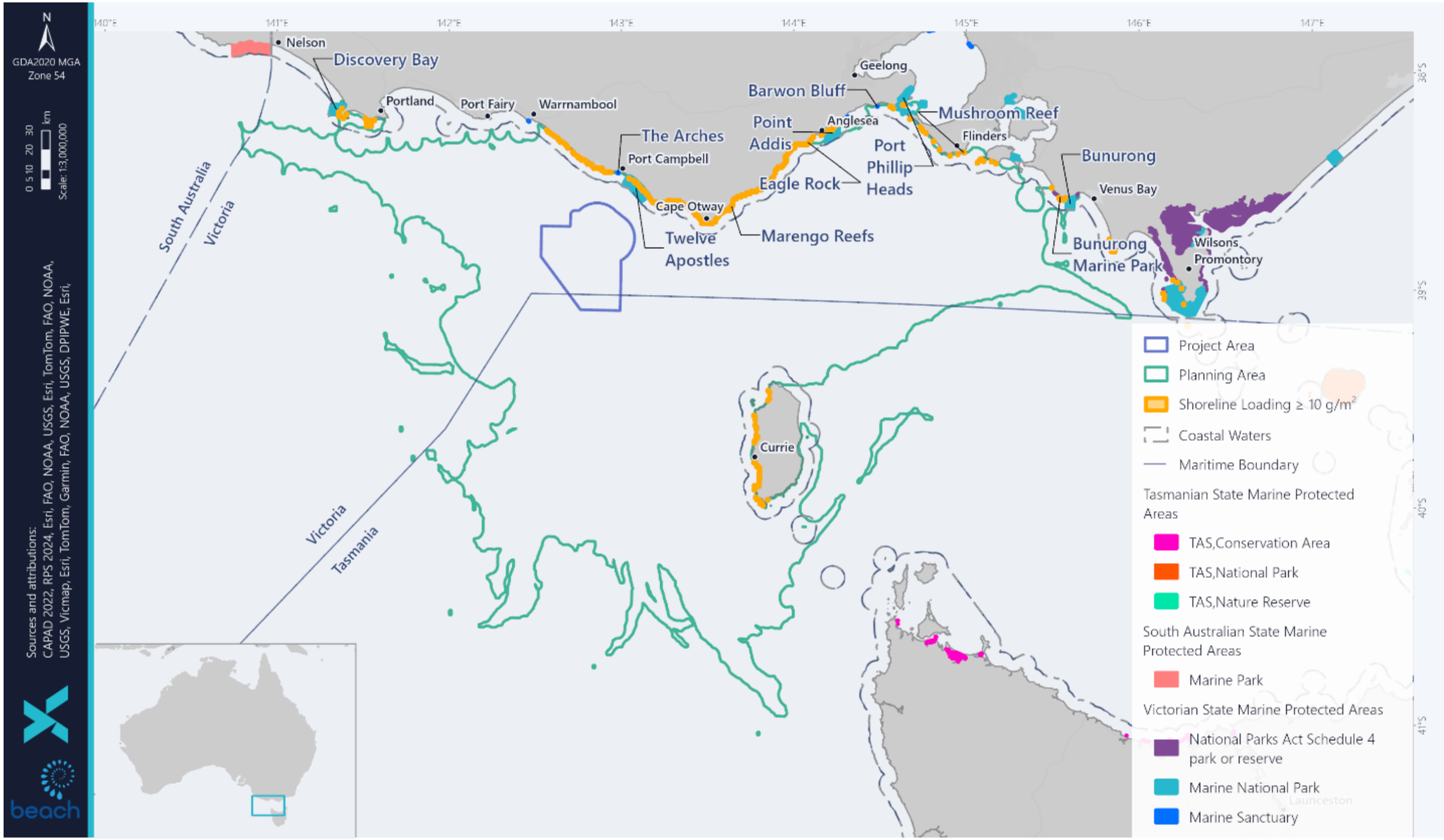
No Victorian marine protected areas were identified within the Project Area (Appendix A).

Victorian marine protected areas identified in the Planning Area (Appendix B) are presented in Table 4-6 and Figure 4-7. Some Victorian marine protected areas are identified in the PMST Report due to the size of the grids used in the PMST but do not actually intersect the Planning Area. These are denoted in the table below with 'X'. Victorian marine protected areas which intersect the Planning Area are described in the subsections below.

Table 4-6: Victorian Marine Protected Areas within the Planning Area

Protected Area Name	**Reserve Type**	**Project Area**	**Planning Area**
Barwon Bluff	Marine Sanctuary	-	✓
Bunurong	Marine National Park	-	✓
Bunurong Marine Park	National Parks Act Schedule 4 park or reserve	-	✓
Discovery Bay	Marine National Park	-	✓
Eagle Rock	Marine Sanctuary	-	X
Marengo Reefs	Marine Sanctuary	-	✓
Mushroom Reef	Marine Sanctuary	-	✓
Point Addis	Marine National Park	-	✓
Port Phillip Heads	Marine National Park	-	✓
The Arches	Marine Sanctuary	-	✓
Twelve Apostles	Marine National Park	-	✓
Wilsons Promontory	Marine National Park	-	✓
Wilsons Promontory Marine Park	National Parks Act Schedule 4 park or reserve	-	✓

Wilsons Promontory Marine Reserve	National Parks Act Schedule 4 park or reserve	-	X



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_S04_A.aprx, P100383_S00_05_StateMPAs, P-UWS-132, 15/09/2024

Figure 4-7: State Marine Protected Areas within the Planning Area

4.2.8.1 Barwon Bluff Marine Sanctuary

Barwon Bluff Marine Sanctuary is managed through the Barwon Bluff Marine Sanctuary Management Plan (Parks Victoria 2007b). The marine sanctuary protects 17 ha of reef and marine environment near the mouth of the Barwon River. The management plan identifies the key values of the sanctuary as:

- Intertidal reef platforms with a high diversity of invertebrate fauna and flora.
- Subtidal reefs that support diverse and abundant flora, including kelps, other brown algae, and green and red algae.
- Calcarenite and basalt reefs extending from The Bluff that are of regional geological significance.
- Intertidal habitats that support resident and migratory shorebirds, including threatened species.
- Subtidal habitats that support sedentary fish and are also used by migratory fish and marine mammals.
- Marine habitats and species that are of scientific interest and valuable for marine education.
- An important landmark and area for gathering fish and shellfish for the Wathaurong people.
- A strong historic and ongoing connection with marine education.
- Remnants from the Earl of Charlemont, a heritage-listed shipwreck.

4.2.8.2 Bunurong Marine National Park

The Bunurong Marine National Park is classified as IUCN II (National Parks) and the Bunurong Marine Park as IUCN IV (Habitat/species management area).

The Bunurong Marine National Park and Bunurong Marine Park are managed through the Bunurong Marine National Park Management Plan (Parks Victoria 2006b). The Plan identifies the key values of the Parks as:

- Extensive intertidal rock platforms and subtidal rocky reefs with a geology and form that is uncommon along the Victorian coast.
- Abundant and diverse marine flora and fauna including over 22 species of marine flora and fauna recorded, or presumed to be, at their eastern or western distributional limits (Plummer et al. 2003).
- Highest diversity of intertidal and shallow subtidal invertebrate fauna recorded in Victoria on sandstone (ECC 2000).
- High proportion of the common invertebrates occurring along the Victorian coast.
- High diversity of vegetation communities, many of which are considered rare, depleted or endangered within the region (WGCMA 2003; Carr 2003).
- Important coastal habitat for several threatened species.

- Spectacular coastal scenery, featuring rugged sandstone cliffs, rocky headlands, intertidal rock platforms and sandy cove.
- Eagles Nest, a prominent rock stack, recognised as a site of national geological and geomorphological significance (Buckley 1993).
- One of the richest Mesozoic fossil areas in Victoria.
- Landscape and seascape of cultural significance to Indigenous people.
- Numerous places and objects of significance to Indigenous people.
- European history rich in diversity, including sites associated with shipping, coal mining, holidaying and living on the coast.
- Two historical shipwrecks listed on the Victorian Heritage Register (Heritage Victoria 2004).
- Opportunities for cultural values investigation in an area protected from human disturbance.
- Extensive subtidal reefs with magnificent underwater seascapes, offering numerous opportunities for diving and snorkelling.
- Highly accessible intertidal rock platforms offering opportunities for rock-pooling, marine education, and interpretation.
- Spectacular coastal drive, with numerous lookouts and panoramic views of the coast and surrounding waters.
- Coastline offering opportunities for swimming, surfing, boating, fishing, and rock-pooling in a natural setting.

4.2.8.3 Discovery Bay Marine National Park

Discovery Bay Marine National Park protects 2,770 ha within the Southern Ocean and experiences some of the highest wave energy environments in Victoria. It is managed under the Ngootyoong Gunditj Ngootyoong Mara South West Management Plan (Parks Victoria 2015). It is part of Koonang Mirring (Sea Country) with the coast of Discovery Bay filled with Aboriginal artefacts that are evidence of earlier ages of plenty and integral to the cultural heritage of the Gunditjmara people.

The Bonney Coast, which extends from Robe in South Australia to Discovery Bay, is a productive area because of a nutrient rich cold water upwelling, known as the Bonney Upwelling, which provides a nutrient-rich environment for fish, whales, seals, penguins, and invertebrates (Parks Victoria 2015).

Conservation Action Planning for marine protected areas across Victoria identified two key focal ecosystems in the park (Parks Victoria 2015):

- Subtidal Reefs with six key natural assets – Brown macroalgae dominated beds, large mobile fish including sharks and rays, motile macroinvertebrates, Giant Kelp Forest communities, sessile invertebrate dominated communities such as thick growths of sponges, ascidians, bryozoans and gorgonians, and mixed red algae sessile invertebrate dominated communities.

- Water Column with key assets including planktonic and other species, baleen whales and seabirds.

4.2.8.4 Marengo Reefs Marine Sanctuary

The Marengo Reefs Marine Sanctuary (12 ha) is in Victorian State waters near Marengo and Apollo Bay, which are on the Great Ocean Road, approximately 220 km south-west of Melbourne. The sanctuary protects two small reefs and a wide variety of microhabitats. Protected conditions on the leeward side of the reefs are unusual on this high wave energy coastline and allow for dense growths of bull kelps and other seaweed. There is an abundance of soft corals, sponges, and other marine invertebrates, and over 56 species of fish have been recorded in and around the sanctuary. Seals rest on the outer island of the reef and there are two shipwrecks (the Grange and Woolamai) in the sanctuary (Parks Victoria 2007a).

The Marengo Reefs Marine Sanctuary Management Plan (Parks Victoria 2007a) identifies the environmental, cultural, and social values as:

- Subtidal soft sediments, subtidal rocky reefs, and intertidal reefs.
- High diversity of algal, invertebrate and fish species.
- Australian Fur-seal haul out area.
- Evidence of a long history of Indigenous use, including many Indigenous places and objects nearby.
- Wrecks of coastal and international trade vessels in the vicinity of the sanctuary.
- Spectacular underwater scenery for snorkelling and scuba diving.
- Intertidal areas for exploring rock pools.
- Opportunities for a range of aquatic recreational activities including seal watching.

4.2.8.5 Mushroom Reef Marine Sanctuary

Mushroom Reef Marine Sanctuary covers 80 ha along the southern Mornington Peninsula and protects a system of ancient basalt platforms and reefs. The sanctuary is adjacent to Mornington Peninsula National Park, extending from the high water mark to approximately 1 km offshore. The Mushroom Reef Marine Sanctuary Management Plan (Parks Victoria 2007d) identifies the following important natural values:

- Among the most diverse intertidal and rocky reef communities in Victoria.
- Numerous subtidal pools and boulders in the intertidal area that provide a high complexity of intertidal basalt substrates and a rich variety of microhabitats.
- Subtidal reefs that support diverse and abundant flora including kelps, other brown algae, and green and red algae.
- Sandy bottom habitats that support large beds of *Amphibolis* seagrass and patches of green algae.

- Diverse habitats that support sedentary and migratory fish species.
- A range of reef habitats that support invertebrates including gorgonian fans, seastars, anemones, ascidians, barnacles and soft corals.
- A distinctive basalt causeway that provides habitat for numerous crab, seastar and gastropod species.
- Intertidal habitat that support resident and migratory shorebird species including threatened species.

The Burinyung-Bulluk, one of the six clans that made up the Boonwurrung people, inhabited the coastal area from Point Nepean to Hastings, which incorporates the sanctuary area. The reefs and waters of this coast provided excellent sites for gathering shellfish and hunting fish and seals and were among the most important sources of food for Boonwurrung people (Parks Victoria 2007d).

4.2.8.6 Point Addis Marine National Park

Point Addis Marine National Park lies east of Anglesea and covers 4,600 ha. This park protects representative samples of subtidal soft sediments, subtidal rocky reef, rhodolith beds and intertidal rocky reef habitats. The park also provides habitat for a range of invertebrates, fish, algae, birds and wildlife. The world-famous surfing destination of Bells Beach is within Point Addis Marine National Park.

It is managed under the Management Plan for Point Addis Marine National Park, Point Danger Marine Sanctuary and Eagle Rock Marine Sanctuary (Parks Victoria 2005b) and is classified as IUCN II. The plan identifies the following environmental, cultural, and social values for the parks and sanctuaries:

- Sandy beaches, subtidal soft sediments, subtidal rocky reefs, rhodolith beds and intertidal reefs.
- High diversity of algal, invertebrate and fish species.
- High diversity of sea slugs (opisthobranchs) and other invertebrate communities within Point Danger Marine Sanctuary.
- Evidence of a long history of Indigenous use, including many Indigenous places and objects adjacent to the park and sanctuaries near dunes, headlands, estuaries, and creeks.
- Surf breaks, including those at Bells Beach, which are culturally important to many people associated with surfing.
- Coastal seascapes of significance for many who live in the area or visit.
- Recreational and tourism values.
- Spectacular underwater scenery for snorkelling and scuba diving.
- Intertidal areas for exploring rock pools.
- Opportunities for a range of recreational activities.

- Spectacular seascape complementing well-known visitor experiences on the Great Ocean Road.

4.2.8.7 Port Phillip Heads Marine National Park

Port Phillip Heads Marine National Park protects 3,850 ha across six sections including Swan Bay, Mud Islands, Point Lonsdale, Point Nepean, Popes Eye and Portsea Hole. The Port Phillip Heads Marine National Park is managed under the Port Phillip Heads Marine National Park Management Plan (Parks Victoria 2006c). The plan identifies the key values of the park as:

- Incised entrance to Bay (the Rip) and the 'Heads' at Point Nepean and Point Lonsdale.
- Spectacular dive sites such as the Lonsdale and Nepean Walls and popular recreational dive locations.
- Intertidal rock platforms at Cheviot Beach and Point Lonsdale the coastal landscape of Point Nepean in Point Nepean National Park.
- Bottlenose dolphin populations sites listed under the Ramsar Convention for their importance for migratory wading birds (Swan Bay, Mud Islands).
- Distinctive bird-dominated island ecosystem of Mud Islands.
- Sheltered environments such as the seagrass meadows of Swan Bay.

Indigenous tradition indicates that the Mornington Peninsula side of the park, including Mud Islands is part of Country of the Boonwurrung and that the Bellarine Peninsula side of the park is part of Country of the Wathaurong (Parks Victoria 2006c).

4.2.8.8 The Arches Marine Sanctuary

The Arches Marine Sanctuary protects 45 ha of ocean directly south of Port Campbell. It is managed in conjunction with the Twelve Apostles Marine Park under the Management Plan for Twelve Apostles Marine National Park and The Arches Marine Sanctuary (Parks Victoria 2006d).

It has a spectacular dive site of limestone formations, rocky arches, and canyons. The sanctuary is also ecologically significant, supporting habitats such as kelp forests and a diverse range of sessile invertebrates on the arches and canyons. These habitats support schools of reef fish, seals, and a range of invertebrates such as lobster, abalone, and sea urchins.

It is also important to indigenous culture based on spiritual connection to Sea Country.

4.2.8.9 Twelve Apostles Marine National Park

The Twelve Apostles Marine National Park (75 km^2) is located 7 km east of Port Campbell and covers 16 km of coastline from east of Broken Head to Pebble Point and extends offshore to 5.5 km (Plummer et al. 2003).

The area is representative of the Otway Bioregion and is characterised by a submarine network of towering canyons, caves, arches, and walls with a large variety of seaweed and sponge gardens plus resident schools of reef fish. The park contains areas of calcarenite reef supporting the highest diversity of intertidal and sub-tidal invertebrates found on that rock type in Victoria (DSE 2012).

The park includes large sandy sub-tidal areas consisting of predominantly fine sand with some medium to coarse sand and shell fragment (Plummer et al. 2003). Benthic sampling undertaken within the park in soft sediment habitats at 10 m, 20 m and 40 m water depths identified 31, 29 and 32 species respectively based upon a sample area of $0.1m^2$. These species were predominantly polychaetes, crustaceans, and nematodes with the mean number of individuals decreasing with water depth (Heisler and Parry 2007). No visible macroalgae species were present within these soft sediment areas (Plummer et al. 2003; Holmes et al. 2007). These sandy expanses support high abundances of smaller animals such as worms, small molluscs, and crustaceans; larger animals are less common.

The Twelve Apostles Marine Park is managed in conjunction with the Arches Marine Sanctuary under the Management Plan for Twelve Apostles Marine National Park and The Arches Marine Sanctuary (Parks Victoria 2006d) and is classified as IUCN II. The Plan describes the key environmental, cultural, and social values as:

- Unique limestone rock formations, including the Twelve Apostles.
- Range of marine habitats representative of the Otway marine bioregion.
- Indigenous culture based on spiritual connection to Sea Country and a history of marine resource use.
- Wreck of the Loch Ard (shipwreck).
- Underwater limestone formations of arches and canyons.
- Diverse range of encrusting invertebrates.
- Spectacular dive site.

4.2.8.10 Wilsons Promontory Marine National Park

The Wilsons Promontory Marine National Park protects 15,500 ha and is located approximately 220 km south-east of Melbourne on Victoria’s southernmost tip (Parks Victoria 2006a). Adjacent to Wilsons Promontory Marine National Park are the marine park (overlapped by the Planning Area) and marine reserve (not overlapped by the Planning Area).

Wilsons Promontory Marine National Park is located in the Flinders marine bioregion, as identified by the Interim Marine and Coastal Regionalisation for Australia (IMCRA). The Flinders marine bioregion extends across Bass Strait and is characterised by cool wet winters and warm summers, predominately granite and unconsolidated clastic sediments with rocky headlands and promontories interspersed by long sandy beaches, highly variable wave exposure, and high fish and plant species richness (Parks Victoria 2006a).

The Wilsons Promontory Marine National Park is managed under the Wilsons Promontory Marine National Park Management Plan (Parks Victoria 2006a). The plan identifies the key values of the park as:

- biological communities with distinct biogeographic patterns, including shallow subtidal reefs, deep subtidal reefs, intertidal rocky shores, sandy beaches, seagrass and subtidal soft substrates.

- Important habitat for several threatened shorebird species, including species listed under international migratory bird agreements.
- Important breeding sites for a significant colony of Australian fur seals
- Indigenous cultural lore and interest maintained by the Gunai / Kurnai and Boonwurrung people. Also is part of a past land link to Tasmania occupied and used by Indigenous people.
- magnificent underwater seascapes for diving and snorkelling.

4.2.9 Victorian Protected Areas – Terrestrial

No Victorian terrestrial protected areas were identified within the Project Area (Appendix A).

Victorian terrestrial protected areas identified in the Planning Area (Appendix B) are presented in Table 4-7 and Figure 4-8. Some Victorian terrestrial protected areas were identified in the PMST Report due to the size of the grids used in the PMST but do not actually intersect the Planning Area. These are denoted in Table 4-7 with 'X'. Victorian terrestrial protected areas which intersect the Planning Area and have a coastal component which may be exposed to hydrocarbons from a spill event are discussed in the subsections below where information is available.

Table 4-7: Victorian Terrestrial Protected Areas within the Planning Area

Protected Area Name	Reserve Type	Coastal Component	Project Area	Planning Area
Aire River	Heritage River	✓	-	✓
Aire River W.R.	Natural Features Reserve	✓	-	X
Aireys Inlet B.R.	Natural Features Reserve	-	-	X
Anglesea B.R	Natural Features Reserve	-	-	X
Anser Isalnd	Reference Area	-	-	X
Barham Paradise S.R.	Natural Features Reserve	-	-	X
Bay of Islands Coastal Park	Conservation Park	✓	-	✓
Breamlea F.F.R.	Nature Conservation Reserve	✓	-	X
Cape Liptrap	Coastal Park	✓	-	✓
Cape Nelson	State Park	✓	-	✓
Cape Patterson N.C.R	Natural Features Reserve	-	-	X
Discovery Bay Coastal Park	Conservation Park	✓	-	✓
Edna Bowman N.C.R	Natural Features Reserve	-	-	X
Great Otway	National Park	✓	-	✓
Johanna Falls S.R	Natural Features Reserve	-	-	X
Lake Connewarre W.R	Natural Features Reserve	✓	-	✓
Lake Gillear W.R	Natural Features Reserve	-	-	X
Latrobe B.R.	Natural Features Reserve	-	-	X

Lily Pond B.R.	Natural Features Reserve	✓	-	✓
Marengo N.C.R.	Nature Conservation Reserve	-	-	✓
Mornington Peninsula	National Park	✓	-	✓
Painkalac Creek	Reference Area	-	-	X
Phillip Island Nature Park	Other	✓	-	✓
Point Nepean	National Park	✓	-	X
Port Campbell	National Park	✓	-	✓
Portland B.R.	Natural Features Reserve	-	-	X
Princetown W.R	Natural Features Reserve	-	-	X
Southern Wilsons Promontory	Remote and Natural Area - Schedule 6, National Parks Act	✓	-	✓
Stony Creek (Otways)	Reference Area	✓	-	X
Unnamed P0176	Private Nature Reserve	-	-	X
Wild Dog B.R.	Natural Features Reserve	-	-	X
Wild Dog Creek SS.R.	Natural Features Reserve	-	-	X
Wilsons Promontory	National Park	✓	-	✓
Wilsons Promontory Islands	Remote and Natural Area	✓	-	✓
Wonthaggi Heathlands N.C.R.	Natural Features Reserve	-	-	X

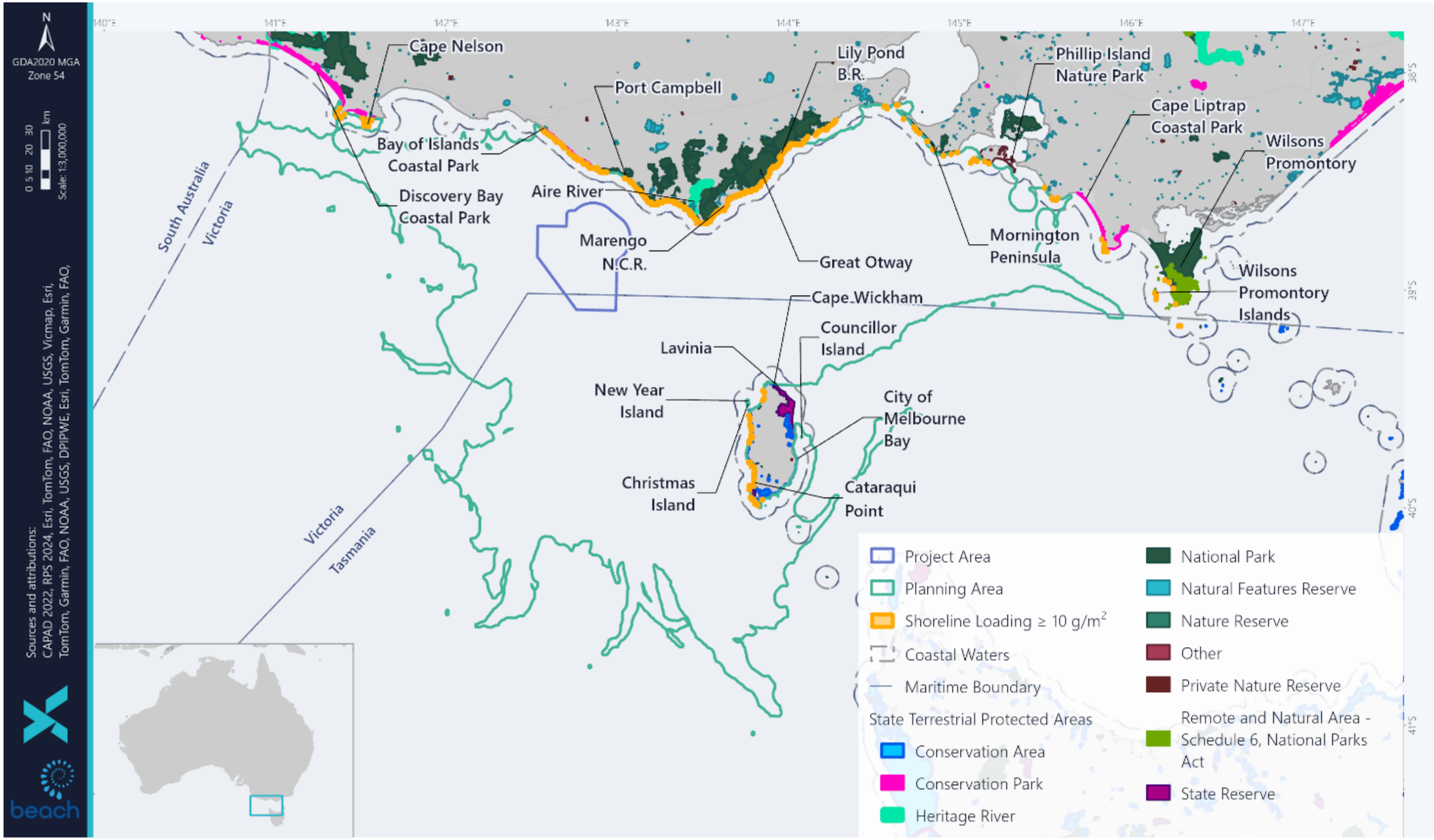


Figure 4-8: State Terrestrial Protected Areas within the Planning Area

4.2.9.1 Aire River Heritage River

The Aire River is a perennial river of the Corangamite catchment, located in the Otway region. The river generally flows west by south then south through the Great Otway National Park, joined by three minor tributaries, before reaching its mouth and emptying into Bass Strait west of Cape Otway. It is a popular fishing and camping area.

4.2.9.2 Bay of Islands Conservation Park

This coastal park has outstanding ocean views and geological features and covers an extensive area of the coastline (~32 km in length and 950 ha), stretching east from Warrnambool to Peterborough. Sheer cliffs and rock stacks dominate the bays, and the heathlands contain wildflowers. Beaches are accessible at some points (Parks Victoria 1998).

This park protects the terrestrial environment above the low water mark of this coastline. This Coastal Park is protected under the Port Campbell National Park and Bay of Islands Coastal Park Management Plan (Parks Victoria 1998).

4.2.9.3 Cape Nelson State Park

Cape Nelson State Park comprises 210 ha and is located near Portland, 377 km south-west of Melbourne. The park is a popular destination for hikers as it is positioned along the Great South West Walk as well as several other popular day walks. The park is managed under the Ngootyoong Gunditj Ngootyoong Mara South West Management Plan (DELWP 2015). Cape Nelson contains rocky platforms which provide habitat for the Australian Fur-seal and New Zealand Fur-seal.

4.2.9.4 Discovery Bay Coastal Park

Discovery Bay Coastal Park comprises 10,460 ha and extends along the coast of Discovery Bay from Cape Nelson north-westwards for 50 kilometres to the border with South Australia. The park is managed under the Ngootyoong Gunditj Ngootyoong Mara South West Management Plan (DELWP 2015). The Cape Bridgewater fur seal colony is located within the park.

4.2.9.5 Great Otway National Park

The Great Otway National Park (103,185 ha) is located near Cape Otway and stretches from the low water mark inland on an intermittent basis from Princetown to Apollo Bay (approximately 100 km).

Landscapes within the park are characterised by tall forests and hilly terrain extending to the sea with cliffs, steep and rocky coasts, coastal terraces, landslips, dunes and bluffs, beaches, and river mouths. There is a concentration of archaeological sites along the coast, coastal rivers, and reefs. The park contains many sites of international and national geological and geomorphological significance including Dinosaur Cove (internationally significant dinosaur fossil site), Lion Headland and Moonlight Head to Milanesia Beach (internationally significant coastal geology and fossils).

The park provides habitats for the conservation of the Rufous Bristlebird, Hooded Plover, White-Bellied Sea Eagle, Fairy Tern, Caspian Tern and Lewin's Rail and native fish such as the Australian Grayling.

The park contains significant Aboriginal cultural sites adjacent to rivers, streams and the coastline including over 100 registered archaeological sites, particularly shell middens along the coast, as well as non-physical aspects such as massacre sites, song lines, family links and stories. The park also contains four sites listed on the Victorian Heritage Register including the Cape Otway Light Station and several shipwreck features along the coast (i.e. anchors) (Parks Victoria and DSE 2009).

This park protects the terrestrial environment above the low water mark of this coastline. The Park is protected under the Great Otway National Park and Otway Forest Park Management Plan (Parks Victoria and DSE 2009) and relevant values are:

- a large area of essentially unmodified coastline, linking the land to marine ecosystems and marine national parks.
- a diverse range of lifestyle and recreation opportunities for communities adjacent to the parks – for local permanent residents and holiday homeowners Regionally, nationally, and internationally.
- significant tourist attractions, close to access routes and accommodation, such as spectacular coastal scenery along the Great Ocean Road, access to beautiful beaches, clifftop lookouts, picnic areas, historic sites, waterfalls and walking tracks such as the Great Ocean Walk.
- the basis for continued growth of nature-based tourism associated with the parks and the region, providing economic opportunities for accommodation providers, food and services providers, and recreation, tourism, and education operators.

4.2.9.6 Lake Connewarre Wilderness Reserve

Lake Connewarre Wilderness Reserve is within the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site.

4.2.9.7 Mornington Peninsula National Park

Mornington Peninsula National Park protects 2,686 ha of land along the coast approximately 70 km south of Melbourne, often described as ‘Melbourne’s Playground’ due to its popularity for recreation. Mornington Peninsula National Park is the most visited park in Victoria.

The park is managed under the Mornington Peninsula National Park and Arthurs Seat State Park Management Plan (Parks Victoria 1998a) which identifies the following natural values:

- largest and most significant remaining areas of native vegetation on the Mornington Peninsula.
- numerous sites and features of geomorphic significance, particularly along the coast (cliffed calcarenite coast, sandy forelands and basalt shore platforms).
- only representation in the Victorian conservation reserve system of four particular land systems formed within the Southern Victorian Coastal Plains and the Southern Victorian Uplands.
- many significant native plants and vegetation communities.
- highly scenic landscape values along the ocean coast and at Port Phillip heads and prominent feature of Arthurs Seat.
- many significant fauna species, including populations of the nationally significant Hooded Plover, over 30 species of State significance and many species of regional significance.

- high quality marine and intertidal habitats, with some pristine areas within Point Nepean.

4.2.9.8 Phillip Island Nature Park

Phillip Island is east of Melbourne and forms a natural breakwater for the shallow waters of Western Port. Phillip Island is Biologically Important Area (BIA) for the Little Penguin, with breeding and foraging sites present. There is no management plan for Phillip Island Nature Park.

4.2.9.9 Point Nepean National Park

Point Nepean National Park protects 560 ha of land at the tip of Mornington Peninsula, surrounded by Port Phillip Heads Marine National Park (see Section 4.2.8.7). The park is of great cultural significance as a sacred place to Traditional Owners for over 35,000 years, a landmark and natural resource to European settlers, as well as a line of defence for Victoria and Australia (Parks Victoria 2017). Restricted access has allowed the park to maintain the largest and most intact area of remnant coastal vegetation on the Port Phillip coast and Victoria's largest remnant area of coastal alkaline scrub. Intertidal rock platforms support a diverse marine ecosystem while dune habitats provide roosting and feeding opportunities for resident and migratory seabirds.

4.2.9.10 Port Campbell National Park

Port Campbell National Park is slightly west of Twelve Apostles Marine National Park and 10 km east of Warrnambool. The park is 1,750 ha that presents an extraordinary collection of wave-sculptured rock formations. Port Campbell National Park is home to various fauna such as the Little Penguin, Short-tailed Shearwater and various whale species (Parks Victoria 2019).

4.2.10 Tasmanian Protected Areas – Marine

No Tasmanian marine protected areas were identified within the Project or Planning Areas (Appendix A; Appendix B).

4.2.11 Tasmanian Protected Areas – Terrestrial

No Tasmanian terrestrial protected areas were identified within the Project Area (Appendix A).)

Tasmanian terrestrial protected areas identified in the Planning Area (Appendix B) are presented in Table 4-8 and Figure 4-8. Areas identified in the PMST Report due to the size of the grids used in the PMST but not actually intersecting the Planning Area are listed in the table with 'X'. Tasmanian terrestrial protected areas which intersect the Planning Area and have a coastal component which may be exposed to hydrocarbons from a spill event are described in the subsections below, where information is available.

Table 4-8: Tasmanian Terrestrial Protected Areas identified within the Planning Area

Protected Area Name	Reserve Type	Coastal Component	Project Area	Planning Area
Badger Box Creek	Nature Reserve	-	-	X
Cape Wickham	Conservation Area	✓	-	✓
Cataraqui Point	Conservation Area	✓	-	✓
Christmas Island	Nature Reserve	✓	-	✓

City of Melbourne Bay	Conservation Area	✓	-	✓
Colliers Forest Reserve	Conservation Covenant	-	-	X
Colliers Swamp	Conservation Area	-	-	X
Councillor Island	Nature Reserve	✓	-	✓
Counsel Hill	Conservation Area	-	-	X
Currie Lightkeepers Residence	Historic Site	-	-	X
Disappointment Bay	State Reserve	✓	-	X
Eldorado	Conservation Area	-	-	X
Lavinia	State Reserve	✓	-	✓
Muddy Lagoon	Nature Reserve	-	-	X
New Year Island	Game Reserve	✓	-	✓
Porky Beach	Conservation Area	✓	-	✓
Red Hut Point	Conservation Area	✓	-	✓
Red Hut Road #1	Conservation Covenant	-	-	X
Red Hut Road #2	Conservation Covenant	-	-	X
Reid Rocks	Nature Reserve	✓	-	✓
Rodondo Island	Nature Reserve	✓	-	✓
Sea Elephant	Conservation Area	✓	-	✓
Sea Elephant River	Conservation Covenant	-	-	X
Seal Rocks	Conservation Area	-	-	X
	State Reserve	✓	-	X
South Rd Nugara	Conservation Covenant	-	-	X
Stokes Point	Conservation Area	✓	-	✓

4.2.11.1Badger Box Creek Nature Reserve

Badger Box Creek Nature Reserve covers an area of 23.51 ha on King Island. It is designated as IUCN Category V which is a protected landscape/seascape. There is no management plan for the Badger Box Creek Nature Reserve.

4.2.11.2Cape Wickham Conservation Area

The Cape Wickham Conservation Area on the northern tip of King Island and contains Cape Wickham lighthouse and the gravesites of the crew of Loch Leven, a ship that was wrecked nearby. It is designated as IUCN Category V which is a protected landscape/seascape. There is no management plan for the Cape Wickham Conservation Area.

4.2.11.3 Cataraqui Point Conservation Area

Cataraqui Point Conservation Area is located on the west coast of King Island covering an area of 3.05 km^2 and extending from the coast to 100-200 m inland. The conservation area is designated as IUCN Category V and there is no management plan in place.

4.2.11.4 Christmas Island Nature Reserve

Christmas Island Nature Reserve covers 84.24 ha surrounding the granite island to the north-west of King Island. The reserve is part of the King Island Important Bird Area recognised by BirdLife Australia for providing important habitat for the Orange-bellied Parrot during its migration as well as significant numbers of Short-tailed Shearwater, Black-faced Cormorant, Fairy Tern, Hooded Plover and Pacific Gull (BirdLife Australia 2023c).

4.2.11.5 City of Melbourne Bay Conservation Area

City of Melbourne Bay Conservation Area covers 201.03 ha on King Island. The conservation area is designated as IUCN Category V and there is no management plan in place.

4.2.11.6 Colliers Swamp Conservation Area

Colliers Swamp Conservation Area covers 1,089.8 ha on King Island. The conservation area is designated as IUCN Category VI and there is no management plan in place.

4.2.11.7 Councillor Island Nature Reserve

Councillor Island Nature Reserve covers 17.58 ha of the granite island within the New Year Group. The reserve is part of the King Island Important Bird Area recognised by BirdLife Australia for providing important habitat for the Orange-bellied Parrot during its migration as well as significant numbers of Short-tailed Shearwater, Black-faced Cormorant, Fairy Tern, Hooded Plover and Pacific Gull (BirdLife Australia 2023d). The conservation area is designated as IUCN Category Ia and there is no management plan in place.

4.2.11.8 Lavinia State Reserve

Lavinia State Reserve covers 7,860.4 ha on King Island at the Lavinia Ramsar Site. See Section 4.2.6.1.

4.2.11.9 New Year Island Game Reserve

New Year Island Game Reserve covers 118.22 ha to the north-west of King Island. The reserve is part of the King Island Important Bird Area recognised by BirdLife Australia for providing important habitat for the Orange-bellied Parrot during its migration as well as significant numbers of Short-tailed Shearwater, Black-faced Cormorant, Fairy Tern, Hooded Plover and Pacific Gull (BirdLife Australia 2023f).

4.2.11.10 Porky Beach Conservation Area

Porky Beach Conservation Area is located on the west coast of King Island covering an area of 4.55 km^2 and extending from the coast to 100-200 m inland. The conservation area is designated as IUCN Category V and there is no management plan in place.

4.2.11.11 Red Hut Point Conservation Area

Red Hut Point Conservation Area covers an area of 159.84 ha on King Island. The conservation area is designated as IUCN Category V and there is no management plan in place.

4.2.11.12 Reid Rocks Nature Reserve

Reid Rocks Nature Reserve covers 6.62 ha in the New Year Island Group. It is the only breeding site in Tasmania for Australian Fur-seals (PWS 2000).

4.2.11.13 Sea Elephant Conservation Area

Sea Elephant Conservation Area covers 722.06 ha on King Island, approximately 25 km north-east of Currie. The conservation area is designated as IUCN Category VI and there is no management plan in place.

4.2.11.14 Seal Rocks State Reserve

Seal Rocks State Reserve is a 5.84 km^2 area on the south-western coast of King Island. The state reserve is an IUCN category III and there is no management plan in place. Images produced by google maps and google earth, show the coastal sections of the reserve consist primarily of large rocks and rocky cliffs.

4.2.11.15 Stokes Point Conservation Area

Stokes Conservation Area is a 2.44 km^2 area on the south-western coast of King Island. The state reserve is an IUCN category V and there is no management plan in place.

4.2.12 Key Ecological Features

Key Ecological Features (KEFs) are elements of the marine environment, based on current scientific understanding, and are considered to be of regional importance for either the region's biodiversity or ecosystem function and integrity of a Commonwealth Marine Area.

No KEFs were identified within the Project Area. Areas identified in the PMST Report (Appendix A) due to the size of the grids used in the PMST but not actually intersecting the Project Area are listed in the table with 'X'

KEFs identified in the Planning Area (Appendix B) are presented in Table 4-9 and Figure 4-9 and described in the subsections below.

Table 4-9: Key Ecological Features within the Planning Area

Key Ecological Feature	Project Area	Planning Area
Bonney Coast Upwelling	-	✓
West Tasmania Canyons	X	✓

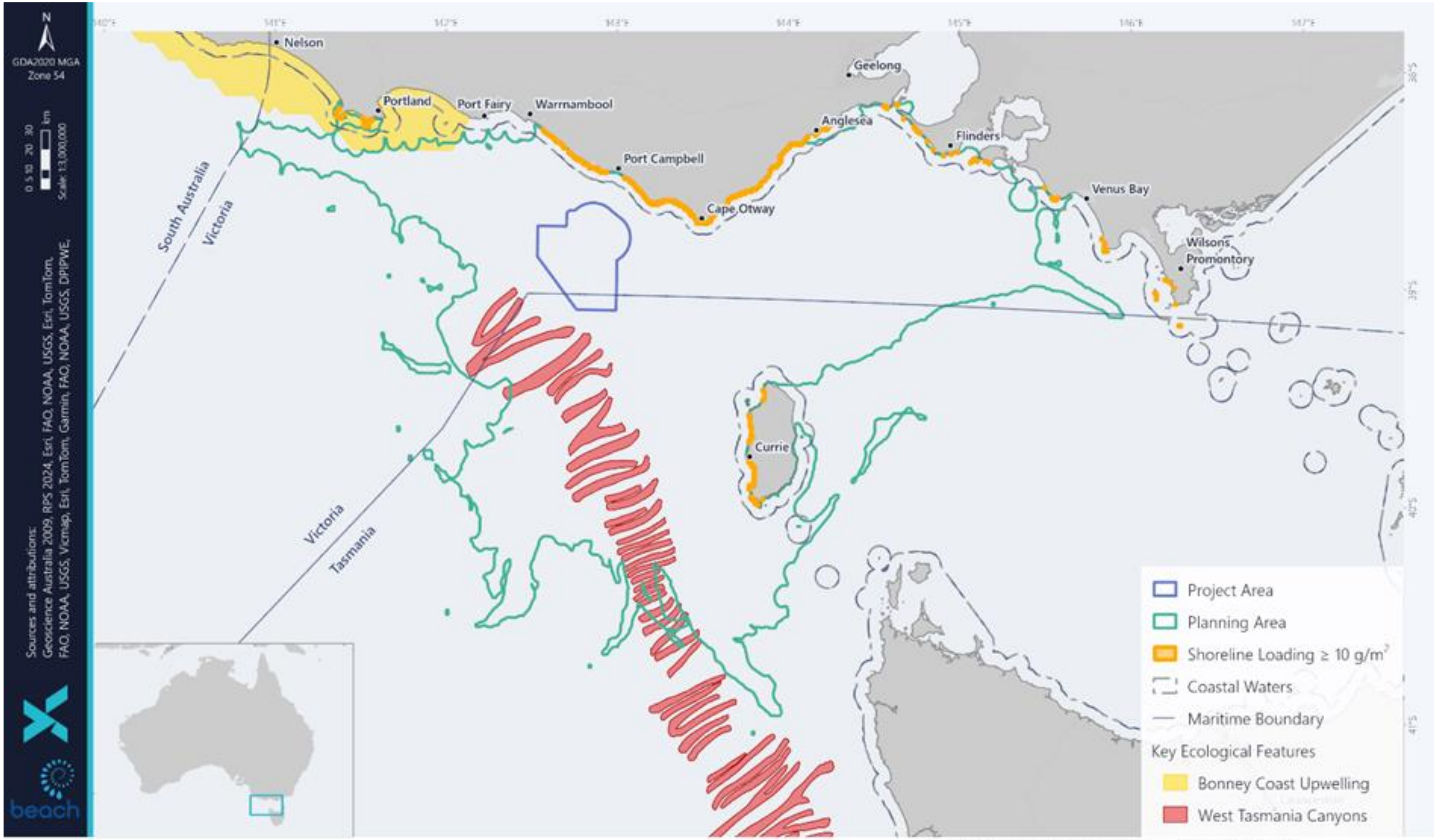


Figure 4-9: Key Ecological features within the Planning Area

4.2.12.1 Bonney Coast Upwelling

The Bonney Coast upwelling is a predictable, seasonal upwelling bringing cold nutrient rich water to the sea surface and supporting regionally high productivity and high species diversity in an area where such sites are relatively rare and mostly of smaller scale (CoA 2015). The Bonney Coast upwelling is defined as a key ecological feature as it is an area of enhanced pelagic productivity and has high aggregations of marine life (DCCEEW 2023b). In addition to whales, many endangered and listed species frequent the area, possibly also relying on the abundance of krill that provide a food source to many seabirds and fish. The high productivity of the Bonney coast upwelling is also capitalised on by other higher predator species such as little penguins and Australian Fur-seals feeding on baitfish (CoA 2015).

The Bonney Coast Upwelling KEF lies on the continental shelf situated approximately 120 km north-west of Cape Jaffa, South Australia to Portland, Victoria (Figure 4-9). The location of the Bonney Coast Upwelling KEF was originally derived through a review of enhanced chlorophyll occurrence for summer seasonal data between the years of 1998 and 2010 (Research Data Australia 2013).

4.2.12.2 West Tasmanian Canyons

The West Tasmanian Canyons are located on the relatively narrow and steep continental slope west of Tasmania. This location has the greatest density of canyons within Australian waters where 72 submarine canyons have incised a 500 km-long section of slope (Heap and Harris 2008). The canyons in the Zeehan AMP are relatively small on a regional basis, each less than 2.5 km wide and with an average area of 34 km^2 shallower than 1,500 m (Williams et al. 2009). The Zeehan canyons are typically gently sloping and mud-filled with less exposed rocky bottoms compared with other canyons in the south-east marine region (e.g. Big Horseshoe Canyon).

Submarine canyons modify local circulation patterns by interrupting, accelerating, or redirecting current flows that are generally parallel with depth contours. Their size, complexity and configuration of features determine the degree to which the currents are modified and therefore their influences on local nutrients, prey, dispersal of eggs, larvae and juveniles and benthic diversity with subsequent effects which extend up the food chain.

Eight submarine canyons surveyed in Tasmania, Australia, by Williams et al. (2009) displayed depth-related patterns with regard to benthic fauna, in which the percentage occurrence of faunal coverage visible in underwater video peaked at 200-300 m water depth, with averages of over 40% faunal coverage. Coverage was reduced to less than 10% below 40 m depth. Species present consisted of low-relief bryozoan thicket and diverse sponge communities containing rare but small species in 150 to 300 m water depth.

Sponges are concentrated near the canyon heads, with the greatest diversity between 200 m and 350 m depth. Sponges are associated with abundance of fishes and the canyons support a diversity of sponges comparable to that of seamounts. Based upon this enhanced productivity, the West Tasmanian canyon system includes fish nurseries (Blue Wahoo and Ocean Perch), foraging seabirds (albatross and petrels), White Shark and foraging Blue and Humpback Whales (TSSC 2022).

4.3 Physical Environment

4.3.1 Climate

The climate in the Otway Basin is typical of a cool temperate region with cold, wet winters and warm dry summers. It is located on the northern edge of the westerly wind belt known as the Roaring Forties. In winter, when the subtropical ridge moves northwards over the Australian continent, cold fronts generally create sustained west to south-westerly winds and frequent rainfall in the region (McInnes and Hubbert 2003). In summer, frontal systems are often shallower and occur between two ridges of high pressure, bringing more variable winds and rainfall.

4.3.2 Oceanography

4.3.2.1 Winds

The Otway Basin is a high-energy environment exposed to frequent storms and significant wave heights. Winds in the area generally exceed 13 knots (23.4 km/h) for more than 50% of the time contributing to the moderate to high wave-energy environment. Strongest winds are associated with eastward-moving low pressure and frontal systems that cross the site every 4 to 6 days in winter. Directions are predominantly south-westerly veering north-westerly. September is the windiest month, with average wind speeds of 29 km/h.

4.3.2.2 Waves

The Otway Basin has a predominantly south-westerly aspect and is highly exposed to swell from the Southern Ocean. Wave heights generally range from 1.5 m to 2 m. Waves up to 10 m can occur during winter storm events.

4.3.2.3 Tides

Tides are semi-diurnal with a diurnal inequality (Jones and Padman 1983). The maximum tidal range in western Bass Strait is 1.2 m. Currents are directed along a north-east/south-west axis, with maximum speeds of 0.3 m/s (Fandry 1983).

4.3.2.4 Ocean Currents

The South-east Marine Region is oceanographically complex, with subtropical influences from the north and subpolar influences from the south. The Leeuwin Current transports warm, subtropical water southward along the Western Australian coast and then eastward into the Great Australian Bight where it mixes with the cool waters from the Zeehan Current running along the west coast of Tasmania. These currents are stronger in winter than in summer (Figure 4-10).

The eastern parts of the Region are strongly influenced by the East Australian Current (EAC) that flows southward adjacent to the east coast of New South Wales, Victoria, and Tasmania, carrying warm equatorial waters. The EAC is up to 500m deep and 100 km wide and is strongest in summer when it can flow at up to 5 knots. In winter it flows at 2–3 knots as the oceanographic and climatic drivers in the Coral Sea diminish.

The EAC tends to form ocean eddies that rotate around warm, central cores that can be up to 200 km across and may persist for months. The eddies can cross the continental shelf, and when mixing with shelf break waters, create upwellings that form isolated areas of enhanced productivity 200–300 km in diameter. Eddies form more frequently off the south coast of New South Wales than other areas but are also common along the east coast of Tasmania. The EAC affects sea surface temperatures on the eastern Tasmanian shelf, which can vary substantially among years depending on the relative influence of subtropical waters.

During winter, the South Australian current moves dense, salty warmer water eastward from the Great Australian Bight into the western margin of the Bass Straight. In winter and spring, waters within the straight are well mixed with no obvious stratification, while during summer the central regions of the straight become stratified.

4.3.2.5 Sea Temperature

Surface seawater temperatures in the Otway Basin typically range from 14°C in winter to 21°C in summer. However, upwelling of cooler nutrient-rich water occur along the seafloor during mid to late summer. This upwelling is an extension of the regional Bonney coast upwelling system, which affects southern Australia because of south-east winds forcing surface water offshore thus triggering a compensatory subduction along the bottom. If the wind is strong enough the water sometimes shoals against the coast. The water originates from a subsurface water flow called the Flinders current and has the characteristics of reheated Antarctic Intermediate Water (Levings and Gill 2011).

During winter and spring onshore winds cycling from the south-west to north-west mound the surface layer against the land and cause a south-easterly flow along the coast that fills the shelf from the shore outwards to a depth of 500 m deep. Shelf water temperatures at these times range from between 18°C to 14°C with seafloor temperatures warmer in winter than in summer.

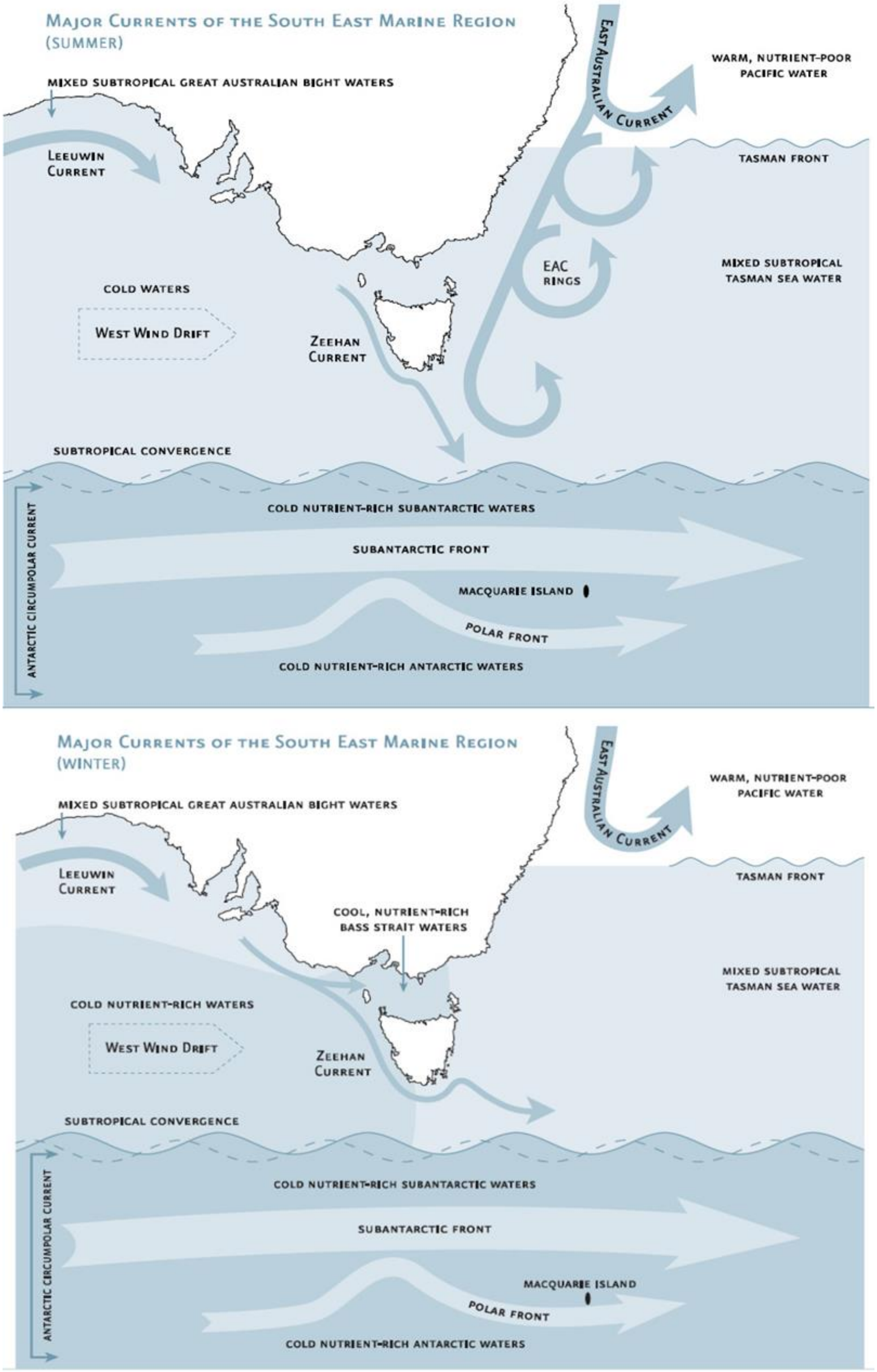


Figure 4-10: Ocean Currents in South-eastern Australian Waters during Summer (top) and Winter (bottom) (Source: CoA 2015)

4.3.3 Geomorphology

The south-eastern section of Australia's continental margin comprises the Otway Shelf and the Bonney Coast, Bass Strait, and the western shelf of Tasmania. The 400 km long Otway Shelf lies between 37° and 43.5°S and 139.5°E (Cape Jaffa) and 143.5°E (Cape Otway). The narrowest point is off Portland, where the shelf is less than 20 km wide. It broadens progressively westward, to 60 km off Robe, SA, and eastward to 80 km off Warrnambool. The Otway shelf is comprised of Miocene limestone below a thin veneer of younger sediments.

Boreen et al. (1993) examined 259 sediment samples collected over the Otway Basin and the Sorell Basin of the west Tasmanian margin. Based on assessment of the sampled sediments the authors concluded the Otway continental margin is a swell-dominated, open, cool-water, carbonate platform. A conceptual model was developed which divided the Otway continental margin into five depth-related zones – shallow shelf, middle shelf, deep shelf, shelf edge and upper slope (Figure 4-11).

In the shallow shelf are exhumed limestone substrates that host dense encrusting mollusc, sponge, bryozoan, and red algae assemblages. The middle shelf is a zone of swell-wave shoaling and production of mega-rippled bryozoan sands. The deep shelf is described as having accumulations of intensely bioturbated, fine, bioclastic sands. At the shelf edge and top of slope, nutrient-rich upwelling currents support extensive, aphotic bryozoan/sponge/coral communities. The upper slope sediments are a bioturbated mixture of periplatform bioclastic debris and pelleted foraminiferal/nano-fossil mud. The lower slope is described as crosscut by gullies with low accumulation rates, and finally, at the base of the slope the sediments consist of shelf-derived, coarse-grain turbidites and pelagic ooze.

The Project Area is primarily located within the shallow, middle and deep shelf zones with the south-western portions extending beyond the shelf edge to the upper slope.

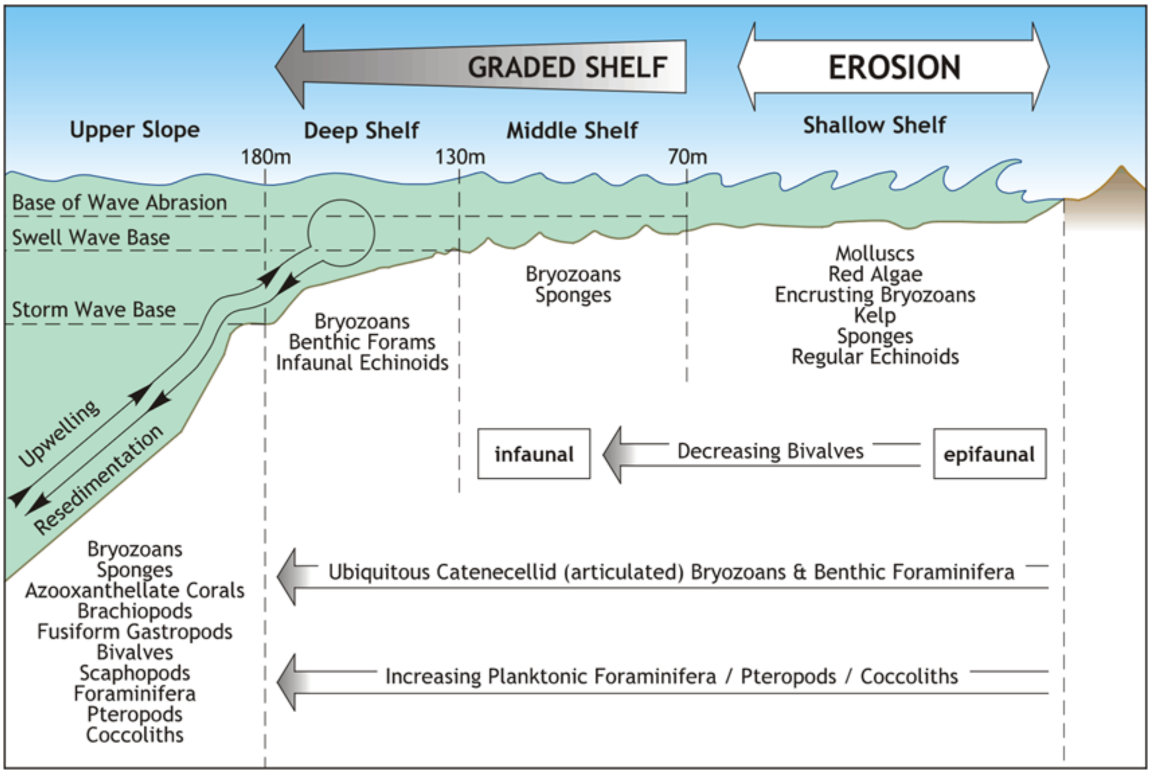


Figure 4-11: Model of the Geomorphology of the Otway Shelf (Boreen et al. 1993)

Previous surveys of the shallow shelf and middle shelf zones where existing Beach infrastructure is located are provided in detail in Section 4.4.1. A video survey of the seabed at selected sites along proposed offshore pipeline routes for the Otway Gas Development (BBG 2003) found that the substrate in water depths between 82 and 66m were predominantly low-profile limestone with an incomplete sand veneer that supported a low to medium density, sponge dominated filter feeding community. Fish and other motile organisms were uncommon.

In shallower depths of between 63 and 30 m, the video surveys showed a rippled, sand or sand/pebble substrate with minor sponge dominated benthic communities. The epibenthic organisms were generally attached to outcropping or sub-outcropping limestone pavements. Only in waters shallower than approximately 20 m, was an area of significant, high profile reef and associated high density macroalgae dominated epibenthos encountered.

Prior to activities in the deep shelf and upper slope, further studies will be undertaken to understand the geomorphology of areas where infrastructure will be installed. Section 4.4.1 provides further detail on studies to be undertaken.

4.3.4 Sediment Quality

Sediments were sampled during the Otway Basin Environmental Survey (Ramboll 2020; Appendix C). Sediment samples were collected at two of the gas fields, Artisan and Thylacine. For sample locations see Appendix C. The Artisan field would be representative of the sediments closer to shore, while the Thylacine field which is further offshore would be representative of the sediments in the deeper waters of the Project Area. Further studies are planned to understand the sediment quality of the deepest portion of the Project Area, located on the deep shelf (refer to Section 4.4.1).

The sediment within all samples was predominantly sand with a range of 95-97% as a proportion of each sample. There was very little silt and a maximum of 4.7% for the clay fraction. There were no discernible trends based on the location of sample collection.

The oxidation reduction potential (ORP) of sediments within the samples was measured and the anoxic layer with low ORP was not detected in any of the sediments analysed and the range of measurements indicated that these sediments maintain a well oxygenated, unmodified environment.

There was a notable degree of variability in the nutrient samples collected in the Thylacine field, however the small number of samples means that a trend or pattern was not discernible. Nitrate-nitrite was not detected in any samples. Total organic content and detectable nitrogen concentrations were slightly higher in the Artisan samples compared to the Thylacine samples. Generally, the concentrations of nutrients in the marine sediments were to be expected for this environment and type of sediment.

Of the inorganic compounds tested, Cd, Cu, Pb, Hg, Ni and Sn were below the limit of reporting in all sediment samples. The concentration of Cr in sediments was low, and well below the default guideline values which indicate the concentrations below which there is a low risk of unacceptable effects occurring within the recommended sediment quality guidelines set out in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018). The concentration of Cr was slightly higher in the samples from Artisan than those from Thylacine. Zn was detected in two of the six samples (one sample from each field) and was well below the default guideline values set out within the Sediment Quality Guidelines.

BTEXs, PAHs, PCBs and TRHs were either below the LOR or at levels of no concern.

In summary, sediments had a high ORP and low or undetectable levels of toxicants indicating an unmodified seabed environment. It is expected that sediment quality within the Project Area and Planning Area will be typical of the offshore marine environment of the Otway Basin.

4.3.5 Water Quality

Water quality was sampled during the Otway Basin Environmental Survey (Ramboll 2020; Appendix C). For sample locations see Appendix C. Water samples were collected at two of the gas fields, Artisan and Thylacine. The Artisan field would be representative of the water quality closer to shore, while the Thylacine field which is further offshore would be representative of the water quality in the deeper waters of the Project Area.

In situ measurements were taken for dissolved oxygen (DO), pH and ORP and DO and pH were assessed against the default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems set out in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018). Trigger values are used to assess risk of adverse effects due to nutrients, biodegradable organic matter, and pH in various ecosystem types.

DO was between the lower and upper limits of 90 and 110% saturation for marine waters in all samples. Likewise, pH was between the lower and upper limits of 8.0 and 8.4 for all samples. The range of ORP measurements indicated a well oxygenated, ecologically healthy environment.

Laboratory analyses for a suite of analytes were undertaken and has been compared to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) default guideline values for physical and chemical stressors for nutrient analytes and the trigger values for toxicants at alternative levels of protection for all other analytes.

The concentration of ammonia, nitrite and reactive phosphorus was at or below the level of reporting (LOR) for all samples. Only one sample contained a concentration of nitrate-nitrite, NO_3, Total Kjeldahl Nitrogen and Total Nitrogen above the LOR. This same sample site (Thylacine_1_3) slightly exceeded ANZG (2018) default guideline values for Total Nitrogen. Concentrations of Total Phosphorus were recorded in all samples, but all measurements were below ANZG (2018) default guideline values. Total Suspended Solids was typically within the range expected for unmodified marine waters.

The concentrations of Cd, Cr, Co, Pb, Hg, and Ni were at or below LOR in all samples. The concentration of Cu was below, at or very close to the LOR for all samples. The concentration of all contaminants (Cd, Cr, Co, Pb, Hg, Zn, Ni and Cu) against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) were all below the default guideline values in all samples. This is consistent with a slightly disturbed marine system which is described in (ANZG 2018) as an ecosystem in which biodiversity may have been affected to small degree by human activity.

BTEXs and PAHs were below the detection limit in all water samples. Very low traces of Total Recoverable Hydrocarbon (TRHs) were detected in a Thylacine water sample but were at levels of no concern. TRHs were below detection limits in all other samples. The level of chlorophyll a in filtered samples was below the detection level.

In summary, the water quality at the Thylacine and Artisan survey areas indicated an undisturbed mid-depth environment.

It is expected that water quality within the Project Area and Planning Area will be typical of the offshore marine environment of the Otway Basin, which is characterised by high water quality with low background concentrations of trace metals and organic chemicals.

4.3.6 Ambient Light

Ambient light is defined as the light that is already present within an environment. Ambient light is predominantly from solar/lunar luminescence. There are minor anthropogenic sources from townships and nearby shipping lanes within the vicinity of the light EMBAs (Figure 4-12). Within the Otway Basin artificial light emissions can be expected from both permanent (e.g. onshore/ offshore developments) and temporary (e.g. vessel) activities. Lighting from the existing Thylacine- A Wellhead Platform is required for navigational and safety purposes and complies with Sections 2.1 and 2.2 of the Recommendation O-139 on *The Marking of Man-Made Offshore Structures* (IALA, Ed 2, 2013). Moderate levels of commercial vessel traffic are expected within the Planning Area (Section 4.5.6) and light EMBAs with navigation and working lighting complying with Australian Maritime Safety Authority (AMSA) Marine Orders Part 30 (Prevention of Collisions). Closer to shore, particularly in coastal communities, natural light is considered to be a community value. Major population centres and areas associated with popular tourist attractions and their potential presence within the light EMBAs are detailed in Table 4-10. Artificial light may attract light sensitive species such as shorebirds, seabirds, and turtles (Section 6.3.3).

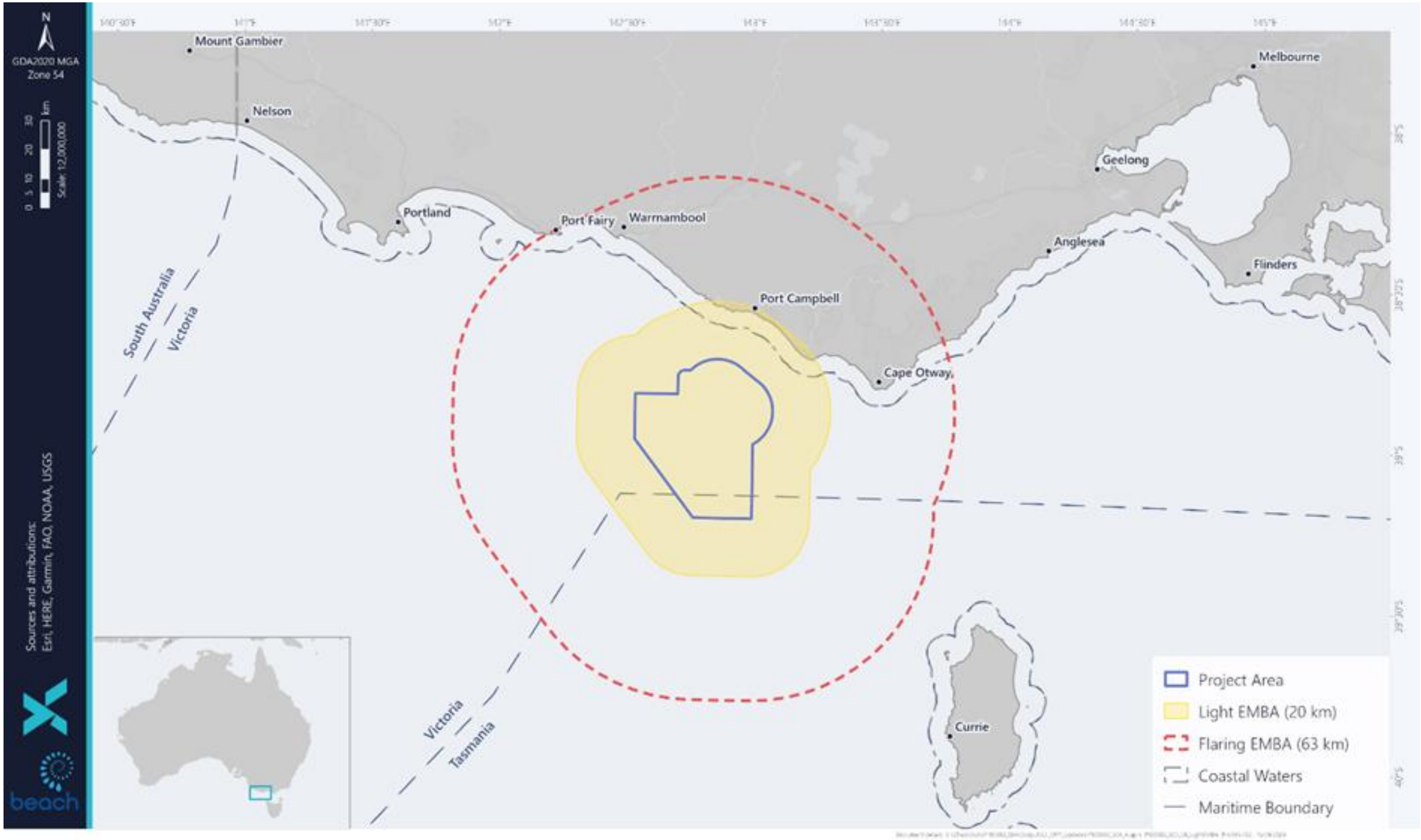


Figure 4-12: Light EMBAs

Table 4-10: Population centres and other anthropogenic light sources within the light EMBAs

Anthropogenic Light Source	**Light EMBA**	**Flaring EMBA**
Port Fairy Population: 3,742	-	-
Warrnambool Population: 31,308	-	✓
Peterborough Population: 322	✓	✓
Port Campbell Population: 440	✓	✓
Princetown Population: 236	-	✓
Thylacine A Platform	✓	✓
Shipping	✓	✓

4.3.7 Ambient Sound

McCauley and Duncan (2001) undertook a desktop review of natural and man-made sea sound sources likely to be encountered in the Otway Basin. They concluded that natural sea sound sources are dominated by wind noise, but also include rain noise, biological noise and the sporadic noise of earthquakes. Man-made underwater sound sources in the region comprise shipping and small vessel traffic, petroleum production and exploration drilling activities and sporadic petroleum seismic surveys.

Between 2009 and 2016 the Integrated Marine Observing System (IMOS) recorded underwater sound south of Portland, Victoria (38°32.5' S, 115°0.1'E). Prominent sound sources identified in recordings include Blue and Fin Whales at frequencies below 100 Hz, ship noise at 20 to 200Hz and fish at 1 to 2 kHz (Erbe et al. 2016). In the broader region, primary contributors to background sound levels were wind, rain and currents-and waves associated sound at low frequencies under 2kHz (Przeslawski et al. 2016). Biological sound sources including dolphin vocalisations were also recorded (Przeslawski et al. 2016).

During April-May 2001 two underwater noise loggers were placed (5.1 km and 2.9 km south-west of an exploration petroleum drilling vessel at the Thylacine site) to measure underwater noise before, during and after drilling activity. A further logger was placed in the shipping lane approximately 60 km due south of Port Fairy to measure ambient noise produced by physical, manmade and biological sources between late November 2001 and early March 2002 (Woodside 2003). Baseline broadband underwater noise for the period was in the order of 93 to 97 dB re 1 µPa with shipping raising the averaged noise level above 105 dB re 1 µPa for 6% of the deployment time.

An acoustic monitoring program was also undertaken during exploratory drilling of the Casino-3 well. A sound logger located 28.03 km from the drill site did not detect drilling noise and recorded ambient noise that ranged between 90 and 110 dB re 1 µPa (McCauley 2004). Passive acoustic monitoring commissioned by Origin from April 2012 to January 2013, 5 km offshore from the coastline east of

Warrnambool, identified that ambient underwater noise in coastal areas is generally higher than further offshore, with a mean of 110 dB re 1 µPa and maximum of 161 dB re 1 µPa (Duncan et al. 2013).

More recently JASCO Applied Sciences (Australia) (JASCO) completed a monitoring study for Beach in relation to exploration drilling activities at the Artisan 1 well with the aim of completing an acoustic characterisation of the drilling and associated vessel activity within the Otway Basin. McPherson et al. (2021) details the monitoring program and results. Four recorders were deployed in February and retrieved in early April 2021 with Stations 1 through 4 deployed at distances of 0.336, 1.13, 5.11, and 25 km from the Ocean Onyx drill rig.

The results for Station 4, the furthest from the drill rig, were a median broadband ambient noise of 104.5 dB re 1 µPa, a mean of 118.3 dB re 1 µPa, a minimum of 86.6 dB re 1 µPa, and a maximum of 153.6 dB re 1 µPa. This is both quieter and louder than those for Casino 3. The mean levels at Station 4 are 8.3 dB higher than those recorded 5 km offshore of Warrnambool, while the maximum recorded at Station 4 is lower by 7.4 dB. For Station 4 contributors to the soundscape were weather, shipping, and marine mammals. Local variations in ambient noise and received levels can depend upon water depth and the proximity to contributors. In this case, the shipping lanes and the frequency and proximity of vessel passes are strong drivers of the ambient noise at Station 4. The quieter levels reported at Thylacine in Lattice Energy (2017) are likely due to the placement of the monitoring station at a distance from the shipping lanes, which limited their contributions to the data set and thus resulted in a lower reported range of received sound levels.

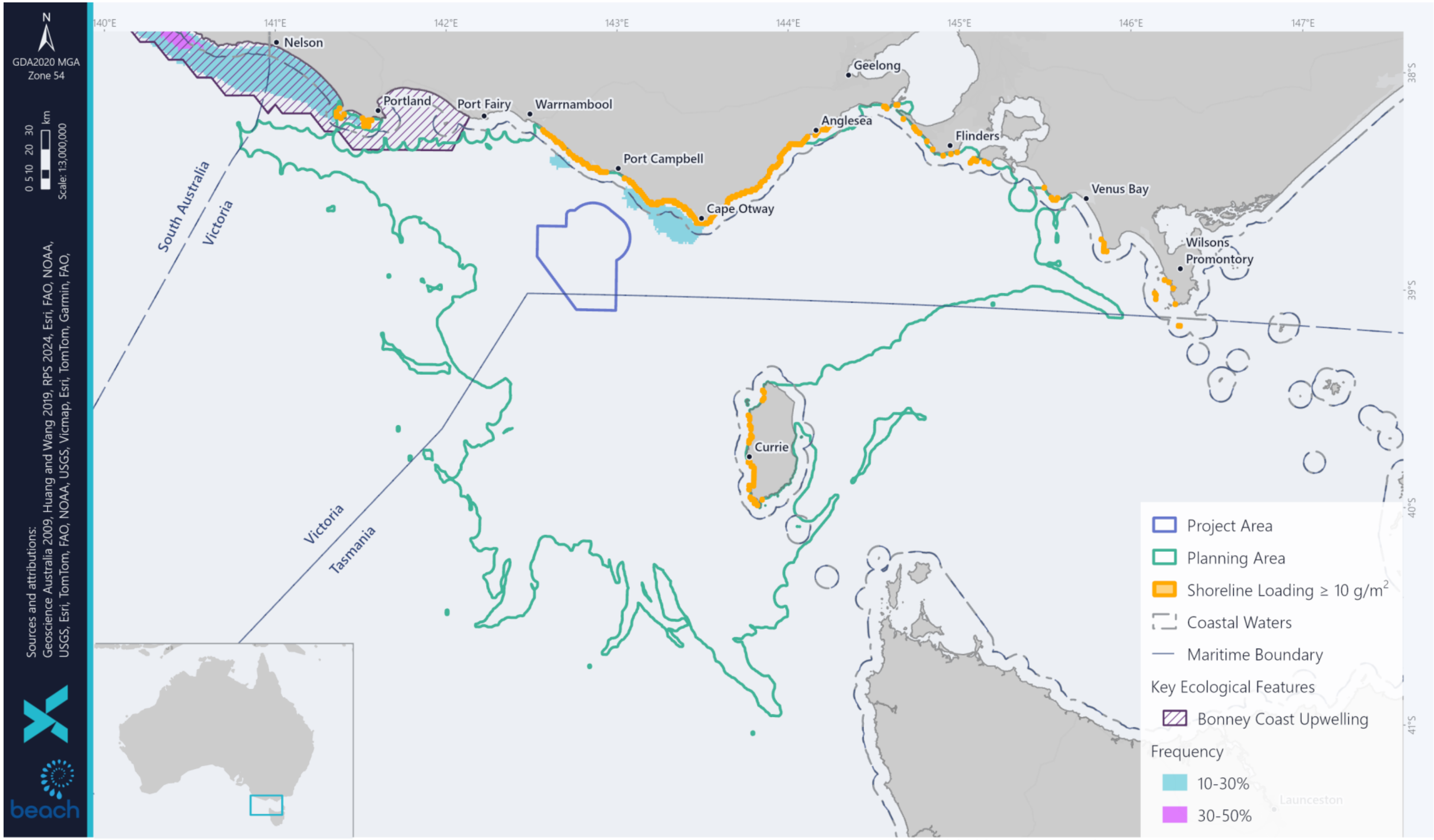
4.3.8 Bonney Coast Upwelling

The Bonney coast upwelling is mainly driven by the frequent south-easterly winds during the austral summer (Lewis 1981, Middleton and Bye 2007, Nieblas et al. 2009, Schahinger 1987). The frequent south-easterly winds are the result of southern migration of the subtropical ridge (Nieblas et al. 2009, Schahinger 1987). The upwelling occurs via Ean dynamics, where the ocean surface experiences a steady wind stress which results in a net transport of water at right angles to the left of the wind direction which brings cold, nutrient rich water to the sea surface.

Huang and Wang (2019) developed an image processing technique to map upwelling areas along the south-eastern coast of Australia. This study used monthly Moderate Resolution Imaging Spectroradiometer (MODIS) sea surface temperature (SST) composites between July 2002 and December 2016, which were generated from daily SST images with a spatial resolution of ~1 km. As upwelling in winter is unlikely to occur images during this period were not analysed. Upwelling reaching the surface often displays a colder SST signature than the adjacent area (e.g., Dabuleviciene et al. 2018, Gill et al. 2011, Kampf et al. 2004, McClatchie et al. 2006, Oke and Griffin 2011, Oke and Middleton 2001, Roughan and Middleton 2004, Willis and Hobday 2007). This negative SST anomaly is the foundation of upwelling mapping using SST data (Huang and Wang 2019).

The spatial patterns of the mapped Bonney coast upwelling have been shown to follow a clear temporal pattern. When the upwelling season starts during late spring and early summer (November and December), the influence of the Bonney coast upwelling was found to be often restricted to the coast. During the mid-summer and early autumn (January to March) when the upwelling is the strongest, the upwelling influence often extended to the shelf break before retreating in April (Huang and Wang 2019).

Gill et al (2011) states that the Bonney coast upwelling generally starts in the eastern part of the Great Australian Bight and spreads eastwards to the Otway Basin. At the height of the Bonney coast upwelling during February and March, the upwelling's area of influence often exceeds 12,000 km^2, its SST anomaly often exceeds 1°C, and its chlorophyll-a concentrations are often >1.5 times of its adjacent areas (Huang and Wang 2019).



Sources and attributions: Geoscience Australia 2009, Huang and Wang 2019, RPS 2024, Esri, FAO, NOAA, USGS, Esri, TomTom, FAO, NOAA, USGS, Vicmap, Esri, TomTom, Garmin, FAO,

Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_S04_A.aprx, P100383_S00_12_Bonney, P-UWS-132, 14/09/2024

Figure 4-13: Bonney Coast Upwelling Frequency within the Project and Planning Areas (Source: Huang and Wang 2019, Geoscience Australia 2020)

4.3.8.1 Variability

While the general characteristics of the Bonney coast upwelling are broadly understood virtually nothing is known of the longer-term variability of the phenomenon. Alongshore wind is the predominant mechanism in the upwelling, which is, therefore, directly impacted by any changes to the strength or frequency of these winds. However, not all favourable upwelling winds lead to an upwelling event. Huang and Wang (2019) state that each year for the period of 14 years (Sept 2002 to May 2016) of their study there was large variability in the distribution of the upwelling influence areas, month to month, season to season and year to year.

The El Niño – Southern Oscillation (ENSO) has been identified by some authors as a potential driver of upwelling strength along the south Australian coast. The ENSO is the dominant global mode of inter-annual climate variability, is a major contributor to Australia's climate and influences Australia's marine waters to varying degrees around the coast. The two phases of ENSO, El Niño and La Niña, produce distinct and different changes to the climate.

Middleton et al. (2007) examined meteorological and oceanographic data and output from a global ocean model. The authors concluded that El Niño events lead to enhanced upwelling along Australia's southern shelves. However, it has been found that relationships between ENSO events and upwelling and production indices off southern Australia are weak due to the high interannual and inter-seasonal variability in these indices.

Huang and Wang (2019) results indicate that the ENSO events are likely to have a low-to-moderate impact on the upwelling intensity although the El Nino events tend to strengthen upwelling intensity along the south-east coast of Australia with La Nina events tending to weaken upwelling intensity. Previous studies (Middleton and Bye 2007; Middleton et al. 2007) indicated that the El Nino events would raise the thermocline (along the Australian margin) which effectively forms a colder and nutrient-rich pool at shallower depths. This is likely to enhance upwelling intensity, with higher SST and chlorophyll-a anomalies and a larger area of influence.

4.3.8.2 Ecological Importance

The primary ecological importance of the Bonney coast upwelling is as a feeding area for the Blue Whale (Balaenoptera musculus). The upwelled nutrient-rich re-heated Antarctic intermediate water promotes blooms of coastal krill, *Nyctiphanes australis*, which in turn attracts Blue Whales to the region to feed.

The Bonney coast upwelling is one of only two identified seasonal feeding areas for Blue Whales in Australian coastal waters and is one of 12 known Blue Whale feeding aggregation areas globally. Sightings of the sei whale in the upwelling indicate this is potentially an important feeding ground for the species (Gill et al. 2015). There have also been sightings of the fin whale, which indicate this could potentially be an important feeding ground (Morrice et al. 2004)

The high productivity of the Bonney coast upwelling also leads to other attributes such as algal diversity and its productivity as a fishery. This productivity is also capitalised on by other higher predator species such as Little Penguins and Fur-seals feeding on baitfish. Robinson et al. (2008) postulated that upwelling waters may bring fish prey of Australian Fur-seals to surface waters, which are then flushed into Bass Strait within foraging range of seals.

4.3.8.3 Linkages between Climate, Upwelling Strength, and Blue Whale Abundance

The complex interaction between climatic conditions, upwelling strength and seasonal Blue Whale distribution and abundance within the Bonney coast upwelling is currently poorly understood other than at a general level. Factors to be resolved to enable a more detailed understanding include observations that not all strong upwelling-favourable winds necessarily lead to strong upwelling events (Griffin et al. 1997) and that increased upwelling does not necessarily equate to increased productivity as conditions may be less optimal for plankton growth. Huang and Wang (2019) found a generally weak and unclear correlation between chlorophyll-a and SST. This weak correlation may be due to chlorophyll-a concentrations (a remote measure of plankton population) are also influenced by other complex oceanographic and biological mechanisms such as grazing, seasonality and transportation.

Further an increase in plankton biomass does not necessarily coincide with the presence of the Blue Whales. Review of pygmy Blue Whale aerial observation data from Gill et al. (2011) from the 2001-02 to 2006-07 seasons, and additional surveys in the Otway Basin commissioned by Origin during February 2011 and November -December 2012 did not find a significant positive correlation between El Niño conditions and pygmy Blue Whale abundance. Such a positive correlation could be expected if El Niño conditions caused stronger upwelling, stronger upwelling led to increased planktonic productivity and Blue Whales were more likely to be present when productivity is higher.

Two of the six seasons subject to aerial surveys in the eastern section of the Otway Basin (Gill et al. 2011) were determined by the Bureau of Meteorology to demonstrate weak to moderate El Nino conditions. The remainder of the years were assessed to be neutral. The two El Nino seasons (2002-03 and 2006-07) corresponded with the lowest observation frequencies (sightings/1,000 km) for pygmy Blue Whales of all the yearly surveys.

Aerial surveys commissioned by Origin undertaken during February 2011 and November-December 2012 were undertaken during La Nina events classified by the Bureau of Meteorology as very strong and strong respectively. Although observation frequencies are not available, the absolute numbers of pygmy Blue Whales observed was substantially higher than during the 2001-01 to 2006-07 surveys. Also, of note is that pygmy Blue Whales observed during February 2011 were congregated along the seaward edge of a plume of terrestrial runoff, potentially suggesting use of this plume as a feeding resource, which has no relationship to upwelling.

As such, the interactions between climate and ecology for this upwelling system are complex and no definitive linkages between climatic events, upwelling strength and Blue Whale abundance have yet been described.

4.3.8.4 Operational Setting

Mapping of the Bonney coast upwelling frequency by Huang and Wang (2019) identified that the occurrence of an upwelling event between 2002 and 2016 (measured by remote sensing of a combination of SST anomaly and chlorophyll-a) within the Project Area was unlikely with an upwelling frequency for this area of <10%. The closest areas of increased frequency of upwelling events to the Project Area (10-30% occasional/semi-seasonal) were small, isolated areas situated in coastal areas to the north and north-east (Gill et al (2011) states that the Bonney coast upwelling generally starts in the eastern part of the Great Australian Bight and spreads eastwards to the Otway Basin. At the height of the Bonney coast upwelling during February and March, the upwelling's area of influence often exceeds 12,000 km^2, its SST anomaly often exceeds 1°C, and its chlorophyll-a concentrations are often >1.5 times of its adjacent areas (Huang and Wang 2019). Areas of further increased frequencies of Bonney coast upwellings (30-50% seasonal) were found over 198 km to the west of the Project Area (Figure 4-13).

4.4 **Ecological Environment**

To characterise the ecological environment, a literature search and online resources and databases were reviewed to identify and assess species that may be present or potentially present in the Project and Planning Areas. The following information sources were used:

- Online government databases, publications, and interactive mapping tools, such as the SPRAT database and National Conservation Values Atlas.
- Protected Matters Search Tool (PMST) for Matters of National Environmental Significance (MNES) protected under the EPBC Act.
- Species conservation advice and recovery plans.
- In field survey data for the Otway area.
- Published observations, data, and statistics on marine mammals.
- Reports from scientific experts and institutions, marine biologist and experts in Blue Whale and Southern Right Whale populations in the Otway area.
- Relevant listings under the *Victorian FFG Act 1988*
- Relevant listings under the *Tasmanian Threatened Species Conservation Act (1995)*
- Relevant environmental guidelines and publicly available scientific literature on individual species.

4.4.1 Benthic Habitats and Communities

As discussed in Section 4.3.3, a number of studies (Boreen et al. 1993, BBG 2003, CEE Consultants Pty Ltd 2003 and Ramboll 2020) have been undertaken within the Project Area within the shallow and middle shelf zones. These studies have identified the seabed is similar across these areas, consisting of carbonate rich coarse to medium sands with areas of exposed limestone substrate. This type of seabed is highly mobile making it difficult for filter feeders and soft body invertebrates to survive and establish in significant populations. Epifauna is dominated by low density, patchy assemblages of branching bryozoans, gorgonian cnidarians and sponges. A summary of these studies is provided below.

The existing studies focus on the shallow and middle shelf zones of up to approximately 130 m water depth (refer to Section 4.3.3). Further seabed assessments will be undertaken of the deep shelf zone (from approximately 130m to 160m water depth) located predominantly in the southern and western portions of the Project Area. These assessments will enable the seabed composition, benthic habitats and communities to be identified for locations where seabed disturbance activities such as drilling and infrastructure installation may take place and will include:

- geophysical surveys consisting of multibeam bathymetry, side scan sonar, magnetometer, and sub-bottom profiling

- geotechnical sampling consisting of cone penetration tests and coring
- biological sampling consisting of sediment and water samples, and use of seabed imagery to identify benthic habitats at representative locations.

4.4.1.1 Existing Studies

In 2002, 2003 and 2004, Fugro undertook a number of bathymetric surveys of the two proposed pipeline rights of way: one constructed for the Thylacine Geographe pipeline and one extending from the completed Geographe A well to Flaxman's Hill.

A review of the available geotechnical data was carried out in March 2011 for the Geographe location (Advanced Geomechanics 2011). Overall, the seabed in the Otway area surveyed slopes to the south at a gentle average gradient of less than 1 degree. However, the local topography is predominantly irregular in nature, varying from gently undulating and locally smooth in areas of increased sediment deposition, to areas of outcropping cemented calcrete features that are from smooth to jagged relief. These areas are covered in marine growth. ROV video survey confirmed the presence of a shallow hard underlying substrate at a depth of 50 mm below the sediment in areas of marine growth (JP Kenny 2012).

The Flaxman's Hill alignment traverses the Thistle drilling area and the Thylacine Geographe pipeline runs parallel and north east of this area. During 2003, bathymetric data was collected, and the right of way was assessed and recorded using an underwater video camera (CEE Consultants Pty Ltd 2003). The Flaxman's Hill pipeline route travels approximately 68 km from the Geographe gas field to the shoreline. Visual assessment of the sea floor was undertaken from a water depth of 99 m to 16 m terminating at Flaxman's Hill.

A summary of the seabed morphology and benthic assemblages is provided in Table 4-11 to Table 4-15.

Table 4-11: Otway Margin Geomorphology (Boreen et al. 1993)

Zone	Depth (m)	Width (m/km)	Gradient	Features
Shallow Shelf	30 - 70	4 – 28	1.5 – 10	Drops rapidly from strandline to depths of 30 m, characterised by rugged but subdued topography
Middle Shelf	70 - 130	7 – 65	1 - 8.5	Generally smooth topography with occasional rock out crops

Table 4-12: Thylacine to Geographe Seabed Morphology and Benthic Assemblages (CEE Consultants Pty Ltd 2003)

Depth (m)	Seabed morphology	Benthic assemblage
92	High profile reef stone with deep sand gutters.	Diverse, high density sessile: sponge, coral dominated crinoids common and mobile species
88	Low profile with areas of high profile limestone ridges; incomplete sand veneer.	Diverse, high density sessile: sponge, dominated and mobile species

Table 4-13: Geographe to Flaxman's Hill Seabed Morphology and Benthic Assemblages (CEE Consultants Pty Ltd 2003)

Depth (m)	Seabed morphology	Benthic assemblage
82	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Medium density sessile: sponge, dominated low density mobile species. (small shark)
82	Equal % of exposed low profile limestone and sand. Two reef outcrops. Low profile with areas of high profile limestone ridges; incomplete sand veneer.	Medium density, sessile: sponge, dominated
78	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Medium density, sessile: sponge, dominated Motile: sea urchins dominated
76		Medium density, sessile: sponge, dominated
76		Low - Medium density, sessile: sponge, dominated
70		Diverse, med density sessile, sponge dominated
68		Medium density, sessile: sponge, dominated
65		Diverse, med density sessile, sponge dominated
60		Medium density, sessile: sponge, dominated

Table 4-14: Geographe to Rifle Range Seabed Morphology and Benthic Assemblages (CEE Consultants Pty Ltd 2003)

Depth (m)	Seabed morphology	Benthic assemblage
82	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Very low density sessile; large sponge.
79		Diverse, low – high density sessile
75	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Medium density, sessile: sponge, dominated. Motile: sea urchins dominated
74		Medium density, sessile: sponge, dominated
70		Low - Medium density, sessile: sponge, dominated
67		Diverse, med density sessile, sponge dominated
66	Low profile limestone with sand gutters	Medium density, sessile: sponge, dominated
66	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Diverse, med density sessile, sponge dominated
70	(Pock marks) Data not documented.	Medium density, sessile: sponge, dominated
63	Corse gravel to fine sand	High density sessile: micro algae dominated

Table 4-15: Nearshore Seabed Morphology and Benthic Assemblages (CEE Consultants Pty Ltd 2003)

Depth (m)	Seabed morphology	Benthic assemblage
53	Sand	None observed
45		Only sea pens noted
16-30	Very high profile l/stone reef to sand	High density, sessile: sponge, macroalgae (Bull Kelp common)

A video survey of the seabed at selected sites along proposed offshore pipeline routes for the Otway Gas Development was undertaken by BBG during 2003 (Figure 4-14). BBG (2003) found that the substrate in water depths between 82 and 66 m were predominantly low- profile limestone with an incomplete sand veneer that supported a low to medium density, sponge dominated filter feeding community. Fish and other motile organisms were uncommon.

In shallower depths of between 63 and 30 m, the video surveys showed a rippled, sand or sand/pebble substrate with minor sponge dominated benthic communities. The epibenthic organisms were generally attached to outcropping or sub-outcropping limestone pavements. Only in waters shallower than approximately 20 m, was an area of significant, high profile reef and associated high density macroalgae dominated epibenthos encountered. Details of the seabed and benthic epifaunal assemblage are provided in Table 4-16.

Table 4-16: Nearshore Seabed Morphology and Benthic Assemblages (CEE Consultants Pty Ltd 2003)

Site No.	Depth (m)	Seabed type	Benthic Assemblage
3097	99	Bare rippled sand; minor limestone outcrops	Low density sessile; small sponge dominated
3118	99	Low profile limestone reef with sand veneer. isolated areas of raised l/stone	Low density sessile; sponge dominated
3084	99	Low profile limestone reef with incomplete sand veneer	Low density sessile; sponge dominated
3072	99	Low profile limestone reef with incomplete sand veneer	Low density sessile; sponge dominated
3054	98	Mix of low and high profile l/stone; shallow and deep sand	Low density sessile on low l/stone; high density sessile on high l/stone plus fish; sponge dominated
3185	95	Low profile limestone reef with incomplete sand veneer	Low density sessile; sponge dominated
3196	94	Low profile limestone reef with incomplete sand veneer	Low density sessile; sponge dominated
3232	92	High profile reef stone with deep sand gutters.	Diverse, high density sessile: sponge, coral dominated crinoids common and mobile species
3267	88	Low profile with areas of high profile limestone ridges; incomplete sand veneer.	Diverse, high density sessile: sponge, dominated and mobile species
2801	82	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Very low density sessile; large sponge.

Site No.	Depth (m)	Seabed type	Benthic Assemblage
2720	79		Diverse, low – high density sessile
2590	75	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Medium density, sessile: sponge, dominated. Motile: sea urchins dominated
2490	74		Medium density, sessile: sponge, dominated
2339	70		Low - Medium density, sessile: sponge, dominated
2291	67		Diverse, med density sessile, sponge dominated
2191	66	Low profile limestone with sand gutters	Medium density, sessile: sponge, dominated
2181	66	Low profile with areas of high profile limestone ridges; incomplete sand veneer	Diverse, med density sessile, sponge dominated
1191	63	Coarse gravel to find sand	High density sessile: micro algae dominated
1668	53	Sand	None observed

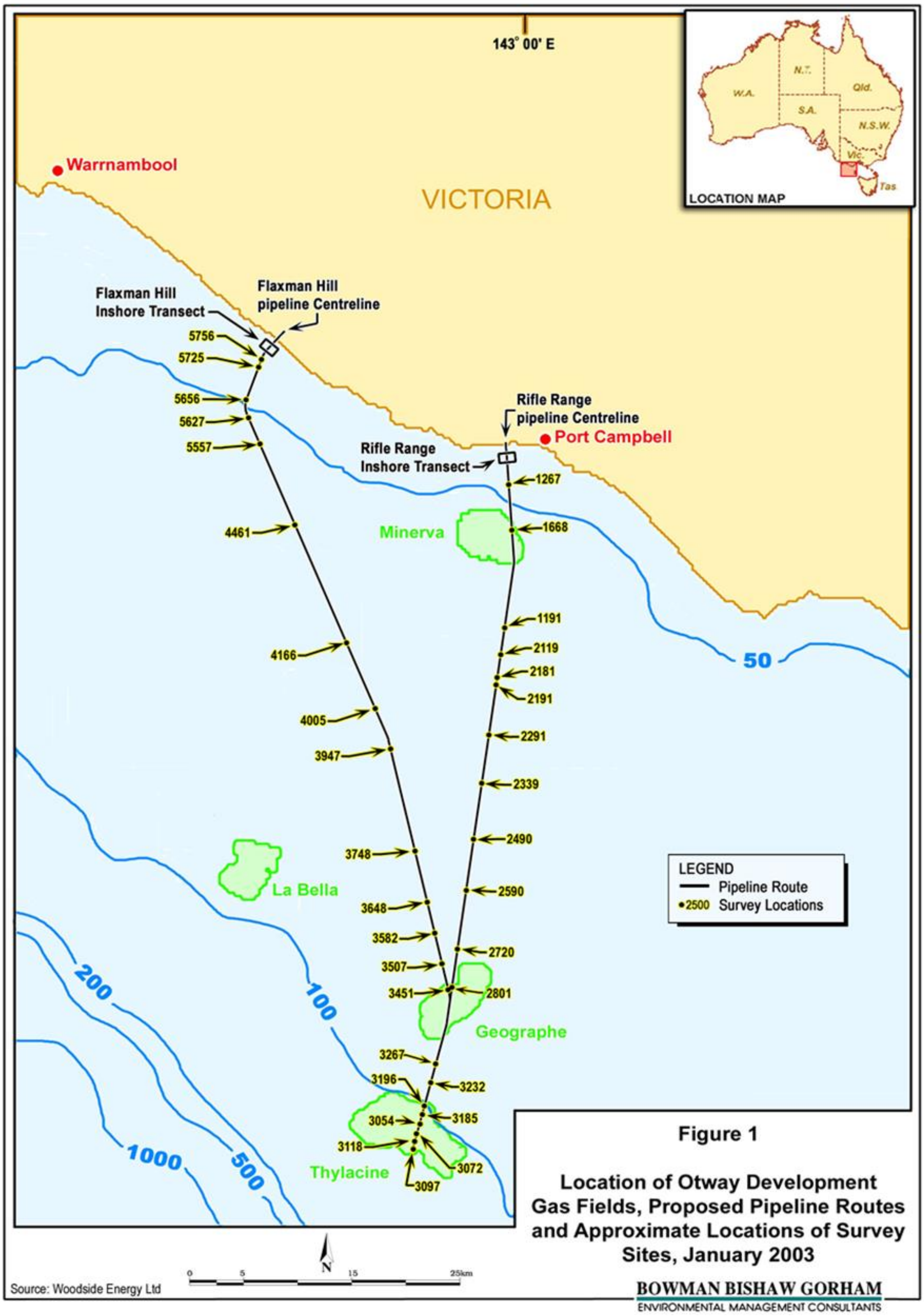


Figure 4-14: Seabed Sites Assessed by Video Survey During 2003 (BBG 2003)

Beach commissioned a seabed site assessment of the preferred infrastructure routes for the Otway Gas Development which was undertaken during the Otway Basin Environmental Survey from November

2019 to January 2020 and ranged in water depths from 70 to 104 m (Ramboll, 2020. Appendix C). details the survey area and sample locations.

The objective of the seabed site assessment was to determine suitable locations for anchoring and MODU placement for drilling operations and the installation of infrastructure to connect new production wells to the existing infrastructure. Several different investigation techniques were used to examine and describe the seabed and benthic habitats, as well as identify possible hazards from manmade, natural, and geological features including benthic habitats

The survey comprised of multibeam bathymetry, side scan sonar, magnetometer, and sub-bottom profiling, cone penetration tests and seabed samples. In addition, sediment samples for infauna were collected and the composition and percent coverage of epifauna was assessed from photographs of the seafloor taken with a drop camera. Drop camera images at various locations are shown in Figure 4-16 to Figure 4-23 and survey results are summarised in Table 4-17.

Sediment samples for infauna were collected at two of the gas fields, Artisan and Thylacine. It was considered that the Artisan field would be representative of the infauna closer to shore (such as along the pipeline route), while the Thylacine field which is further offshore would represent the Geographe field.

The benthic infauna identified and counted from samples collected at the Thylacine and Artisan sites were relatively depauperate in both abundance and diversity. A total of 22 morpho-species were identified, from a total of 45 organisms collected from the grab samples, most of which were polychaete worms or crustaceans. These results are reflective of the sedimentary environment at the Thylacine and Artisan fields. All sites were dominated by sand, which typically have a lower abundance and diversity of infauna given that this abrasive type of substrate tends to be more easily subjected to laminar flows that move the sediment more dynamically than muddy substrates. The consequence of this is a physical environment that is not favourable for filter feeding and burrowing infauna species to inhabit. The types of species that were present in the samples were all those which can be expected to tolerate this somewhat dynamic environment. There were no discernible spatial trends in the distribution of sediment particle size. Likewise, there were no clear trends in the abundance, diversity, or composition of benthic infauna.

The composition and percent coverage of epifauna was assessed from photographs of the seafloor taken with a drop camera system. Percent cover ranged from 0 to 80% of the sample photograph for all samples but on average the percent cover was typically no more than 37%. The seabed at Hot Tap X had the greatest average coverage of epibiota (Figure 4-21) while the lowest coverage of epibiota was recorded along the route between Artisan and Hot Tap Y (Figure 4-16). Of the gas field sites, Artisan and Hercules had a slightly greater coverage of epifauna, while the routes between gas fields and Hot Tap Y have the least coverage of epifauna. Of the individual epibenthic organisms, *Gastropoda* sp. 2 (a cone shell) and crionids (featherstars) were the most abundant.

Further analysis of epifauna from grab samples at Artisan showed that much of the epifauna is comprised of branching bryozoans, feather-like gorgonian cnidarians and sponges. This complex of encrusting/branching fauna provides refuge for macrofauna such as amphipods, isopods, polychaete worms and molluscs.

Based on the assessment of epifauna using seabed photographs, the general impression of the seafloor is of an unmodified marine environment that supports a patchy complex of branching epibiota (i.e., bryozoans, gorgonian cnidarians, and sponges). This complex was highly patchy, covering 0.25 m^2 on average but could be found in patches of at least 0.4 m^2. A microscopic examination of a qualitative sample of this epibiota indicated that this complex of fauna provide microhabitat for a range of macrofauna such as amphipods, isopods, polychaete worms and molluscs. Such epifaunal habitats are known to provide refuge and other resources for benthic species (Jones 2006). By comparison, there was a low abundance and diversity of infauna living within the sediment which reflects the coarse nature of the substrate. This type of substrate is highly mobile making it difficult for filter feeders and soft bodies invertebrates to survive and establish significant populations.

Ramboll (2020) summarise that the epibiota on the seabed in the vicinity of the Thylacine and Artisan gas fields is representative of what is expected at depths around 70-100 m. The infauna was of relatively low abundance and diversity as expected for coarse sand substrates. No benthic species or ecological communities listed as threatened under the Environmental Protection and Biodiversity Conservation Act 1999 (the EPBC Act) were identified.

The findings from Ramboll (2020) align with findings from the Otway Gas Development studies (CEE Consultants Pty Ltd 2003; BBG 2003) and Boreen et al. (1993) concerning the subsea features and biological communities likely to dominate the middle shelf zones of the Project Area. In summary the seabed of the Project Area can be characterised as a carbonate mid shelf and deeper sections (60 – 70 m) of the shallow shelf with surficial sediments of carbonate rich coarse to medium sands with areas of exposed limestone substrate. The epifauna is dominated by low density, sessile sponge assemblages.

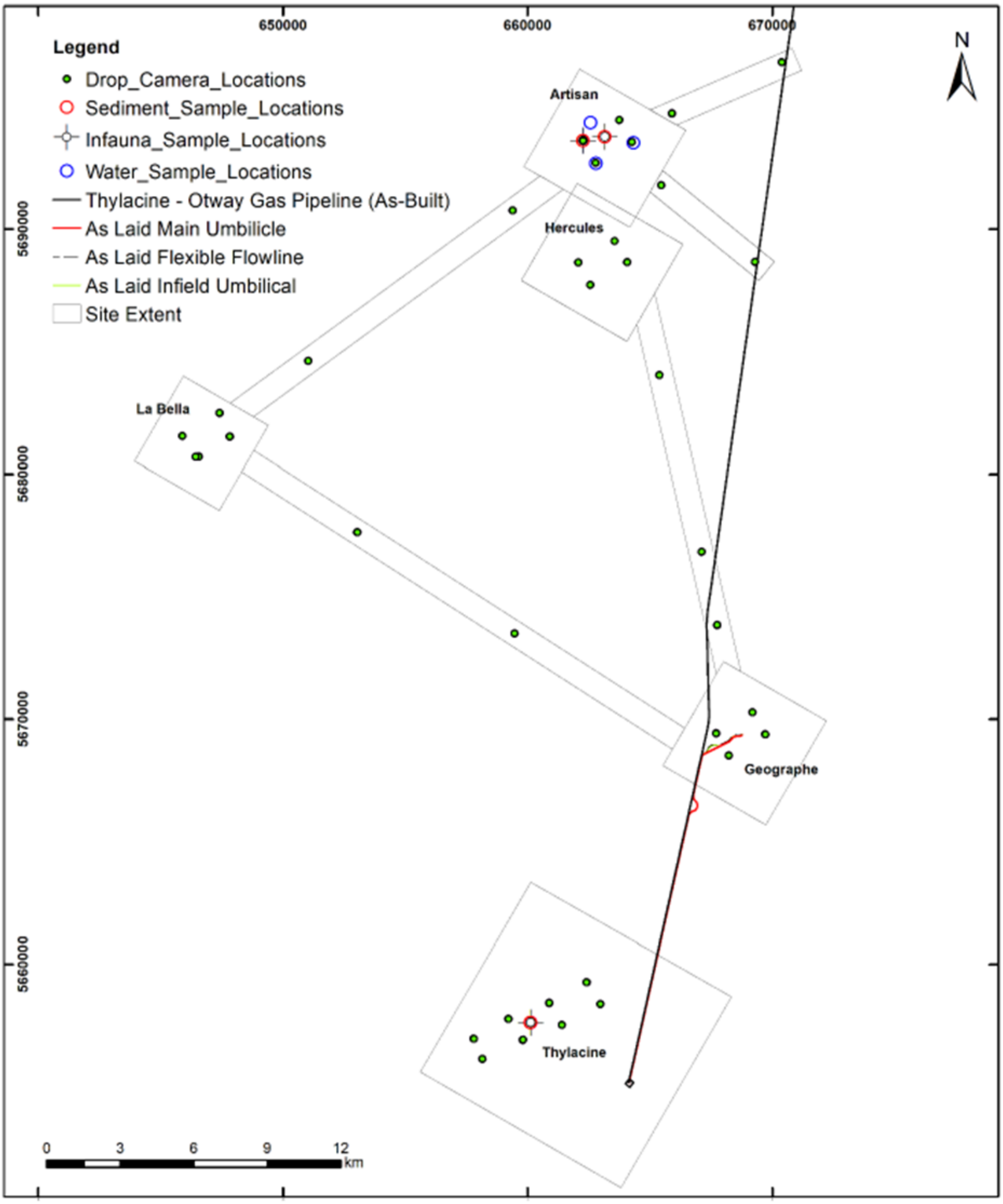
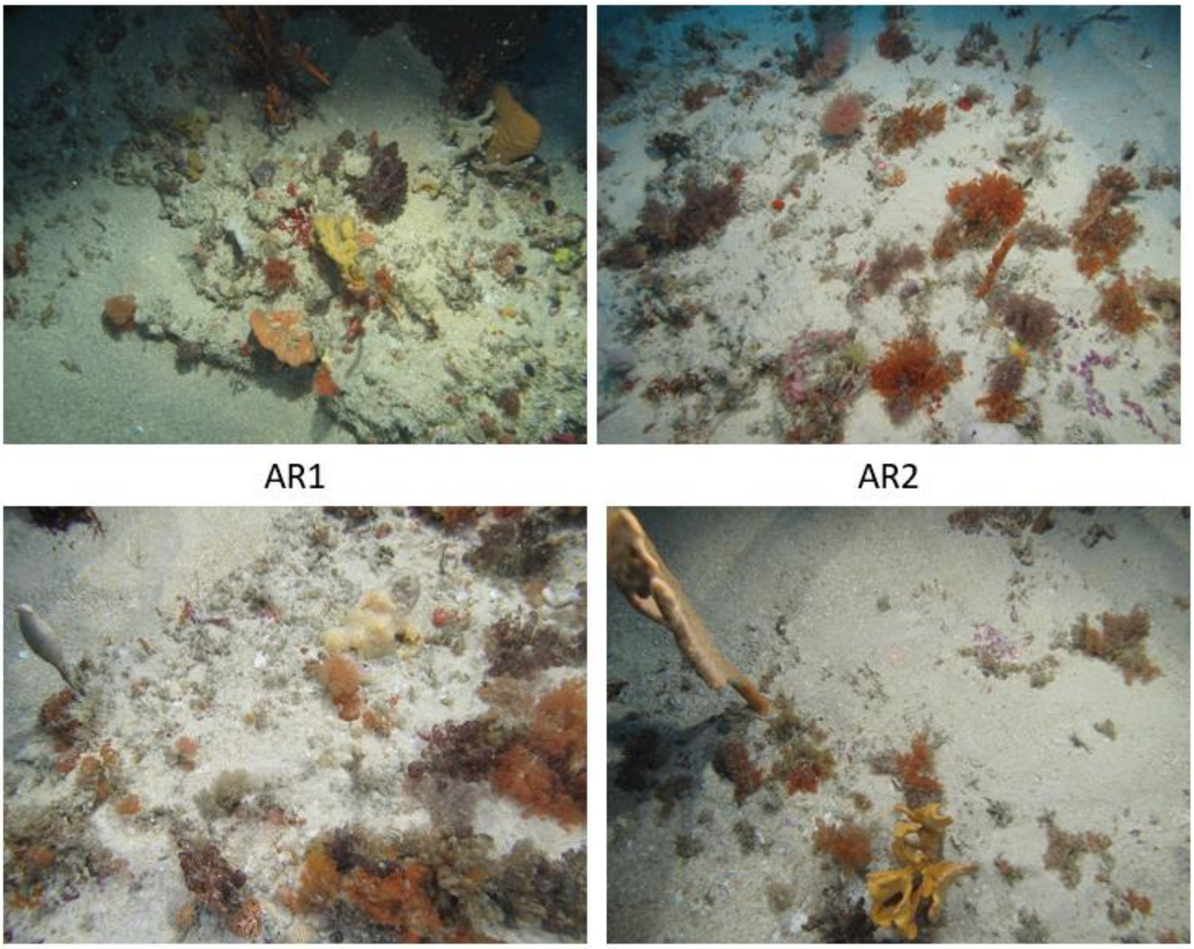


Figure 4-15: Seabed Sites Assessed during the Otway Gas Development Phase 4 Seabed Survey (Fugro, 2019; Ramboll, 2020)

Table 4-17: Results of the Otway Gas Development Phase 4 Seabed Survey (Fugro, 2019; Ramboll, 2020)

Survey Location	Results
Artisan (Figure 4-16)	Very little bathymetric variation across the survey area with water depths ranging from 68 to 74m. Seabed topography dominated by exposed rock on the seabed. Small patches of very thin transgressive coarse sand are present across the survey area. Megaripples were seen in some areas, with a wavelength of 1.5 to 2m and a height of 0.3 to 0.5m. Survey area characterised by low to moderate reflectivity characteristic of rock outcrop. A series of elevated mounds were noted in the north-west of the Artisan survey area 0.5 -1.0m above ambient seabed. Seabed showed a scattered sessile biota on a sandy seafloor.
Thylacine (Figure 4-17)	Seabed depths vary ranging from 92 to 115m, with an overall south-western slope. Seabed topography compromises of rocky outcrops of the regionally dipping Port Campbell limestones. Sands are coarse (siliceous) calcareous medium sand. A local relief of up to 3m is identified on the rocky scarp surfaces, which are separated by shallow depressions often with a transgressive sandy infill. Percentage epifauna cover from the eight drop camera sites ranged from zero to 65% with an average percentage cover of 14%. Predominantly hard seabed with coarse sand substrates that supports a patchy complex of branching epibiota (i.e., bryozoans, gorgonian cnidarians and sponges). Epibiota on the seabed in the vicinity of the Thylacine gas fields is representative of what is expected at depths around 70 – 100m. Infauna was of relatively low abundance and diversity as expected for coarse sand substrates.
Geographe (Figure 4-18)	Very little bathymetric variation across the survey area with water depths ranging from 80 to 91m. Rocky outcrops of the Port Campbell Limestone show some variable relief up to 2m. Sand is clean washed and well sorted and comprising predominantly of angular broken shells and bryozoans. Percentage cover from the four drop camera sites ranged from zero to 55% with an average percentage cover of 13%. Predominantly hard seabed with coarse sand substrates that supports a patchy complex of branching epibiota (i.e., bryozoans, gorgonian cnidarians, and sponges).
La Bella (Figure 4-19)	Water depth varies from 89 to 104m, with an overall south-western slope. Seabed characterised by rocky outcrops interspersed with low-lying areas of shallow uncemented sediment. Seabed topography is typical of an eroded platform, with inferred calcarenite lithology. Side scan sonar results also provide flat seabed and megarippled sands and rock outcrop features. At rock exposures, seabed photographs appear to show biogenic growth.

Survey Location	Results
Hercules (Figure 4-20)	Very little bathymetric variation across the survey area with water depths ranging from 71 to 77m. Seabed characterised by rocky outcrops interspersed with low-lying areas of shallow uncemented sediment. Port Campbell limestone cap rock is covered in places by mobile sediments of 1m thickness. Hercules site is a southern extension of the Artisan site, and therefore the seabed features bear strong similarities to those seen at Artisan site. Seabed features are typical of an eroded platform, including parallel asymmetric ridges with intermittent depressions.
OGPP and Umbilical Routes (Figure 4-21 Figure 4-22 Figure 4-23)	Seabed terrain is largely comprised of outcropping calcarenites, incised with erosional features and interspersed with (relatively) low-lying areas where shallow uncemented sands occur. Sands are generally less than 1m thick. Side scan sonar results also provide flat seabed and megarippled sands and rock outcrop features. At rock exposures, seabed photographs appear to show biogenic growth.



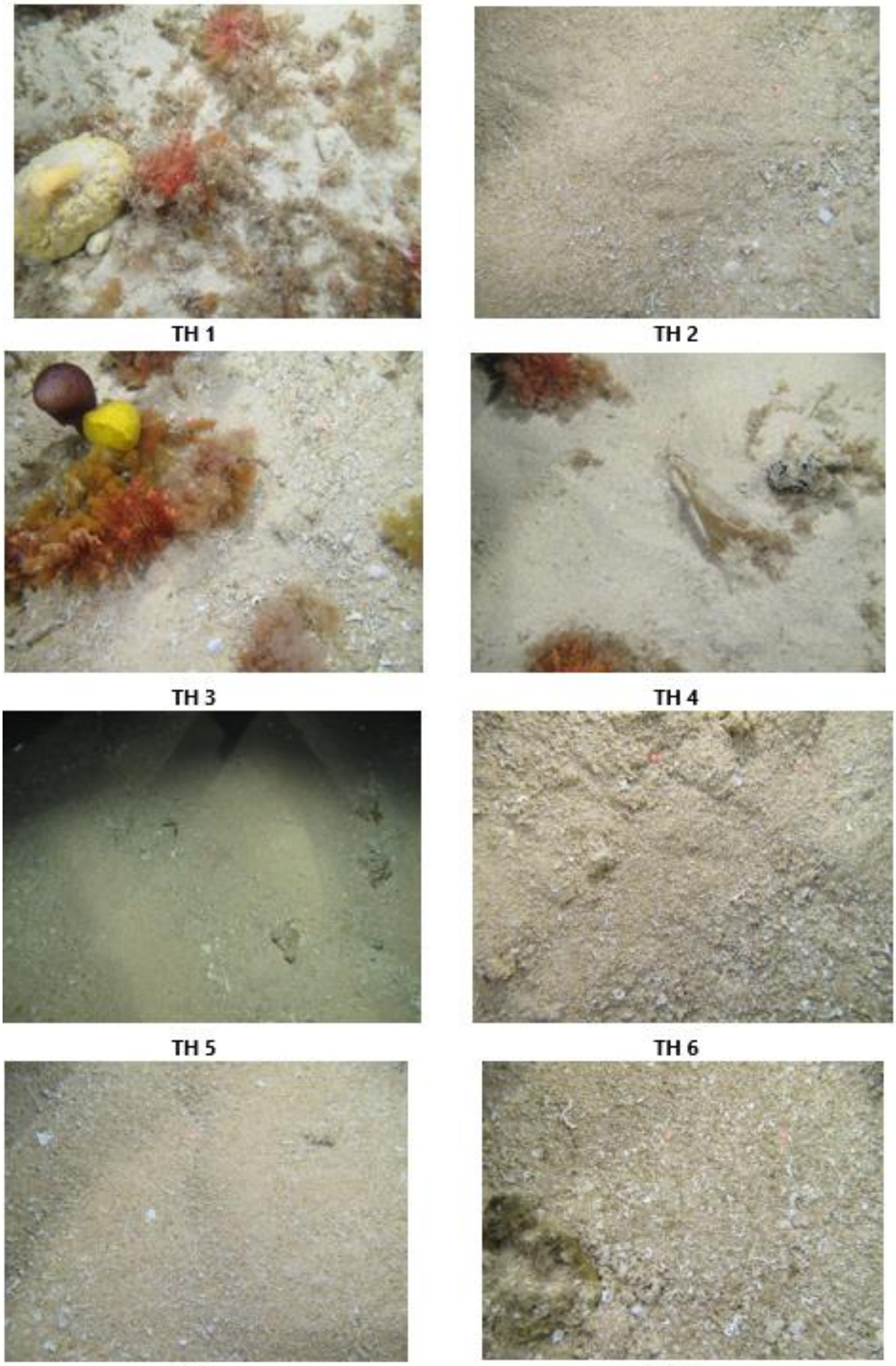
AR1

AR2

AR3

AR4

Figure 4-16: Drop Camera Images at Artisan



TH 1

TH 2

TH 3

TH 4

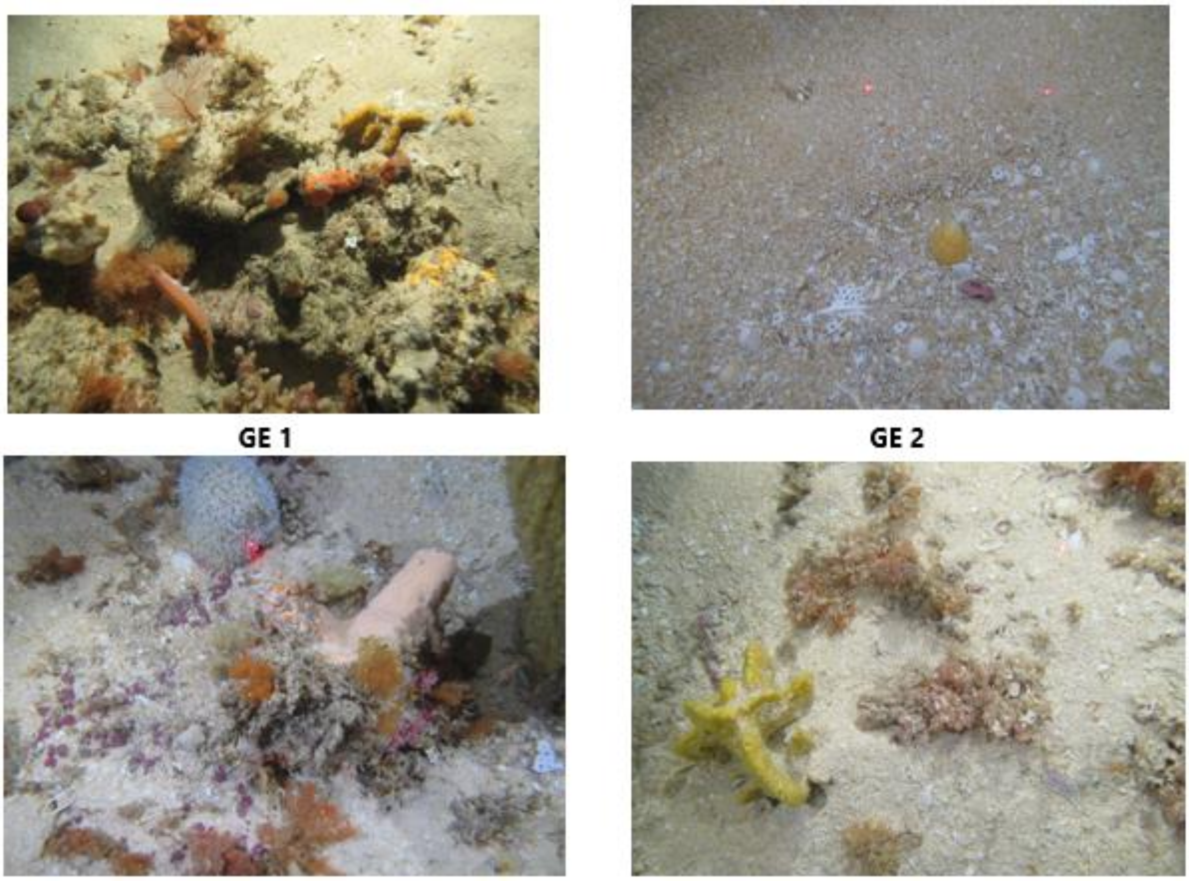
TH 5

TH 6

TH 7

TH 8

Figure 4-17: Drop Camera Images at Thylacine



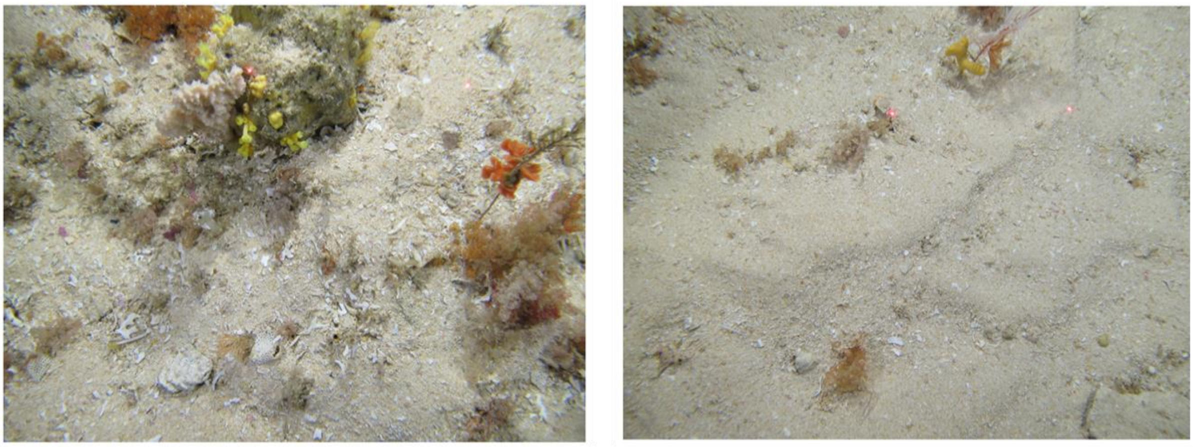
GE 1

GE 2

GE 3

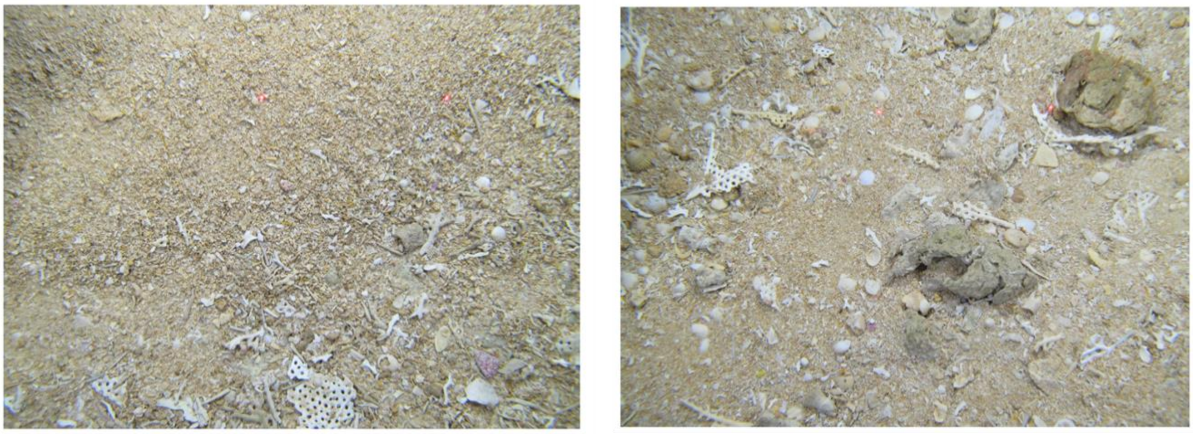
GE 4

Figure 4-18: Drop Camera Images at Geographe



La Bella, LB1

La Bella, LB2



La Bella, LB3

La Bella, LB4

Figure 4-19: Drop Camera Images at La Bella

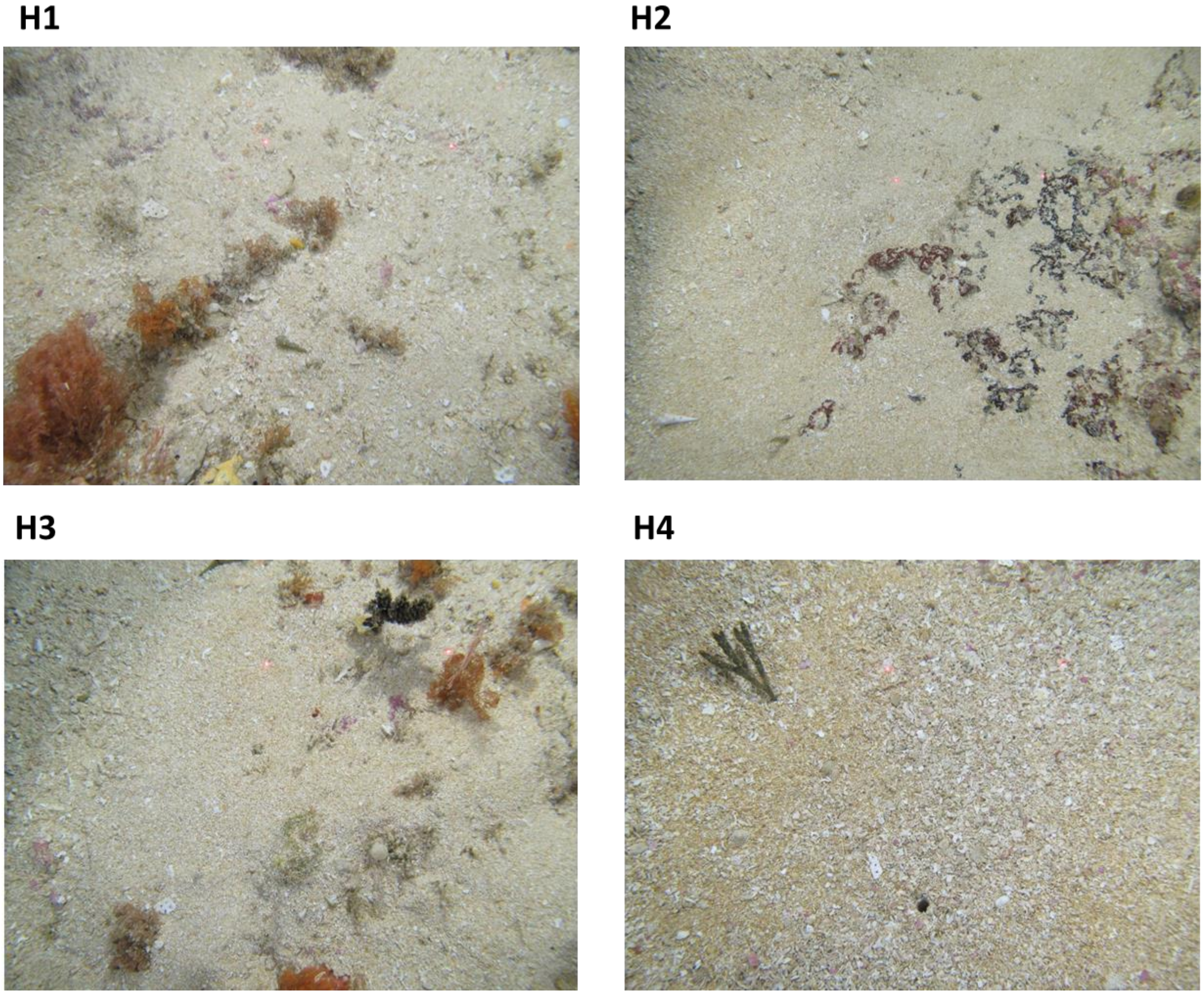


Figure 4-20: Drop Camera Images at Hercules

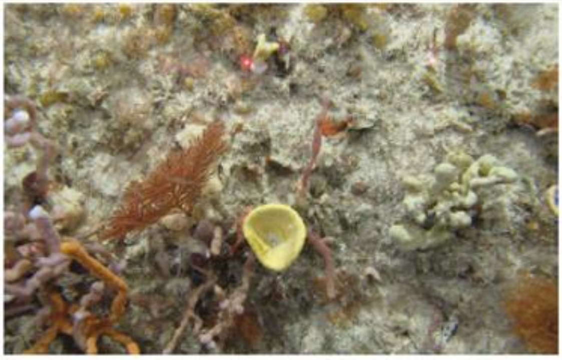
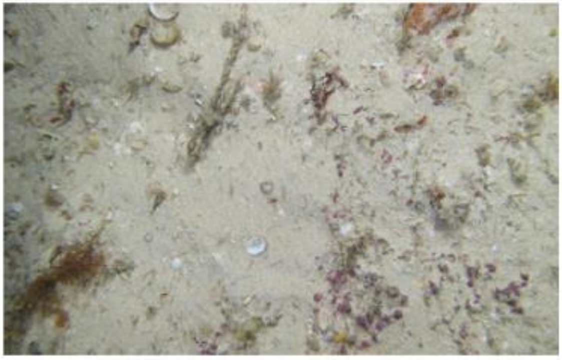
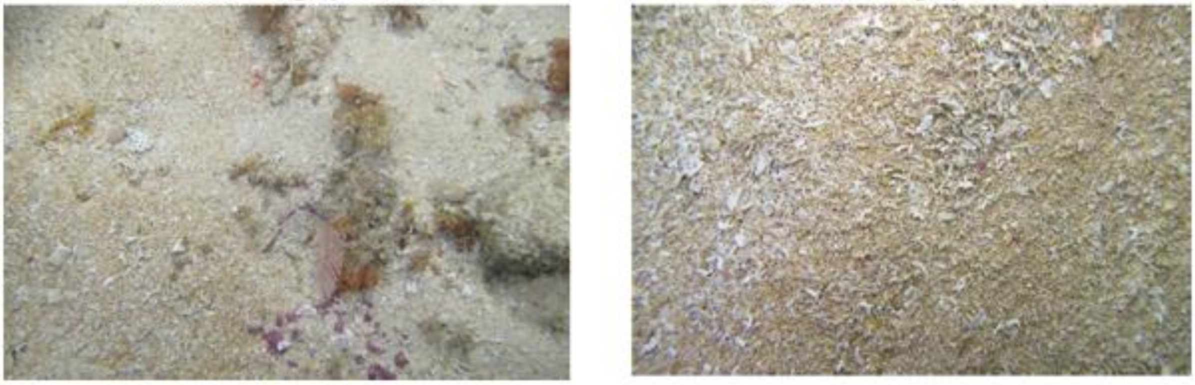
	
Hot Tap Tee X	**Hot Tap Tee X**
	
Hot Tap Tee Y	**Hot Tap Tee Y**

Figure 4-21: Drop Camera Images at Hot Tap Tee locations

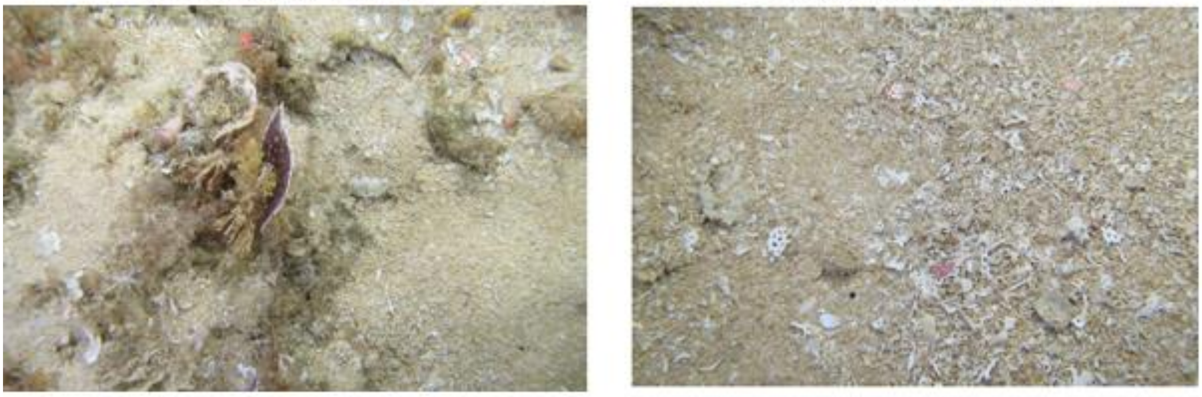
Artisan to Geographe Route

Artisan to Geographe Route



Artisan to La Bella Route

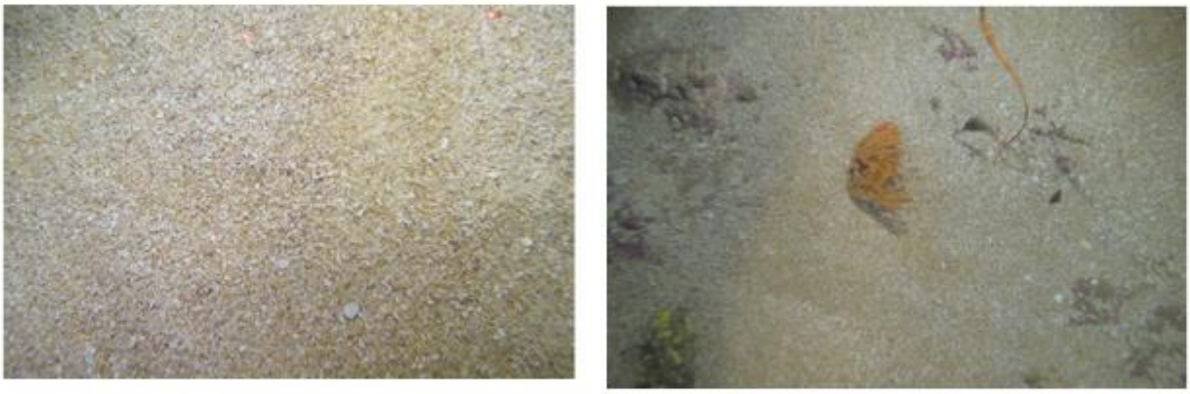
Artisan to La Bella Route



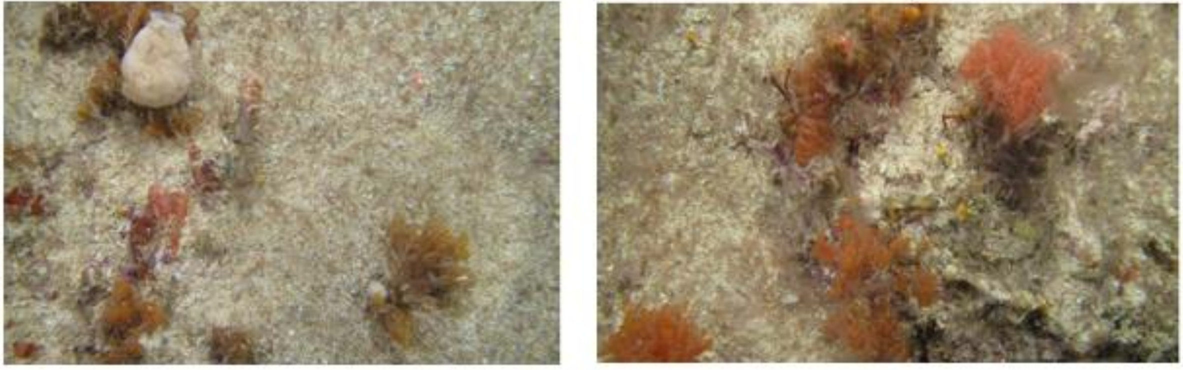
La Bella to Geographe Route

La Bella to Geographe Route

Figure 4-22: Drop Camera Images along Flowline and Umbilical Routes



Artisan to Hot Tap Tee Y Route **Artisan to Hot Tap Tee Y Route**



Artisan to Hot Tap Tee X Route **Artisan to Hot Tap Tee X Route**

Figure 4-23: Drop Camera Images along Flowline Routes

4.4.2 Seagrass

Seagrasses are marine flowering plants, with around 30 species found in Australian waters (Huisman 2000). While seagrass meadows are present throughout southern and eastern Australia, the proportion of seagrass habitat within the south-eastern sector is not high compared to the rest of Australia (in particular with parts of South Australia and Western Australia) (Kirkham 1997).

Seagrass generally grows in soft sediments within intertidal and shallow subtidal waters where there is sufficient light and are common in sheltered coastal areas such as bays, lees of islands and fringing coastal reefs (McClatchie et al. 2006, McLeay et al. 2003). Seagrass meadows are important in stabilising seabed sediments, and providing nursery grounds for fish and crustaceans, and a protective habitat for the juvenile fish and invertebrates species (Huisman 2000, Kirkham 1997).

Known seagrass meadows within the Planning Area are present along the Victorian coastline (Figure 4-24). No seagrass meadows were identified within the Project Area.

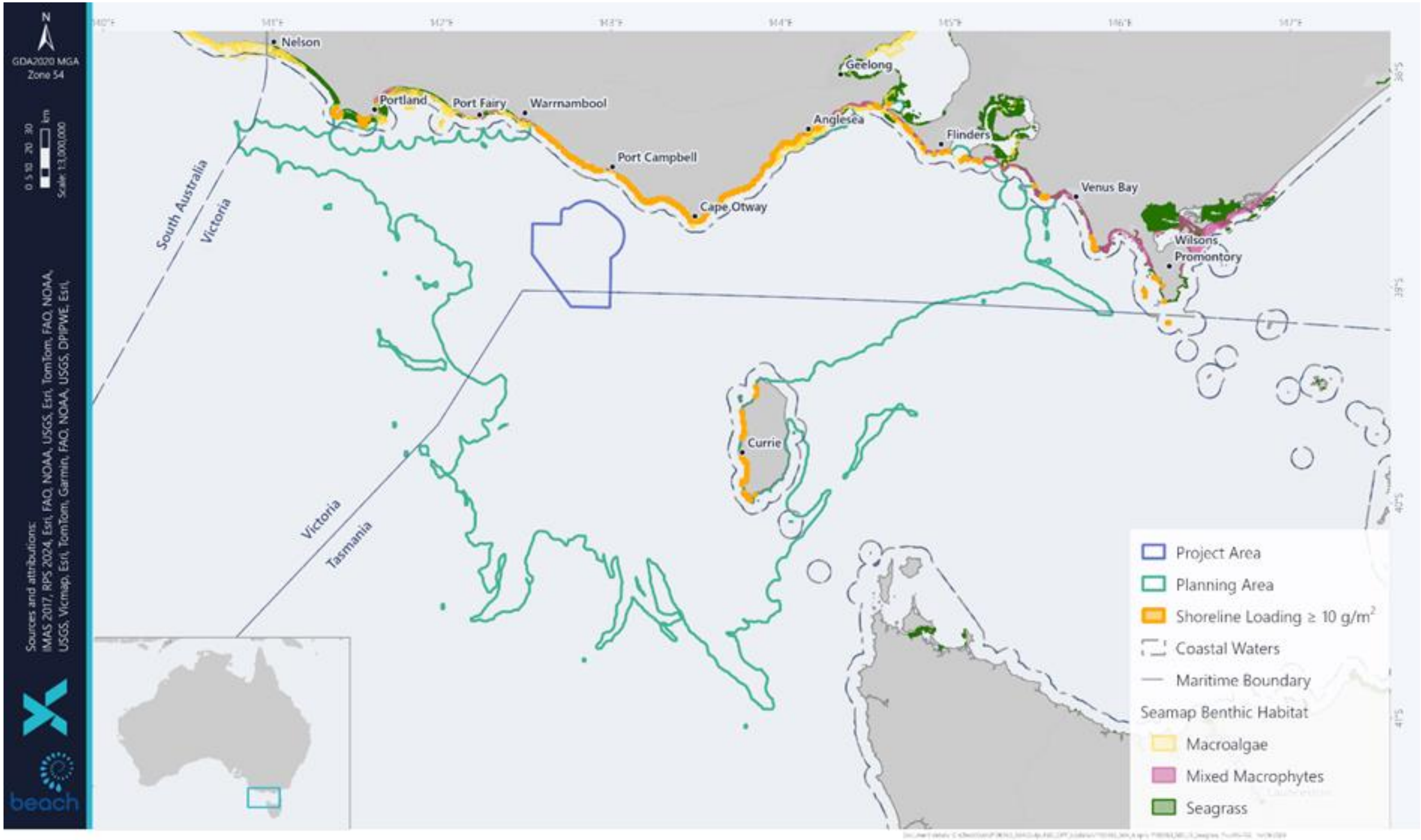


Figure 4-24: Presence of Seagrass (and mixed macrophyte) Habitat within the Planning Area

4.4.3 Algae

Benthic microalgae are present in areas where sunlight reaches the sediment surface. Benthic microalgae are important in assisting with the exchange of nutrients across the sediment-water interface; and in sediment stabilisation due to the secretion of extracellular polymetric substances (Ansell et al. 1999). Benthic microalgae can also provide a food source to grazers such as gastropods and amphipods (Ansell et al. 1999).

Macroalgae communities occur throughout the Australian coast and are generally found on intertidal and shallow subtidal rocky substrates. Macroalgal systems are an important source of food and shelter for many ocean species; including in their unattached drift or wrack forms (McClatchie et al. 2006). Macroalgae are divided into three groups: *Phaeophyceae* (Brown Algae), *Rhodophyta* (Red Algae), and *Chlorophyta* (Green Algae). Brown Algae are typically the most visually dominant and form canopy layers (McClatchie et al. 2006). The presence and growth of macroalgae are affected by the principal physical factors of temperature, nutrients, water motion, light, salinity, substratum, sedimentation, and pollution (Sanderson 1997). Macroalgae assemblages vary, but *Ecklonia radiata* and *Sargassum* sp. are typically common in deeper areas.

Within the Planning Area, macroalgae are present along the Victorian coastline (Figure 4-25). No macroalgae have been mapped within Project Area.

Kelp are a special group of large brown algae that attach themselves to solid structures to form forests. They extend their leaf-like fronds into the waters above them reaching towards the sunlight. These larger algae in turn create a habitat for smaller algae, invertebrates, and fish (VFA 2023). On Victoria's coast kelp forests grow on most rocky reefs in waters to a depth of around 30 m, although most are found in shallower waters (VFA 2023).

Bull Kelp or Southern Bull Kelp (Durvillaea potatorum) is a fast-growing brown macroalgae (seaweed) with large dark brown and leathery strap-like blades. It consists of a body, called the thallus, with a stipe connecting the blades to the holdfast (a structure adhering the Bull Kelp to the seafloor.

Offshore Victoria and Tasmania there are two main species of *Durvillaea*, these are *D. potatorum* and *D. amatheiae*. The approximate distribution of the species is shown in Figure 4-25.

Durvillaea spp. are a significant habitat. The holdfast can be inhabited by a diverse array of epifauna and infauna invertebrates. These burrow into the holdfast creating holes that can be used by a wide variety of animals. In addition, *Durvillaea* spp. grow in large groups or forests that can become important nursery areas and sanctuary areas for fish, crustaceans, and other fauna.

Thurstan et al. (2018) gathered historical data on the use of Bull Kelp by First Nations. Bull Kelp has a long history of use by First Nations people in Australia, New Zealand, and Chile. In Australia this reportedly dates back 65,000 years (Thurstan et al. 2018). First Nations people in Tasmania used dried bull kelp to transport water and food. The species name came from this use: '*potatorum*' means 'to drink' in Latin (Govt of SA 2023).

Thurstan et al. (2018) details a number of First Nations historical references for Bull Kelp including:

- Cultural activities and cultural history –mythology and sacred songs.

- Ceremonial activities –being burned or being used during smoking ceremonies.
- Medicinal use –bandages and medicinal poultice.
- Clothing – cloaks and shoes.
- Diet – raw, jelly, dried and roasted (preserving for several months).
- Fishing – ropes and fishing nets / traps, traps for short-finned eels, also used to assist during diving for crayfish.
- Shelter – waterproofing, wind proofing and carpeting.

Bulk Kelp is also collected by the seaweed industry as described in Section 4.5.14.

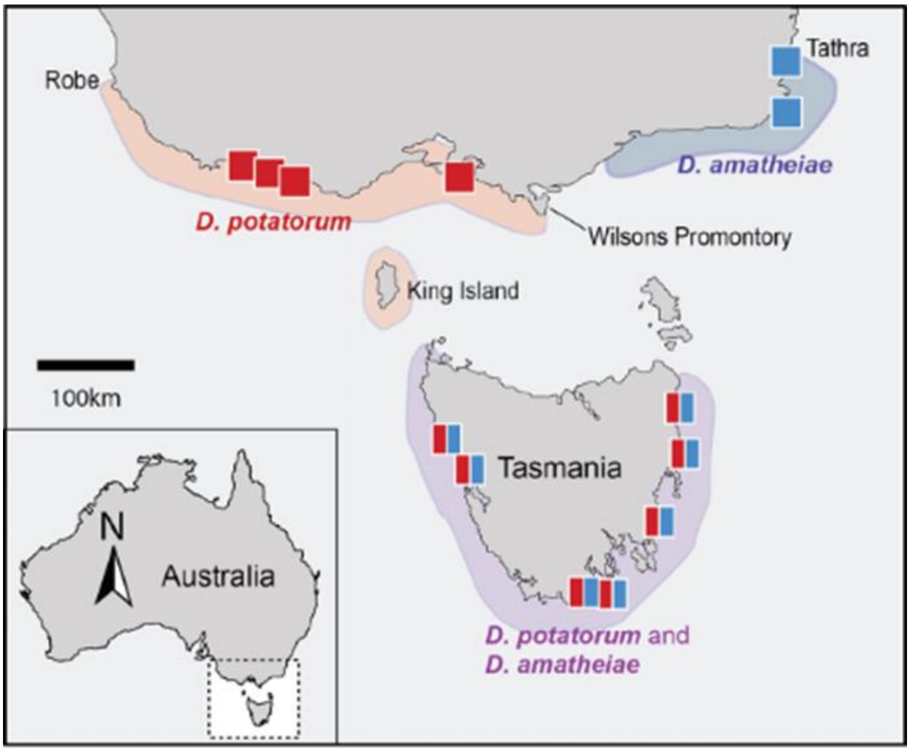


Figure 4-25: Distribution of Bull Kelp off Victoria and Tasmania (Velasquez et al. 2019)

4.4.4 Mangrove

Mangroves grow in intertidal mud and sand, with specially adapted aerial roots (pneumatophores) that provide for gas exchange during low tide (McClatchie et al. 2006). Mangrove forests are important in helping stabilise coastal sediments, providing a nursery ground for many species of fish and crustacean, and providing shelter or nesting areas for seabirds (McClatchie et al. 2006).

The mangroves in Victoria are the most southerly extent of mangroves found in the world and are located mostly along sheltered sections of the coast within inlets or bays (MESA 2015). There is only one species of mangrove found in Victoria, the white or grey mangrove (*Avicennia marina*), which is known to occur at Western Port and Corner Inlet. Small patches of mangroves have been mapped within the Planning Area at the Erskine River (Figure 4-26).

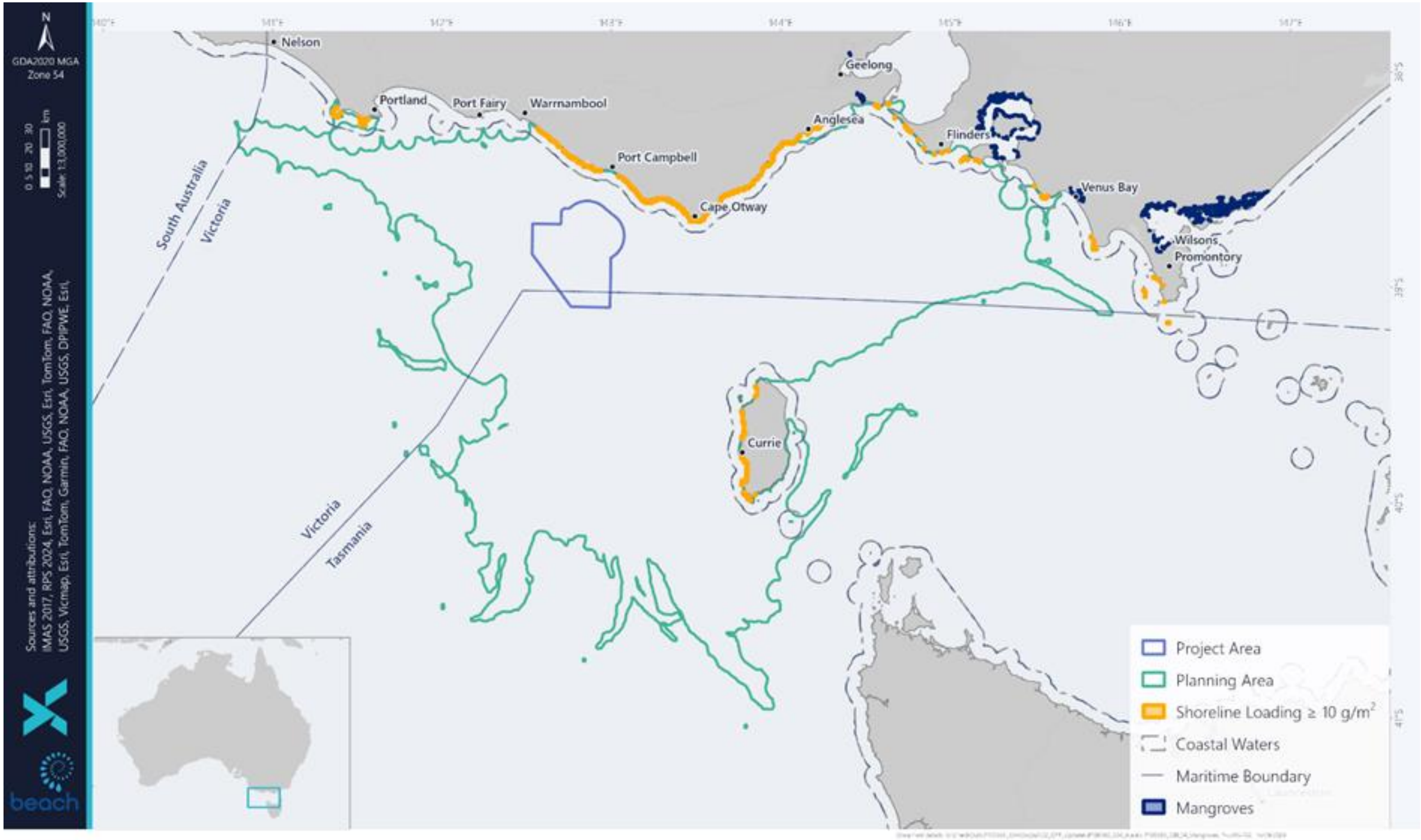


Figure 4-26: Presence of Mangrove Habitat within the Planning Area

4.4.5 Saltmarsh

Saltmarshes are terrestrial halophytic (salt-adapted) ecosystems that mostly occur in the upper-intertidal zone and are widespread along the coast. Saltmarshes are typically dominated by dense stands of halophytic plants such as herbs, grasses, and low shrubs. In contrast to mangroves, the diversity of saltmarsh plant species increases with increasing latitude. The vegetation in these environments is essential to the stability of the saltmarsh, as they trap and bind sediments. The sediments are generally sandy silts and clays and can often have high organic material content. Saltmarshes provide a habitat for a wide range of both marine and terrestrial fauna, including infauna and epifaunal invertebrates, fish, and birds.

Saltmarsh is found along many parts of the Victorian coast, although is most extensive in western Port Phillip Bay, northern Western Port, within the Corner Inlet-Nooramunga complex, and behind the sand dunes of Ninety Mile Beach in Gippsland (Boon et al. 2011). Within the Planning Area, saltmarsh habitat has been mapped along the Victorian coastline including Kennett River (Figure 4-27).

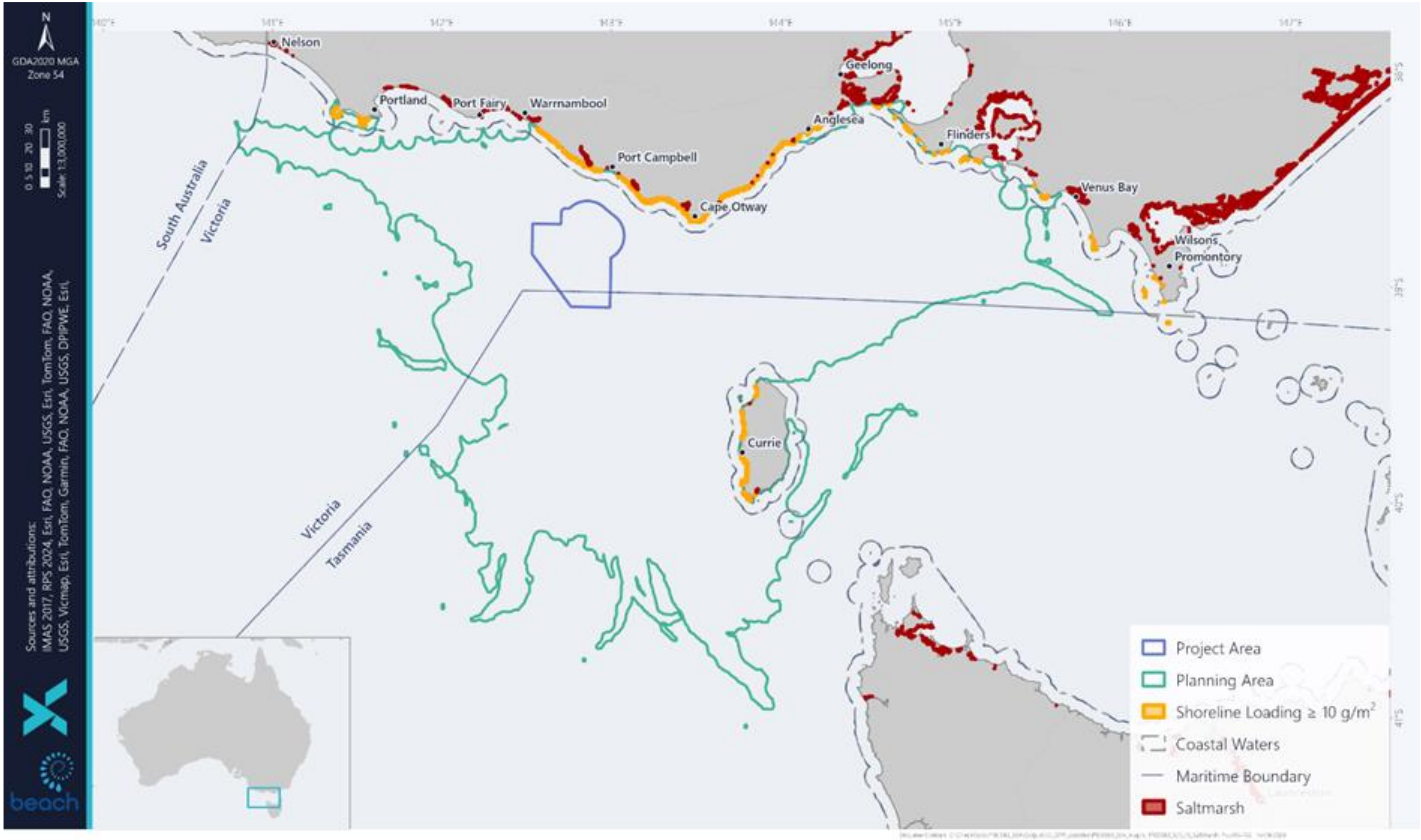


Figure 4-27: Presence of Saltmarsh Habitat within the Planning Area

4.4.6 Plankton

Plankton are small animals and plants that float or drift on the surface or within the water column. Some forms have limited swimming ability but are still dispersed mainly by water currents. Plankton are a very important part of the ecosystem for several reasons:

- Primary production of the phytoplankton is considerable.
- Much of the plankton consists of eggs and juvenile stages of organisms which are not planktonic as adults. It is thus an important contributor to the maintenance of population and diversity in other habitats.
- Plankton is an important food resource for many larger organisms, including fish.

Plankton are abundant and widely distributed in the South East Marine Region. In the Otway Basin, they have patchy distributions linked to localised and seasonal productivity that produces sporadic bursts in populations (CoA 2015). Distribution in the Project Area is expected to be highly variable both spatially and temporally and are likely to comprise characteristics of tropical, Southern Australian, central Bass Strait and Tasman Sea distributions.

Plankton are not protected under the EPBC Act.

4.4.7 Invertebrates

There is a very large number of marine invertebrates in deep waters around Australia. Knowledge of the species in different habitats is extremely patchy; the number of deep-water benthic fauna is large but almost unknown. Throughout the region, a variety of seabed habitats support a range of animal communities such as sparse sponges to extensive ‘thickets” of lace corals and sponges, polychaete worms and filter feeders (DNP 2013).

Characteristics of large species of crustacea, such as lobster, prawn and crab, which are significant commercial species in southern Australia, are well known. Mollusc species, such as oysters, scallops and abalone are also commercially fished, and their biology and abundance are well known. Major fisheries for the blacklip and to a lesser extent, greenlip abalone and scallops have been founded. The cooler waters of southern Australia also support the Maori Octopus commercial fishery, which is one of the largest octopuses in Australia (with arm spans longer than 3 m and weighing more than 10 kg). Other molluscs are abundant in southern Australia and Tasmania such as the sea-slug with more than 500 species. Volutes and cowries represent a relic fauna in southern Australia, with several species being very rare and can be highly sought after by collectors.

Echinoderms, such as sea stars, sea urchins and sea cucumbers are also an important fauna species of the southern Australian and Tasmanian waters, with several species at risk of extinction (DPIPWE 2016).

Studies by the Museum of Victoria found that invertebrate diversity was high in southern Australian waters although the distribution of species was patchy, with little evidence of any distinct biogeographic regions (Wilson and Poore 1987). Results of sampling in shallower inshore sediments reported high diversity and patchy distribution (Parry et al. 1990). In these areas, crustaceans, polychaetes, and molluscs were dominant.

4.4.7.1 Commercially Important Invertebrate Species

1. Abalone

Blacklip abalone (*Haliotis rubra rubra*) and greenlip abalone (*Haliotis laevigata*) are commercially important reef-dwelling species widely distributed across tropical and temperate coastal areas. Abalone are single shelled with a fleshy body and muscular foot which they use to attach to hard substrate, typically in water depths of 5-10 m however they can be found in depths up to 40 m (DPI 2024). A distinguishing feature of this genus is their rows of small holes or ‘pores’ along the edge of their shells where the organism will expel water that has passed through its gills (DPIRD 2016). Females produce and release millions of eggs each year into the water column, where they are fertilised by sperm released by males. Fertilised eggs hatch into larvae and after about a week the larvae develop into small juveniles which settle onto rocks (DPIRD 2016). After settlement, juvenile abalone hide under rocks during the day only emerging in the night to feed. Once abalone reach sexual maturity (approximately 5-8 years old) most animals no longer engage in this behaviour and become sedentary, rarely moving more than a few hundred metres from their natal site (DNRET 2022a). Evidence confirms that the greenlip abalone comprises numerous independent biological stocks at a spatially broad scale, even larger than the biological stock structure of the blacklip abalone (Mayfield et al. 2021).

Stock status records show the blacklip abalone to be sustainable in 2 of 3 South Australian stocks and in 3 of 4 Tasmanian stocks. Of the remaining 5 stocks, 4 are determined to be depleted (SA, TAS, VIC) and the last is undefined (NSW). Stock status records show the greenlip abalone to be depleted in 3 stocks (SA, TAS) and undefined in 3 stocks (VIC, SA). Figure 4-28 and Figure 4-29 show the distribution of reported commercial catch of both species in south-eastern Australia (Mundy et al. 2021; Mayfield et al. 2021) which indicates that they are likely to be present in the Planning Area. Although neither abalone species have EPBC status or an associated recovery or management plans, there are a range of anthropogenic threats that have the potential to affect them including:

- Commercial and recreational fishing, and
- Climate change (i.e. ocean acidification).

During consultation it was identified that Victorian stocks are at risk of a herpes-like virus that is believed to reappear when abalone are under stress.

Figure 4-28: Distribution of Reported Commercial Catch of Blacklip Abalone (Mundy et al. 2021)

Figure 4-29: Distribution of Reported Commercial Catch of Greenlip Abalone (Mayfield et al. 2021)

2. Commercial Scallop

Commercial scallops (*Pecten fumatus*) are a commercially important species that can be distinguished from other scallops by their equal-sized circular shaped shells. This species is distributed throughout southern Australia, from mid NSW to mid-WA including Tasmania in depths between 1-120 m. Scallops are typically sedentary benthic organisms that aggregate into beds and can be found buried in soft sediment (mud and sand). Spawning is known to only occur after a two-year development period and is thought to be triggered by an increase in temperature. Commercial scallops can release up to one million eggs into the water column during spawning.

There are four commercial scallop stocks in Australia: Bass Strait Central Zone Scallop Fishery, Port Phillip Bay Dive Scallop Fishery, Tasmanian Scallop Fishery and Victoria's Ocean Scallop Fishery. Stock status records show the species to be sustainable through the Commonwealth and Port Phillip Bay jurisdictions, while stocks are considered depleted in the Tasmanian and Victorian Fisheries jurisdictions (Semmens and Woodhams 2021). However, since being closed in 2015 due to low stock the Tasmanian Scallop Fishery was approved to reopen in September of 2021 and has continued on with the 2022 season. Figure 4-30 shows the distribution of reported commercial catch of commercial scallop in south-eastern Australia (Semmens and Woodhams 2021) which indicates it is likely to be present in the Planning Area. Although, the commercial scallop does not have EPBC status or an associated recovery or management plan, there are a range of anthropogenic threats that have the potential to affect commercial scallops including:

- Commercial and recreational fishing, and
- Climate change (i.e. ocean acidification).

Figure 4-30: Distribution of Reported Commercial Catch of Commercial Scallops (Semmens and Woodhams 2021)

3. Giant Crab

The giant crab (*Pseudocarcinus gigas*) is a commercially important species in the region that is endemic to the waters of southern Australia (DoE 2014b) (Figure 4-31). This species resides on muddy or rocky bottoms in waters of the Southern Ocean at depths from 18 to 600 m depth (Gardner and Welsford 2003, Poore 2004, Heeren and Mitchell 1997). Most commonly this species is found in the shelf break habitat associated with bryozoan substrates between 140 m and 270 m (Poor 2004, Leon et al. 2017). The habitat of early juveniles has yet to be established, however there is some evidence that smaller individuals occur in deeper water (Williams et al 2009; Leon unpublished data). Additionally, bryozoan communities are rich in prey items suitable for juvenile crabs, suggesting that this particular habitat is likely to be important for the settlement and growth of giant crab (Levings 2001). Williams et al. (2009) notes that giant crabs observed during surveys along the continental slope were using ledges and sponges for shelter. Given its habitat preferences and mapped fishing activity (edge of the continental slope), giant crabs are known to be present in the shelf slope of the Planning Area and may be present in the Project Area.

Giant carb feeds on carrion and slow-moving benthic species including gastropods, crustaceans and starfish. They breed in June and July, and the females carry up to two million eggs for approximately four months. As hatching approaches (October to November), females are thought to migrate to the shelf-break (Currie and Ward 2009). Upon hatching, the larval duration is around 50 days with larvae release occurring at the edge of the continental shelf (FRDC 2017). There is a strong capacity for larval dispersal over large spatial scales prior to settlement (PIRSA 2002). Recruitment is not distributed evenly, with some areas having higher juvenile abundance than others, which is not a function of habitat but larval drift and ocean current movements (FRDC 2018a). Oceanographic modelling has demonstrated the species is of a single biological stock with larval dispersal occurring along the edge of the continental shelf and drifting with plankton for a 50-day period.

Female moulting peaks strongly in winter (June and July). Males moult in summer (November and December). Intermoult period estimates varied from 3 to 4 years for juvenile males and females, with rapid lengthening in time between moulting events to approximately 7 years for females and 4.5 years for males. Gardner (1998) reports that females appear to mate while soft-shelled with stored sperm remaining viable for at least 4 years; broods are produced annually although females occasionally skip a reproductive season, which may be associated with moulting, and several broods may be produced between moults although fecundity declines with successive broods.

The species key biological features (e.g., long-lived, slow growing) have the potential to leave the population vulnerable to decline (FRDC 2018a). While there is little scientific data on the population, stock status records show the species to be sustainable throughout WA, SA and Victoria but depleted in Tasmania (Hartmann et al. 2021). The giant crab does not have EPBC status or an associated recovery or management plan. There are a range of anthropogenic threats that affect giant crabs including:

- Commercial and recreational fishing, and
- Ecosystem effects as a result of habitat modification and climate change.

Figure 4-31: Distribution of Reported Commercial Catch of Giant Crab (Hartmann et al. 2021)

4. Octopus

The pale octopus (*Octopus pallidus*) is a commercially important species found across the Great Australian Bight around Tasmania and towards southern NSW. They can be found inhabiting sand and mud substrates, often in association with sponge gardens or beds of large solitary sea squirts in depths up to 600 m (Atlas of Australia 2022a). This species hides during the day and feeds at night primarily on bivalves, which are pulled apart or drilled. The pale octopus lays large eggs that are attached to hard substrates and foraging begins immediately after hatching. Evidence suggests that there are a number of subpopulations within the Bass Strait due to limited species dispersal and isolation due to distance (Krueck et al. 2021).

Stock status records show the species to be depleting in the Tasmanian jurisdiction, undefined in the Victorian jurisdiction and negligible in both SA and NSW due to historically low catch rates. Figure 4-32 shows the distribution of reported commercial catch of pale octopus in south-eastern Australia (Krueck et al. 2021) which indicates it is likely that they will be present within the Project and Planning Areas. Although, the pale octopus does not have EPBC status or an associated recovery or management plan, there are a range of anthropogenic threats that have the potential to affect them. Key threats identified include:

- Commercial and recreational fishing, and
- Climate change.

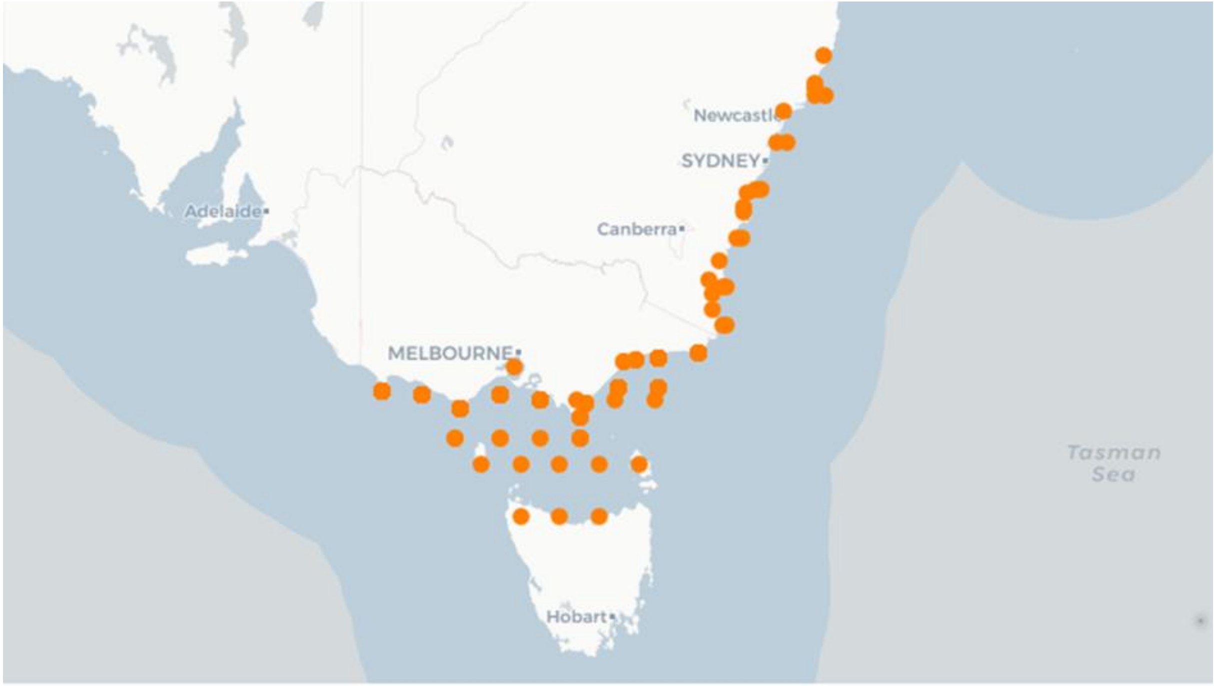


Figure 4-32: Distribution of Reported Commercial Catch of Pale Octopus (Krueck et al. 2021)

5. Pipi

Pipi (*Donax deltoides*) are a commercially important species found on sandy beaches between southern QLD and the Murray River in SA and have been a culturally important species to First Nations people for thousands of years. Life expectancy for this species is between 4-5 years and like most bivalves this species filter feeds by extracting microscopic matter from the water column (Ferguson and Johnson 2021). Typically, pipi reach sexual maturity towards the end of their first year and are then able to spawn year-round. East Australian and South Australian currents act as key drivers of gene flow on the east and south coasts of Australia which has resulted in high genetic variation between populations on either side of Bass Strait (Ferguson and Johnson 2021).

Stock status records show the species to be sustainable through the NSW and SA jurisdiction while the Victorian jurisdiction is undefined. Figure 4-33 shows the distribution of reported commercial catch of pipi in south-eastern Australia (Ferguson and Johnson 2021) which indicates it is likely that they will be present in the Planning Area. Although, pipi does not have EPBC status or an associated recovery or management plan, there are a range of anthropogenic threats that have the potential to affect them. Key threats identified include:

- Commercial and recreational fishing, and
- Climate change.

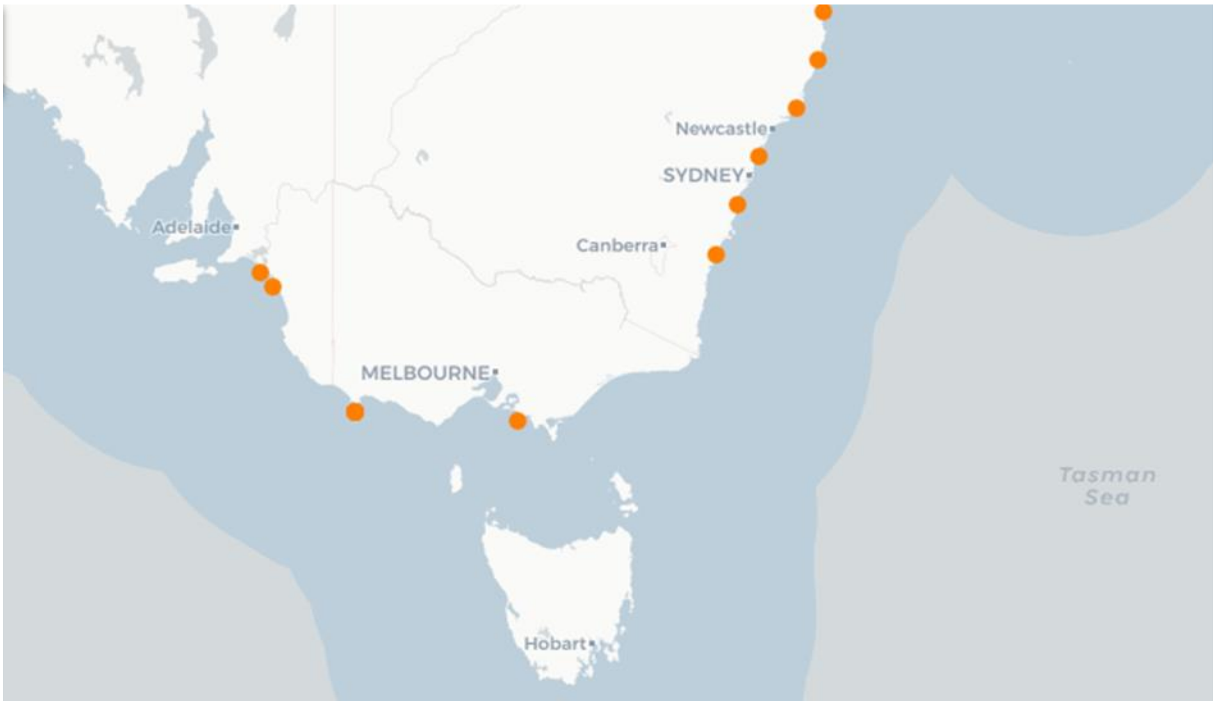


Figure 4-33: Distribution of Reported Commercial Catch of Pipi (Ferguson and Johnson 2011)

6. Southern Rock Lobster

The southern rock lobster (SRL) (*Jasus edwardsii*) is a commercially important species that is found on coastal reefs from the south-west coast of WA to the south coast of NSW, including Tasmania and the New Zealand coastline (Figure 4-34). SRL are found in depths up to 150 m (DPI 2009). In Victoria, the abundance of SRL decreases from west to east reflecting a decreasing area of suitable rocky reef habitat (DPI 2009).

Most adult SRL remain within the same region (moving less than 1 km), though some tagged SRL have moved more than 80 km between inshore and offshore reefs (SRL 2021). More broadly in the region, SRL habitat occurs as patchy, discontinuous low-profile reef running parallel to the coast. Bathymetry mapping, including recent shelf mapping of the Zeehan Multiple Use Zone funded by Parks Australia found the existence of multiple marine canyons in the area as well as areas of deep reef extending across the shelf from the shelf-break. The outer shelf region is limestone reef pavement that becomes significantly more fractured with notable long step-features which were rarely undercut limiting habitat available for crevice-dwelling species such as the SRL (Barrett et al. 2023). Preliminary research in the area has found that while multibeam sonar mapping has identified areas of suitable reef, 300 camera drops identified no lobsters which is likely due to the absence of suitable crevice-like habitat (Barrett et al. 2023). Therefore, the Zeehan Multiple Use Zone is likely low-quality habitat (Barrett et al. 2023) for the SRL at ecologically or commercially important levels. In any case, it is assumed that where rocky reef is located within the Planning Area, SRL are likely to be present.

Adult SRL are carnivorous and feed mostly at night on a variety of bottom dwelling invertebrates such as molluscs, crustaceans and echinoderms. The main predators of SRL are octopus, sharks and reef fish such as wrasse and ling (SRL 2021).

The life cycle of the SRL is complex. After mating between April and July (SRL 2021), fertilised eggs (up to 1,000,000 per female) are carried under the tail of the female for approximately 4-6 months before being released, typically between September and November. Larval release occurs across the southern continental shelf, which is a high-current area, facilitating dispersal. Oceanographic modelling has also indicated that SRL dispersal occurs over large spatial scales, indicating that there is a single biological stock (Bruce et al. 2007). Genetic analyses also indicate that it is a single stock (Ovenden et al. 1992). This suggests that SRL in the Otway Bioregion is present as a connected stock with recruitment into the permit area from upstream subpopulations.

Once released, SRL larvae, or phyllosoma, undergo 11 developmental stages over a period of 12 and 24 months (Hartmann et al. 2013; SRL 2021) while being carried by ocean currents up to 200 km offshore far beyond the continental shelf. At the end of this developmental phase, phyllosoma larvae moult and metamorphose into a puerulus larvae (a transparent miniature version of the adult), still living in the water column but not feeding (SRL 2021). Successful metamorphosis from the final-stage phyllosoma to puerulus stage occurs far offshore sometimes even beyond the continental shelf (SRL 2021). The puerulus swim inshore at night to settle onto reef habitat in depths from 50 m to the intertidal zone (Booth et al. 1991) where they moult into pigmented juvenile lobsters (SRL 2021). Bruce et al. 2007 reported data for state-maintained puerulus collector sites, which indicates that most puerulus settlement in NW Tasmania occurs June through August, tapering off in September.

SRL grow by moulting or shedding their exoskeleton. Juvenile lobsters moult approximately 5 times per year, declining to once a year for mature adults. Research on temporal moulting patterns in adult SRL in Tasmanian waters including King Island (Gardner and Mills 2013), which tracked over 4,000 tagged individuals, found females mainly moult between February and May while males moult mainly in August and September with the greater majority moulting in August. The Tasmanian Seafood Industry Council (TSIC) advised that moulting for adult males occurs in September and October. Males grow faster and larger than females, reaching 160 mm in carapace length after ten years. Females generally reach 120 mm in the same period. Growth rates also vary spatially, with growth faster in the east than in the west (DPI 2009). It can take between 3 and 10 years for SRL to reach commercial fishing size (SRL 2021).

Although rock lobsters have no formal protection under Australian law, Hayes et al. (2021) identified SRL as a key natural value for the South-East marine park network. The key natural values were identified by subject matter experts using a set of criteria developed from the criteria used to identify equivalent or similar concepts in other national and international contexts. Each key natural value is allocated to an ecosystem within the common language and thereby mapped.

The SRL does not have an EPBC status or associated recovery or management plan. While there is little scientific data on the population, stock status records indicate that the southern Australian stock is sustainable (Linnane et al. 2021). However, the stock status is only marginally above the limit reference point for egg production. The populations of SRL in the north-west of Tasmania are characterised by larger individuals and faster growth than much of the rest of the state. The Tasmanian stock assessment area that incorporates King Island and part of the AMP has the second lowest biomass in Tasmania, as well as the lowest egg production in the state (Hartmann 2022).

Surveys of commercial fishers operating in and around the ZMP, as well as analysing commercial rock lobster catch data in the region, identified that most of the fishing reported occurred in waters closer to King Island than the marine park offshore (UTAS 2023). Surveys also identified that the aggregate catches recorded in fishery reporting blocks overlapping the ZMP were low relative to other areas, implying an overall low population density within the park. A review of catch data showed that catch in tonnes appears to have remained steady since 2008 for both the Tasmanian and Victorian fishing blocks.

Pressures on SRL populations include fishing, climate change, with respect to declining individual performance with warming, potential future competition with conspecific lobsters, and future interactions with the range-extending destructive sea urchin (UTAS 2023).

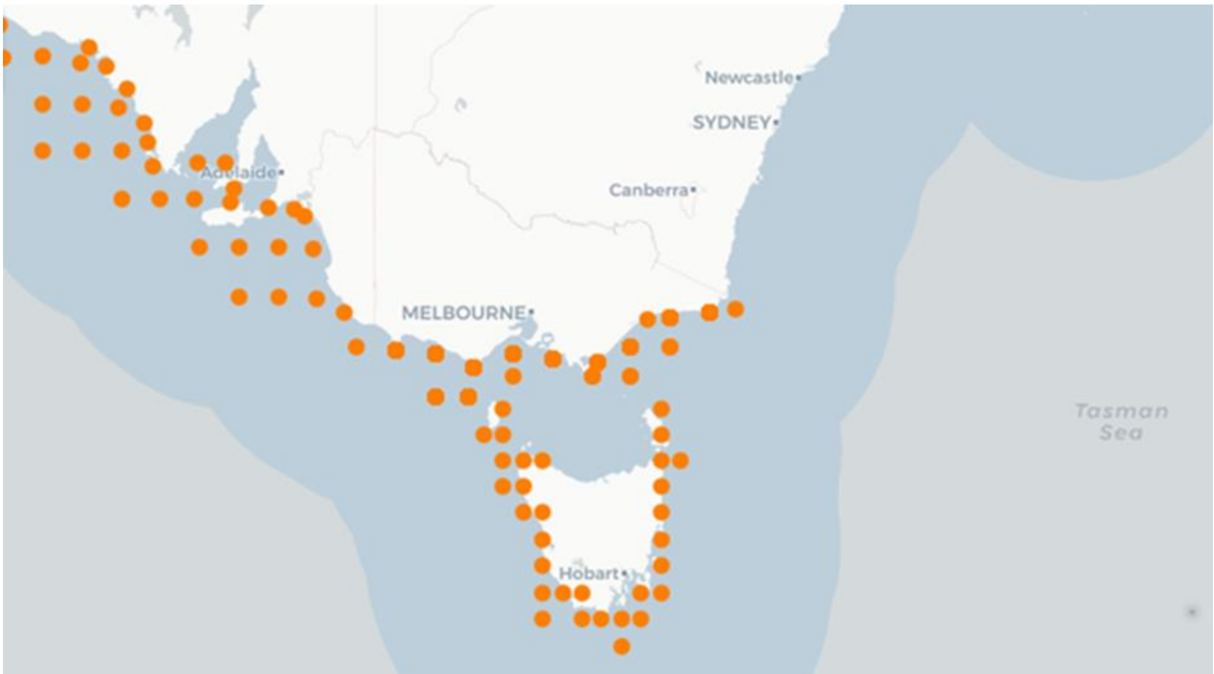


Figure 4-34: Distribution of Reported Commercial Catch of Southern Rock Lobster (Linnane et al. 2021)

7. Squid

Gould's squid (*Nototodarus gouldi*) are a commercially important species typically found at depths from 50 – 200 m off the subtropical and temperate coasts of Australia (Atlas of Living Australia 2022b). Gould's squid feed on crustaceans, fish and cephalopods at night and in turn are prey for birds, large fish, sharks and marine mammals (O'Sullivan and Cullen 1983). Gould's squid are short lived (less than one year), spawn multiple times during their life cycle, and display highly variable growth rates, size and age at maturity (Jackson and McGrath-Steer 2003).

Noriega et al (2021) highlights characteristics of the Gould's squid's lifecycle which lend itself to rapid increases in biomass during favourable environmental conditions, making it less susceptible to becoming overfished than longer-lived species. The species is commercially harvested and the population size in Bass Strait varies from year to year. This is primarily due to its short life cycle, the 'boom and bust' nature of its population dynamics and life history characteristics. Figure 4-35shows the distribution of reported commercial catch of Gould's squid in south-eastern Australia (Noriega et al. 2021) which indicates it is likely that Gould's squid will be present in the Planning Area.

There is no formal stock assessment available for the population, however stock status records show the species in south-eastern Australia to be of a sustainable level (Noriega et al. 2021). However, there are a range of anthropogenic threats that affect the population including:

- Commercial and recreational fishing, and

- Ecosystem effects as a result of habitat modification and climate change.

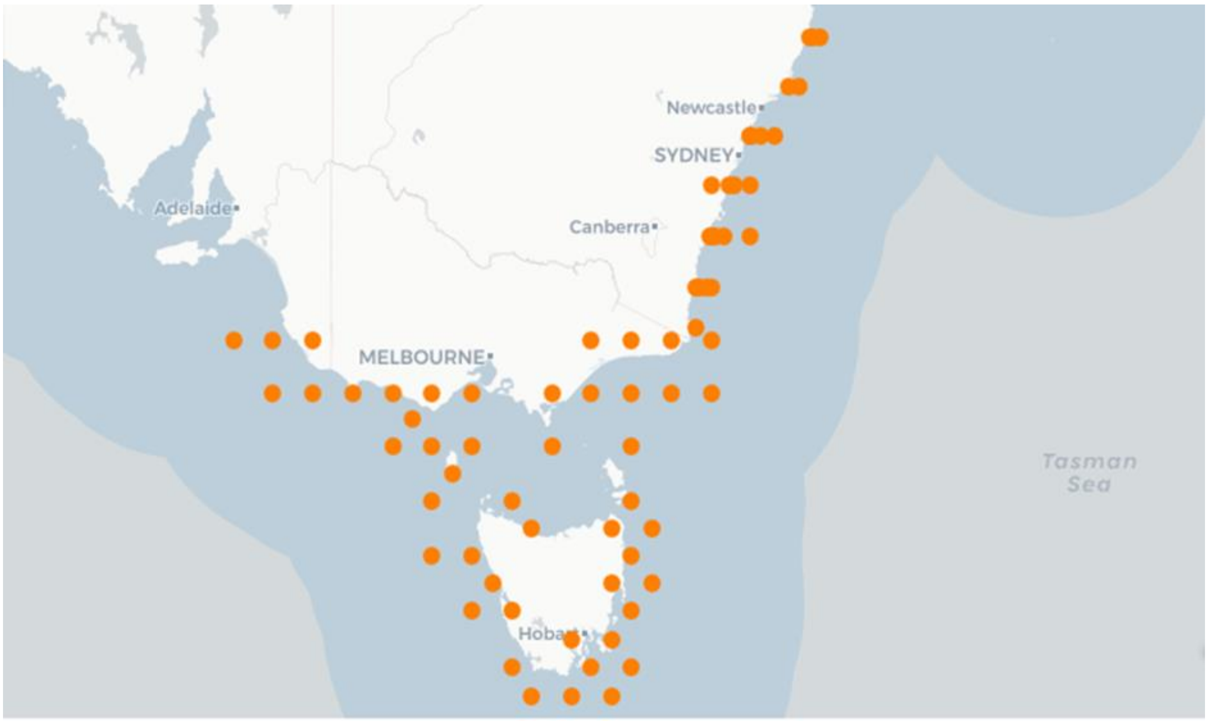


Figure 4-35: Distribution of Reported Commercial Catch of Gould's Squid (Noriega et al. 2021)

4.4.8 Threatened Ecological Communities

Threatened Ecological Communities (TECs) provide wildlife corridors or refugia for many plant and animal species, and listing a TEC provides a form of landscape or systems-level conservation (including threatened species).

No TECs were identified within the Project Area. TECs identified in the PMST Report (Appendix B) as occurring in the Planning Area are presented in Figure 4-36 and Table 4-18. TECs identified in the PMST Report due to the size of the grids used in the PMST but not actually intersecting the Planning Area are listed in the Table with 'X'. TECs which intersect a Planning Area and have a coastal component which may be exposed to hydrocarbons from a spill event are discussed in the subsections below.

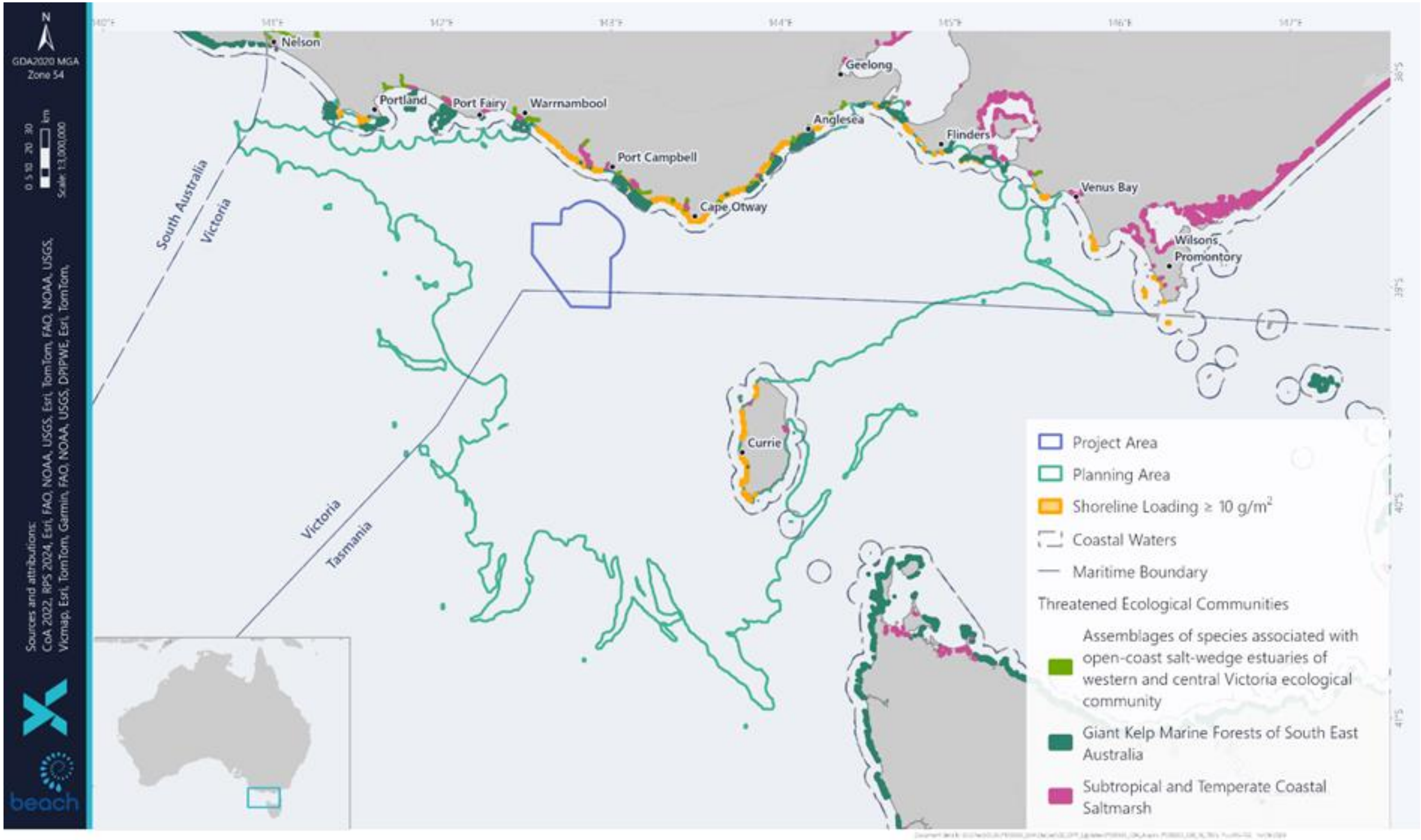


Figure 4-36: Threatened Ecological Communities within the Planning Area

Table 4-18: Threatened Ecological Communities within the Planning Area

Threatened Ecological Community	Threatened Category	Coastal Component	Project Area	Planning Area
Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	Endangered	✓	-	✓
Giant Kelp Marine Forests of South East Australia	Endangered	✓	-	✓
Grassy Eucalypt Woodland of the Victorian Volcanic Plain	Critically Endangered	-	-	X
Karst springs and associated alkaline fens of the Naracoorte Coastal Plain Bioregion	Endangered	-	-	X
King Island Scrub Complex	Endangered	-	-	X
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	-	-	X
Natural Temperate Grassland of the Victorian Volcanic Plain	Critically Endangered	-	-	X
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	Critically Endangered	-	-	X
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	✓	-	✓
Tasmanian Forests and Woodlands dominated by black gum or Brookers gum (*Eucalyptus ovata / E. brookeriana*)	Critically Endangered	-	-	X
Tasmanian white gum (*Eucalyptus viminalis*) wet forest	Critically Endangered	-	-	X
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	-	-	X

4.4.8.1 Assemblages of Species associated with Open-coast Salt-wedge Estuaries of Western and Central Victoria Ecological Community

This TEC is the assemblage of native plants, animals and micro-organisms associated with the dynamic salt-wedge estuary systems that occur within the temperate climate, microtidal regime (<2 m), high wave energy coastline of western and central Victoria. The TEC currently encompasses 25 estuaries in the region defined by the border between South Australia and Victoria and the most southerly point of Wilsons Promontory (TSSC 2018).

Salt-wedge estuaries are usually highly stratified, with saline bottom waters forming a 'salt-wedge' below the inflowing freshwater layer of riverine waters. The dynamic nature of salt-wedge estuaries has important implications for their inherent physical and chemical parameters, and ultimately for their biological structure and ecological functioning. Some assemblages of biota are dependent on the dynamics of these salt-wedge estuaries for their existence, refuge, increased productivity, and reproductive success. The TEC is characterised by a core component of obligate estuarine taxa, with associated components of coastal, estuarine, brackish, and freshwater taxa that may reside in the estuary for periods of time and/or utilise the estuary for specific purposes such as reproduction, feeding, refuge, migration (TSSC 2018).

4.4.8.2 Giant Kelp Marine Forests of South East Australia

Giant kelp (*Macrocystis pyrifera*) is a large brown algae that grows on rocky reefs in cold temperate waters off south east Australia. The kelp grows up from the sea floor 8 m below the sea surface and deeper, vertically toward the water surface. It is the foundation species of this TEC in shallow coastal marine ecological communities. The kelp species itself is not protected, rather, it is communities of closed or semi-closed Giant Kelp canopy at or below the sea surface that are protected (DSEWPaC 2012b).

Giant Kelp is the largest and fastest growing marine plant. Their presence on a rocky reef adds vertical structure to the marine environment that creates significant habitat for marine fauna, increasing local marine biodiversity. Species known to shelter within the kelp forests include weedy sea dragons (*Phyllopteryx taeniolatus*), six-spined leather jacket (*Mesuchenia freycineti*), brittle stars (ophiuroids), sea urchins, sponges, blacklip abalone (*Tosia* spp.) and southern rock lobsters (*Jasus edwardsii*). The large biomass and productivity of the Giant Kelp plants also provides a range of ecosystem services to the coastal environment.

Giant Kelp requires clear, shallow water no deeper than approximately 35 m deep (Edyvane 2003; Shepherd and Edgar 2012; cited in TSSC 2012). They are photo-autotrophic organisms that depend on photosynthetic capacity to supply the necessary organic materials and energy for growth. O'Hara (in Andrew 1999) reported that Giant Kelp communities in Tasmanian coastal waters occur at depths of 5-25 m.

Figure 4-36 shows that the largest extent of Giant Kelp marine forests are along the SA coastline with patches around the Victorian coastline.

James et al (2013) undertook extensive surveys of macroalgal communities along the Otway Shelf from Warrnambool to Portland in south-west Victoria. Sites were adjacent to shore or on offshore rocky reefs covering a depth range of 0 to 36 meters water depth. These surveys did not locate Giant Kelp at any site but identified that other brown algae species (*Durvillaea, Ecklonia, Phyllospora, Cystophora*, and *Sargassum*) are prolific to around 20 m water depth. Brown algae tend to be replaced by red algae in deeper waters.

Surveys of the Arches Marine Sanctuary (Edmunds et al. 2010) and Twelve Apostles Marine National Park (Holmes et al. 2007 cited in Barton et al. 2012) have not located Giant Kelp. The species has been recorded in Discovery Bay National Park forming part of a mixed brown algae community (Ball and Blake 2007) (not part of the TEC), on basalt rocky reefs. An assemblage dominated by the species has been recorded from Merri Marine Sanctuary occupying a very small area (0.2ha) of rocky reef (Barton et al. 2012).

4.4.8.3 Subtropical and Temperate Coastal Saltmarsh

This TEC occurs in a relatively narrow strip along the Australian coast, within the boundary along 23°37′ latitude along the east coast and south from Shark Bay on the west coast (DSEWPaC 2013b). The TEC is found in coastal areas which have an intermittent or regular tidal influence. Figure 4-36 shows that from Corner Inlet to Marlo there is a substantial amount of subtropical and temperate coastal saltmarsh along the Victorian coastline.

The TEC community consists mainly of salt-tolerant vegetation including grasses, herbs, sedges, rushes, and shrubs. Succulent herbs, shrubs and grasses generally dominate, and vegetation is generally less than 0.5 m in height (Adam 1990). In Australia, the vascular saltmarsh flora may include many species, but is dominated by relatively few families, with a high level of endism at the species level.

The TEC is inhabited by a wide range of infaunal and epifaunal invertebrates and low and high tide visitors such as fish, birds, and prawns (Adam 1990). It is often important nursery habitat for fish and prawn species. Insects are also abundance and an important food source for other fauna. The dominant marine residents are benthic invertebrates, including molluscs and crabs (Ross et al. 2009).

The TEC provides extensive ecosystem services such as the filtering of surface water, coastal productivity and the provision of food and nutrients for a wide range of adjacent marine and estuarine communities and stabilising the coastline and providing a buffer from waves and storms. Most importantly, saltmarshes are one of the most efficient ecosystems globally in sequestering carbon, due to the biogeochemical conditions in the tidal wetlands being conducive to long-term carbon retention. A concern with the loss of saltmarsh habitat is that it could release the huge pool of stored carbon to the atmosphere.

4.4.9 Threatened and Migratory Species

PMST Reports (Appendix A, Appendix B) were generated for the Project Area and Planning Area, and were used in combination with reputable peer-reviewed literature to identify the listed Threatened and Migratory species that may be present.

4.4.9.1 Marine Fauna of Conservation Significance

Under Part 13 of the EPBC Act, species can be listed as one, or a combination, of the following protection designations:

- Threatened (further divided into categories; extinct, extinct in the wild, critically endangered, endangered, vulnerable, conservation-dependent)
- Migratory
- Whale or other cetaceans
- Marine

Details of listed fauna and their likely presence in the Project or Planning Areas are provided in the following sections.

For the purpose of the OPP, species listed as threatened or migratory under the EPBC Act and are known or likely to occur in the Project or Planning Areas and/or have an intercepting BIA with the Project or Planning Areas are discussed in more detail. Known and likely occurrence was determined from the PMST report and reputable peer-reviewed literature or through designation of important habitat (e.g. BIA).

4.4.9.2 Biologically Important Areas and Habitat Critical to the Survival of the Species

DCCEEW (2023b) detail that biologically important areas (BIAs) are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration. Their designation is based on expert scientific knowledge about species' distribution, abundance, and behaviour. The presence of the observed behaviour is assumed to indicate that the habitat required for the behaviour is also present.

CoA (2013) details that habitat critical to the survival of a species or ecological community' refers to areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal.
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- to maintain genetic diversity and long-term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

BIAs and habitat critical to the survival of a species within the Project Area and Planning Area are detailed in Table 4-19 with further details in the relevant species sections. Seasonality of important behaviours within BIAs is summarised in Table 4-20. No habitat critical to the survival of species was identified within the Project Area.

Table 4-19: Proximity of BIAs and Habitat Critical to the Survival of a Species to the Project and Planning Areas

Receptor	Project Area	Planning Area	Type of BIA	Habitat Critical to the Survival of a Species
Birds				
Antipodean Albatross	Overlap	Overlap	Foraging	-
Australasian Gannet	59 km	Overlap	Foraging	-
	93 km	Overlap	Aggregation	-
Black-browed Albatross	Overlap	Overlap	Foraging	-
Black-faced Cormorant	82 km	Overlap	Breeding	-
	71 km	Overlap	Foraging	-
Buller's Albatross	Overlap	Overlap	Foraging	-
Campbell Albatross	Overlap	Overlap	Foraging	-
Common Diving-petrel	Overlap	Overlap	Foraging	-

Receptor	Project Area	Planning Area	Type of BIA	Habitat Critical to the Survival of a Species
	70 km	Overlap	Breeding	-
Indian Yellow-nosed Albatross	Overlap	Overlap	Foraging	-
Little Penguin	74 km	Overlap	Foraging	-
	83 km	Overlap	Breeding	-
Short-tailed Shearwater	Overlap	Overlap	Foraging	-
	81 km	Overlap	Breeding	-
Shy Albatross	Overlap	Overlap	Foraging likely	-
Wandering Albatross	Overlap	Overlap	Foraging	-
Wedge-tailed Shearwater	18 km	Overlap	Breeding	-
White-faced Storm Petrel	43 km	Overlap	Foraging	-
	160 km	1.8 km	Breeding	-
Fish				
White Shark	Overlap	Overlap	Distribution	-
	40 km	Overlap	Foraging	-
Cetaceans				
Pygmy Blue Whale	Overlap	Overlap	Foraging	-
	Overlap	Overlap	Foraging (annual high use area)	-
	40 km	Overlap	Known Foraging Area	-
Southern Right Whale	Overlap	Overlap	Migration	-
	14 km	Overlap	Reproduction	-

Table 4-20: Seasonality of Biologically Important Behaviours relevant to the Project. P = possible, L = likely

Species	Biologically Important Behaviour	J	F	M	A	M	J	J	A	S	O	N	D
Birds													
Antipodean Albatross	Foraging	P	P	P	P	P	P	P	P	P	P	P	P
Australasian Gannet	Foraging	L	L	L	L	L	P	P	P	P	L	L	L
	Aggregation	L	L	L	L	L	P	P	P	P	L	L	L
Black-browed Albatross	Foraging						L	L	L				
Black-faced Cormorant	Breeding						P	L	P	P			
	Foraging	L	L	L	L	L	L	L	L	L	L	L	L

Species	Biologically Important Behaviour	J	F	M	A	M	J	J	A	S	O	N	D
Buller's Albatross	Foraging	P	P	P	P	P	P	P	P	P	P	P	P
Campbell Albatross	Foraging					P	P	P					
Common Diving-petrel	Foraging	L	P	P	P	P	P	L	L	L	L	L	L
	Breeding	L						L	L	L	L	L	L
Indian Yellow-nosed Albatross	Foraging						P	P	P				
Little Penguin	Foraging	L	L	P	P	P	P	P	P	L	L	L	L
	Breeding	L	L							L	L	L	L
Short-tailed Shearwater	Foraging	L	L	L	L	L				P	L	L	L
	Breeding	L	L	L	L	L					L	L	L
Shy Albatross	Foraging likely	P	P	P	P	P	P	P	P	P	P	P	P
Wandering Albatross	Foraging	P	P	P	P	P	P	P	P	P	P	P	P
Wedge-tailed Shearwater	Breeding	L	L	L	L	L			L	L	L	L	L
White-faced Storm Petrel	Foraging	P	P	P						P	P	P	P
	Breeding	P	P	P						P	P	P	P
Fish													
White Shark	Distribution	L	L	L	L	L	L	L	L	L	L	L	L
	Foraging	L	L	L	L	L	L	L	L	L	L	L	L
Whales													
Pygmy Blue Whale	Foraging (annual high use)	P	L	L	P	P	P					P	P
Southern Right Whale	Migration				P	P	P	L	L	P	P		
	Reproduction					P	P	P	P	P			

4.4.9.3 Fish

Fish species present in the Project or Planning Areas are either pelagic (living in the water column), or demersal (benthic). Fish species inhabiting the region are largely cool temperate species, common within the South-east Marine Region. Table 4-21 details the listed fish species identified in the PMST Reports (Appendix A, Appendix B) as occurring in the Project and/or Planning Areas.

Two fish species identified in the PMST Reports are freshwater species, Dwarf Galaxias and Yarra Pygmy Perch as they will be outside of the areas potentially affected by the Project they are not discussed further.

Threatened or migratory species that are likely or known to occur or have an intercepting BIA with the Project or Planning Areas are discussed in more detail.

Five species of fish are listed as Conservation Dependent which do not receive special protection, as they are not considered MNES under the EPBC Act. These species are targeted by commercial fisheries as detailed in Sections 4.5.10 to 0.

Information on eels is also provided as Beach's consultation with the Eastern Maar Aboriginal Corporation for the previous Otway Project activities identified that they have interests regarding eels, and they are possibly present within the Planning Area during migration and spawning seasons.

Table 4-21: Listed Fish Species or Species Habitat identified in the Project and/or Planning Areas

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area (BIAs)	Presence in Planning Area	Presence in Project Area
Fish								
Australian Grayling	*Prototroctes maraena*	Vulnerable					Species or species habitat known to occur within area	Species or species habitat may occur within area
		National Recovery Plan for the *Prototroctes maraena* (Australian Grayling) (Backhouse et al. 2008). No threats relevant to the Project identified.						
Blue Warehou	*Seriolella brama*	Conservation Dependent					Species or species habitat known to occur within area	Species or species habitat known to occur within area
Eastern Dwarf Galaxias, Dwarf Galaxias	Galaxiella pusilla	Endangered					Species or species habitat may occur within area	_
Eastern Gemfish	*Rexea solandri (eastern Australian population)*	Conservation Dependent					Species or species habitat likely to occur within area	_
Orange Roughy, Deep-sea Perch, Red Roughy	*Hoplostethus atlanticus*	Conservation Dependent					Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Yarra Pygmy Perch	*Nannoperca obscura*	Endangered					Species or species habitat known to occur within area	_
Sharks								
Grey Nurse Shark	*Carcharias taurus*		Migratory	Migratory Marine Species			Species or species habitat may occur within area	Species or species habitat may occur within area
		Recover Plan for the Grey Nurse Shark (*Carcharias taurus)* (DoE 2014). No threats relevant to the Project identified.						

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area (BIAs)	Presence in Planning Area	Presence in Project Area
Little Gulper Shark	*Centrophorus uyato*	Conservation Dependent					Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Porbeagle, Mackerel Shark	*Lamna nasus*		Migratory	Migratory Marine Species			Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark	*Galeorhinus galeus*	Conservation Dependent					Species or species habitat likely to occur within area	Species or species habitat may occur within area
Shortfin Mako, Mako Shark	*Isurus oxyrinchus*		Migratory	Migratory Marine Species			Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
White Shark, Great White Shark	*Carcharodon carcharias*	Vulnerable	Migratory	Migratory Marine Species		Foraging, distribution	Foraging, feeding or related behaviour known to occur within area	Migration route known to occur within area
		Recovery Plan for the *Carcharodon carcharias* (White Shark) (DSEWPaC 2013c). No relevant threats identified.						
Syngnathids								
Australian Smooth Pipefish, Smooth Pipefish	*Lissocampus caudalis*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse	*Hippocampus abdominalis*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Brushtail Pipefish	*Leptoichthys fistularius*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area (BIAs)	Presence in Planning Area	Presence in Project Area
Bullneck Seahorse	*Hippocampus minotaur*				Listed		Species or species habitat may occur within area	_
Common Seadragon, Weedy Seadragon	*Phyllopteryx taeniolatus*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish	*Histiogamphelus briggsii*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Deepbody Pipefish, Deep-bodied Pipefish	*Kaupus costatus*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Hairy Pipefish	*Urocampus carinirostris*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Halfbanded Pipefish	*Mitotichthys semistriatus*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Javelin Pipefish	*Lissocampus runa*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Knifesnout Pipefish, Knife-snouted Pipefish	*Hypselognathus rostratus*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Leafy Seadragon	*Phycodurus eques*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish	*Vanacampus poecilolaemus*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area (BIAs)	Presence in Planning Area	Presence in Project Area
Mollison's Pipefish	*Mitotichthys mollisoni*				Listed		Species or species habitat may occur within area	_
Mother-of-pearl Pipefish	*Vanacampus margaritifer*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Port Phillip Pipefish	*Vanacampus phillipi*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Pugnose Pipefish, Pug-nosed Pipefish	*Pugnaso curtirostris*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Red Pipefish	*Notiocampus ruber*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish	*Histiogamphelus cristatus*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Ringback Pipefish, Ring-backed Pipefish	*Stipecampus cristatus*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Robust Pipehorse, Robust Spiny Pipehorse	*Solegnathus robustus*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Sawtooth Pipefish	*Maroubra perserrata*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Short-head Seahorse, Short-snouted Seahorse	*Hippocampus breviceps*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area (BIAs)	Presence in Planning Area	Presence in Project Area
Spiny Pipehorse, Australian Spiny Pipehorse	*Solegnathus spinosissimus*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Spotted Pipefish, Gulf Pipefish, Peacock Pipefish	*Stigmatopora argus*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Trawl Pipefish, Bass Strait Pipefish	*Kimblaeus bassensis*				Listed		Species or species habitat may occur within area	_
Tucker's Pipefish	*Mitotichthys tuckeri*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish	*Heraldia nocturna*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish	*Stigmatopora nigra*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area

1. Australian Grayling

The Australian grayling (*Prototroctes maraena*) is a dark brown to olive-green fish attaining 19 cm in length. The species typically inhabits the coastal streams of New South Wales, Victoria, and Tasmania, migrating between streams and the ocean. Spawning occurs in freshwater, with timing dependant on many variables including latitude and temperature regimes (Backhouse et al. 2008). Most of its life is spent in fresh water, with parts of the larval or juvenile stages spent in coastal marine waters (Backhouse et al. 2008), though its precise marine habitat requirements remain unknown (Backhouse et al. 2008). They are a short-lived species, usually dying after their second year soon after spawning (a small proportion may reach four or five years) (DSE 2008).

Australian Grayling has been recorded from the Gellibrand River (DSE 2008) making it likely that it occurs in coastal waters. As marine waters are not part of the species' spawning grounds, the Planning Area is not likely to represent critical habitat for the species.

2. Eels

a. Ecology and Biology

The shortfin eel (*Anguilla australis australis*) and the longfin eel (*A. reinhardtii*) both occur naturally within Victoria and are the target species of the Victorian Eel Fishery. The eels have differing but overlapping distributions east and south of the Great Dividing Range in estuarine and freshwater catchments (VFA 2022b) (Figure 4-37).

The shortfin eel is widespread across the southern parts of Victoria and occurring occasionally in northern streams draining into the Murray River, while the longfin eel is found within south-east parts of Victoria only (VFA 2022a). Both species spend the majority of their life cycle in fresh water or estuaries before travelling to the ocean to spawn once before dying (VFA 2022a). Shortfin eels are listed as 'near threatened' on the IUCN red list, with barriers to riverine movement and freshwater habitat loss being key threats. Additionally, changes in ocean currents, primary production, and thermal regimes may also affect eel migration, spawning success, and recruitment (Koster et al. 2021). The longfin eel is listed as 'least concern' by the IUCN. Neither species are listed as threatened under the EPBC Act.

Both species of eel are primarily carnivorous, however, they will both opportunistically eat plant material (VFA 2022a; 2022c). The shortfin eel is known to eat various types of fish, worms, insects, small crustaceans, molluscs, and water plants and can grow up to 1.1 m long and weigh up to 6.8 kg (VFA 2022a). The longfin eel consumes primarily fish and insects. The longfin eel is larger in size compared to the shortfin eel, reported to grow up to 2 m and weigh up to 16 kg, however, they are usually much smaller and often reach 1 m in length (VFA 2022c). Both species are believed to follow a seasonal feeding pattern, with the most intense feeding window being at night during summer and spring (VFA 2022a; 2022c). Both species sexes are determined by influences such as salinity, temperature, diet, and population density (more females as the population density decreases) (VFA 2017).

b. Migration and Spawning

Both species of eel have a remarkable lifecycle that is not entirely understood, remaining a natural phenomenon. They spend most of their life cycle in freshwater or estuaries before undergoing a mass migration into the ocean, travelling in excess of 3,000 km to spawn once (VFA 2022b). Spawning location is believed to be in the Coral Sea near New Caledonia although no precise spawning location for either species has been identified (VFA 2022a). Both species migrate to the ocean once matured;

male shortfin eels generally mature at 8 to 12 years of age, whilst females mature at 10 to 20 years and long-finned eels can take double this time to mature. Migration occurs during late summer to autumn, and after a period of insatiable feeding and significant growth, the eels undergo a series of physical changes to prepare for their migration (VFA 2022a).

Once the eels are prepared for spawning, they move out of their freshwater environments into the ocean in total darkness and swim north against the current to reach the Coral Sea. By the time they arrive, they have used up all their energy resources then they spawn and die, and their young commence the cycle over again. Their life begins at unknown spawning sites at a depth of 200 m as larvae. The pelagic larvae are then carried southwards by the ocean currents that parallel the east coast of Australia such as the EAC and swing east past Tasmania and then north to New Zealand. Along the way, they feed on microscopic organisms and develop into transparent, leaf-shaped larvae and eventually metamorphose into 'glass eels' which are eel-shaped, but extremely small and still transparent. At this stage, they move closer to land and commence migrating towards estuaries. Most glass shortfin eels migrate in the winter and spring, while glass longfin eels migrate during summer and autumn (VFA 2022a), although glass eels of both species may continue to arrive anytime throughout the year (VFA 2017).

Koster et al. (2021) tracked the shortfin eel spawning migration for the first time in Australia. Sixteen eels were collected and tagged from the Hopkins and Fitzroy River estuaries as they migrated from the river mouths outwards to the Southern Ocean over a sandbar in 2019. They were then released at either Warrnambool Harbour, Hopkins's mouth beach or Killarney beach. Twelve of the 16 tags returned data. The results showed that the shortfin eels exhibit diel vertical migration, meaning they travel in the top layers of water during the night and travel further down in the water column during the day (Koster et al. 2021). Of the small number of eels that made the entire journey to the spawning location, their last movements were recorded in the Coral Sea. Many of the eels (about 30%) migrations were cut short due to predation, suspected by sharks, tuna, or other marine mammals. The conclusion of the study talks about the need for further research to determine the eel's exact spawning locations and timing and how the information can be used to support conservation management, particularly when looking at anthropogenic impacts on the species. Koster et al. (2021) listed construction and operation of energy developments as having potential to interact with eel migration.

c. Victorian Eel Fishery

Both the longfin and shortfin eel are the target species for the Victorian Eel Fishery. The first commercial catches of eel were recorded in 1914, and up until 1950 eel was primarily fished for bait. Export of frozen shortfin eel to Europe began in the 1960s (VFA 2022a). Eel are harvested in Victorian coastal river basins south of the Great Dividing Range using fyke nets, with a maximum of 18 licences allowed in Victoria. Certain waterways are closed to fishing to allow for eels to escape and spawn (VFA 2022a). Shortfin eels are the most abundant and the most keenly targeted eel species in Victoria, productivity from the fishery is highly susceptible to short and long term and seasonal environmental variations, particularly drought (VFA 2017).

The eel fishery comprises both a wild catch sector and a culture (stock enhanced) sector. The culture sector has developed strategies for growth consistent with the species life cycle by translocating juvenile eels from other parts of Victoria into lakes and impoundments (culture waters) in western inland Victoria where they continue to grow (VFA 2017). Fishing for glass eels has been of limited success due to the highly variable abundance in Victoria. Most of Victoria's eel catch is taken by commercial fishers and is comprised of adult eels during different stages of their migration.

d. First Nations Connection to Eels

Eels were, and continue to be, an important resource for certain First Nations communities. Their use for communal gatherings and for barter and trade was extensive in pre-colonial times. Today, eel remains a popular food for community events (VFA 2017). Shortfin eels in particular hold a cultural significance to First Nations people. For example, the Gunditjmara People of south-western Victoria built and used sophisticated aquaculture systems throughout the Budj Bim cultural landscape to exploit eel migrations at least 7,000 years ago. These systems and their eel catches have since provided a lasting and sustainable economic and social base for the Gunditjmara society (Koster et al. 2021). The Budj Bim cultural landscape is outside of the Planning Area.

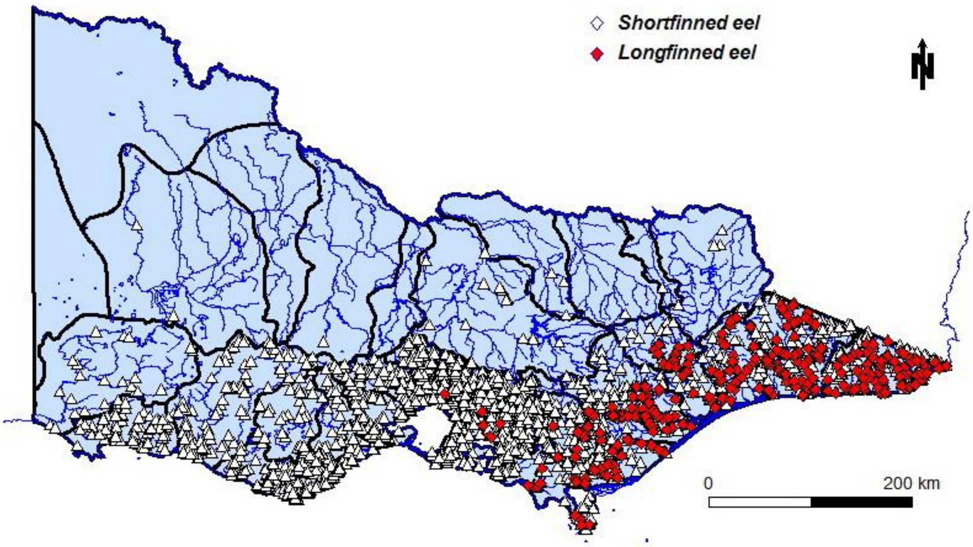


Figure 4-37: Distribution of Longfinned and Shortfinned Eels in Victoria (VFA 2017)

3. Porbeagle Shark

The porbeagle shark (*Lamna nasus*) is widely distributed in the southern waters of Australia including Victorian and Tasmanian waters. The species preys on bony fishes and cephalopods and is an opportunistic hunter that regularly moves up and down in the water column, catching prey in mid-water as well as at the seafloor. It is most commonly found over food-rich banks on the outer continental shelf, but does make occasional forays close to shore or into the open ocean, down to depths of approximately 1,300 m. It also conducts long-distance seasonal migrations, generally shifting between shallower and deeper water (Pade et al. 2009). The porbeagle shark is likely to be present in the Project and Planning Areas in low numbers.

4. Shortfin Mako Shark

The shortfin mako shark (*Isurus oxyrinchus*) is a pelagic species with a circum-global oceanic distribution in tropical and temperate seas (Mollet et al. 2000). It is widespread in Australian waters, commonly found in water with temperatures greater than 16°C. Populations of the shortfin mako shark are considered to have undergone a substantial decline globally. These sharks are a common by-catch species of commercial fisheries (Mollet et al. 2000).

The use of dorsal satellite tags on 10 juvenile shortfin mako sharks captured in the Great Australian Bight between 2008 and 2011 investigated habitat and migration patterns. It revealed the Great

Australian Bight and south east of Kangaroo Island near the norther extent of the Bonney Upwelling Region, to be areas of highest fidelity and indicating critical habitats for juvenile shortfin mako Ssarks (Rogers 2011). The tagged sharks also showed migration to south west Western Australia, Victoria, Bass Strait and south-west of Tasmania. Stomachs of shortfin mako shark were also analysed from specimens collected by game fishing competitors in Port MacDonnell, South Australia and Portland, Victoria from 2008 and 2010 which found they specialise in larger prey including pelagic teleosts and cephalopods (Rogers 2011). Due to their widespread distribution in Australian waters, shortfin mako sharks are likely to be present in the Project Area and Planning Area in low numbers.

5. Syngnathids

Syngnathids identified in the EPBC PMST Reports (Appendix A, Appendix B) as potentially occurring in the Project and Planning Areas include seahorses and their relatives (sea dragon, pipehorse and pipefish). The majority of these species are associated with seagrass meadows, macroalgal seabed habitats, rocky reefs and sponge gardens located in shallow, inshore waters (e.g. protected coastal bays, harbours, and jetties) less than 50 m deep (Fishes of Australia 2015). They are sometimes recorded in deeper offshore waters, where they depend on the protection of sponges and rafts of floating seaweed such as Sargassum.

Of the 29 species of Syngnathids identified in the EPBC PMST Report, only the big-belly seahorse (*Hippocampus abdominalis*) has a documented species profile and threats profile, indicating how little published information exists in general regarding Syngnathids.

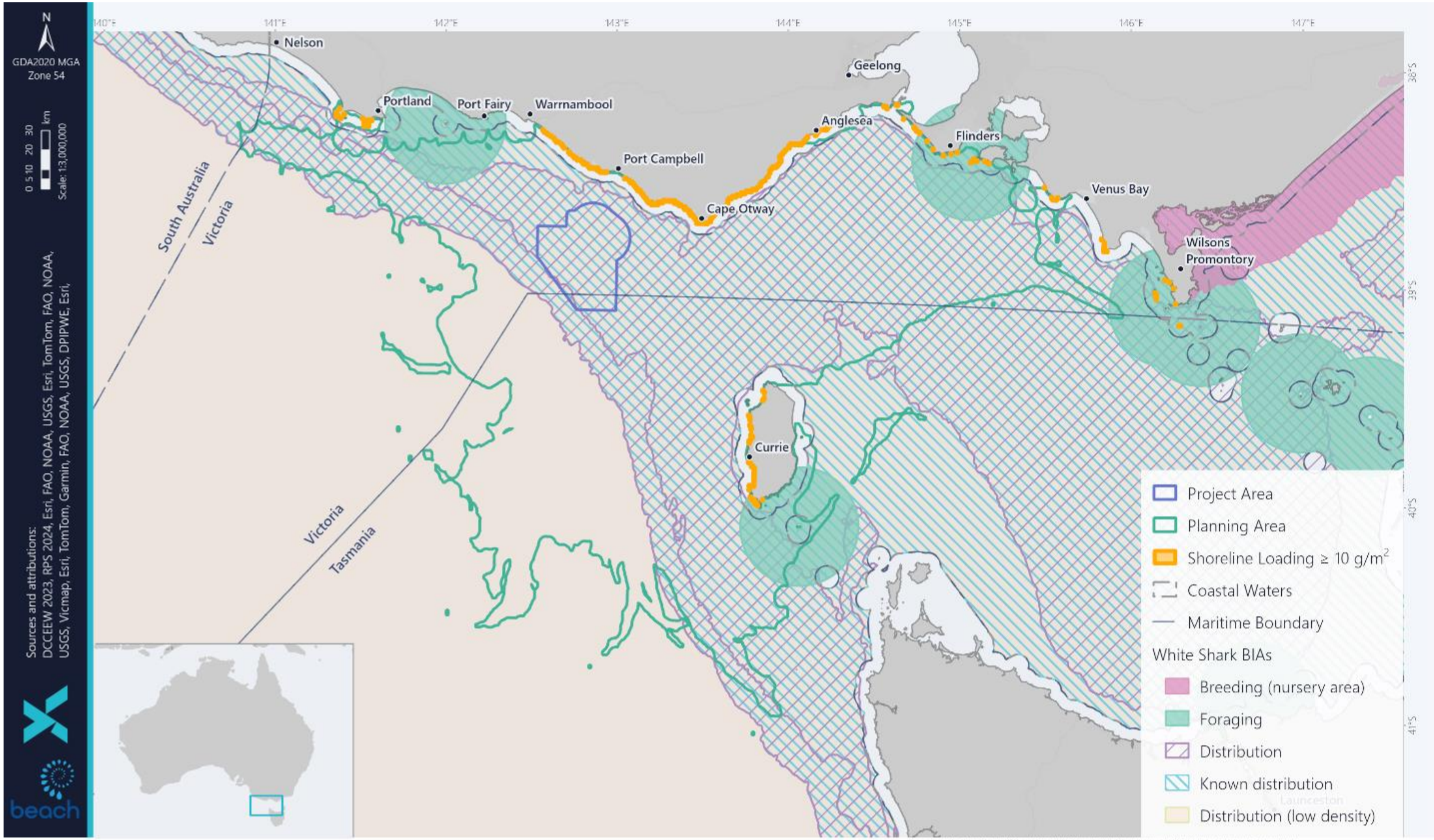
The PMST report species profile and threats profiles indicate that the Syngnathids species identified in the Project Area and Planning Area are widely distributed throughout southern, south-eastern and south-western Australian waters. It is unlikely that these species will be present within the Project Area as water depths are greater than 50 m, however they may be present within the Planning Area.

6. White Shark

The white shark (*Carcharodon carcharias*) is widely distributed and located throughout temperate and sub-tropical waters with their known range in Australian waters from the Northwest Cape, Western Australia, through southern waters to the central coast of Queensland (Last and Stevens 2009; DoE 2023d). Studies of white sharks indicate that they are largely transient, with several discrete populations (Pardini et al. 2000; Gubili et al. 2012). In the Australasian region, white sharks differ genetically from other populations and data suggest there is an eastern and a western population in southern Australia, divided by the Bass Strait (Blower et al. 2012). A recent long-term electronic tagging study of juvenile white sharks off eastern Australia, indicated complex movement patterns over thousands of kilometres, including annual fidelity to spatially restricted nursery areas, directed seasonal coastal movements, intermittent areas of temporary nearshore residency and offshore movement into the Tasman Sea (Bruce et al. 2019). This study also supported the two-population model for the species in Australian waters with restricted east to west movements through Bass Strait. Bruce et al. (2019) observed seasonal movements of juvenile White Sharks being in the northern region during winter and spring (June through November) and southern region during summer and autumn (December through May).

Observations of adult sharks are more frequent around fur seal and sea lion colonies, including Wilsons Promontory and the Skerries. Juveniles are known to congregate in certain key areas including the Ninety Mile Beach area (including Corner Inlet and Lakes Entrance) in eastern Victoria and the Portland area of western Victoria).

The distribution BIA for the white shark intersects the Project Area. The foraging BIA is 38 km, and the breeding BIA is 295 km from the Project Area (Figure 4-38). The known distribution is on the coastal shelf/upper slope waters out to 1000 m and the broader area where they are likely to occur extends from Barrow Island in WA to Yeppoon in NSW. They are more likely to be found between the 60 to 120 m depth contours than in the deeper waters. There is a known nursery area at Corner Inlet, and they are known to forage in waters off pinniped colonies throughout the SEMR. It is likely that White Sharks will be present in the Project and Planning Areas.



Sources and attributions:
DCCEEW 2023, RPS 2024, Esri, FAO, NOAA, USGS, Esri, TomTom, FAO, NOAA,
USGS, Vicmap, Esri, TomTom, Garmin, FAO, NOAA, USGS, DPIPWE, Esri,

Figure 4-38: White Shark BIAs within the Project and Planning Areas

7. Commercially Important Fish Species

a. Blue Warehou

The blue warehou (*Seriolella brama*) is a bentho-pelagic species that inhabits continental slope waters at depth from 50-300 m (AFMA 2024a). The blue warehou is a targeted species within the Southern and Eastern Scalefish and Shark Fishery (SESSF) Commonwealth Trawl and Scalefish Hook sectors. There are two separate stocks of the blue warehou (east and west). The eastern stock extends offshore from southern New South Wales to southern Tasmania and the western stock extends offshore from western Tasmania northward to western Victoria (Bessell-Browne et al. 2021). Both the western and eastern stock of the blue warehou is classified as overfished and was actively avoided in 2022-23 (Butler et al., 2023).

b. Eastern Gemfish

The eastern gemfish (*Rexea solandri*) is a bottom-dwelling species that inhabits temperate waters of Australian and New Zealand and typically found in large schools at water depths of 100-800 m (AFMA 2024b). The species typically preys on bentho-pelagic fish such as grenadier, as well as squid and crustaceans (AFMA 2024b). Female eastern gemfish reach reproductive maturity at 4-6 years and males at 3-5 years, with spawning occurring in northern and central New South Wales during winter (AFMA 2024b). The species is incidentally caught in the SESSF Commonwealth Trawl sector and the Gillnet Hook and trap sector. The eastern Gemfish has been classified as overfished since 1992 and a rebuilding strategy established the eastern gemfish as an incidental catch-only species, which was implemented in 2008 (Butler et al. 2023)

c. Gummy Shark

Gummy sharks (*Mustelus antarcticus*) are a demersal species that inhabits the continental shelf at depths of 80-350 m (AFMA 2024c). The species typically remains on or near the surface feeding on cephalopods, crustaceans and occasionally fish. Newborn and juvenile sharks aggregate across southern Australia, with adults more widely distributed. Gummy sharks reach reproductive maturity at 4-5 years of age, with males maturing at a smaller size. The females are ovoviviparous producing litters of about 14-57 pups during the summer months after an 11–12-month gestation period (AFMA 2024c).

The gummy shark is a key targeted species within the SESSF Gillnet Hook and Trap sector, and incidentally caught in the Commonwealth Trawl Sector (Butler et al. 2024). The species is mainly caught in southern Australia, extending from Bunbury in Western Australia to Jervis Bay in New South Wales (White and Last 2008). As of 2023, the gummy shark is classified as not overfished (Butler et al. 2023).

d. Orange Roughy

Orange roughy (*Hoplostethus atlanticus*) is listed as Conservation Dependent under the EPBC Act. The orange roughy is a deep-water species that inhabits waters over steep continental slopes and ocean ridges at water depths between 700-1400 m (AFMA 2024d). The species usually aggregate 5-10 m above the seabed, with some extending over 50 m from the seafloor, and are associated with submerged hills or pinnacles (AFMA 2024d). At these depths, orange roughy prey on benthopelagic and meso-pelagic fish such as viperfish, lanternfish, whiptails, squid, crustaceans, amphipods and mysids (AFMA 2024d). The orange roughy reach reproductive maturity at 27-32 years of age, with spawning aggregations occurring between mid-July and late August.

The orange roughy is targeted within the SESSF south-East Trawl Sector and incidentally caught within the Great Australian Bight Trawl (Butler et al. 2023). The species has been historically targeted in aggregations around seamounts, mainly at depths from 600 m to about 1,300 m (Butler et al. 2023). However, no commercial catch of orange roughy was landed in 2022-23 (Butler et al. 2023). The species is considered overfished and no documented evidence of recovery (Butler et al. 2023).

e. School Shark

The school shark (*Galeorhinus galeus*) is a temperate demersal species found on the continental shelf and slop at depths of 550 m (AFMA 2024e). The species undertakes long migrations of up to 1,400 km along the southern coast of Australia, which may be associated with mating and pupping grounds (AFMA 2024e). The school shark reaches reproductive maturity at 8-15 years of age, with the females producing litters of 15-42 pups every 2-3 years (AFMA 2024e). Birth occurs in early summer after 12 months gestation period. The pups and juveniles tend to aggregate in shallower waters during the spring and summer.

School sharks were historically the primary target species within the SESSF shark gillnet and shark hook sector. Assessments for the school shark indicate that the stock has been overfished since approximately 1990 (Butler et al. 2023). Although overfished, the school shark remains the second most economically important stock in the fishery (Butler et al. 2023).

f. Southern Bluefin Tuna

The southern bluefin tuna (*Thunnus maccoyii*) is a highly migratory, pelagic species and is distributed throughout the Atlantic, Pacific and Indian Oceans. The species inhabits water depths of 500 m, feeding on fish, cephalopods, crustaceans and salps (AFMA 2024f). In Australia, the southern bluefin tuna and mainly found in the Great Australian Bight and typically caught between December to April (AFMA 2024f). The species reaches reproductive maturity at 11-12 years of age, with spawning occurring in tropical waters during spring and summer (AFMA 2024f). Only one spawning ground has been identified and is located in the north-eastern Indian Ocean, south of Java (AFMA 2024f). The juveniles are generally associated with coastal and continental shelf waters **[PC227]**.

The southern bluefin tuna is a key targeted species within the Southern Bluefin Tuna Fishery and Eastern Tuna and Billfish Fishery. The species is not considered to be overfished (Butler et al. 2023).

4.4.9.4 Seabirds and Shorebirds

A diverse array of seabirds and shorebirds birds utilise the Otway region and potentially forage within or fly over the Project and Planning Areas. Figure 4-39 through Figure 4-42 show the seabird BIAs that overlap the Project and Planning Areas. No shorebird BIAs were identified within the Project and Planning Areas.

Table 4-22 details the listed bird species identified as likely or known to occur in the Project and Planning Areas PMST Reports (Appendix A, Appendix B).

Threatened or migratory species that are likely or known to occur or have an intercepting BIA with the Project or Planning Areas are discussed in more detail.

No habitats critical to the survival of a bird species were identified in the Project Area or Planning Area.

Table 4-22: EPBC Listed Seabird and Shorebird Species Identified in the Project and/or Planning Areas

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
Albatrosses and Petrels								
Antipodean Albatross	*Diomedea antipodensis*	Vulnerable	Migratory	Migratory Marine Birds	Listed	Foraging	Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Black-browed Albatross	*Thalassarche melanophris*	Vulnerable	Migratory	Migratory Marine Birds	Listed	Foraging	Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Blue Petrel	*Halobaena caerulea*	Vulnerable			Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
		Approved Conservation Advice for the *Halobaena caerulea* (Blue Petrel) (TSSC 2015c). No relevant threats identified.						
Buller's Albatross, Pacific Albatross	*Thalassarche bulleri*	Vulnerable	Migratory	Migratory Marine Birds	Listed	Foraging	Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Campbell Albatross, Campbell Black-browed Albatross	*Thalassarche impavida*	Vulnerable	Migratory	Migratory Marine Birds	Listed	Foraging	Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Chatham Albatross	*Thalassarche eremita*	Endangered	Migratory	Migratory Marine Birds	Listed		Foraging, feeding or related behaviour may occur within area	_
Common Diving-petrel	*Pelecanoides urinatrix*				Listed	Breeding, Foraging	Breeding known to occur within area	_
Gibson's Albatross	*Diomedea antipodensis gibsoni*	Vulnerable			Listed (as *Diomedea gibsoni*)		Foraging, feeding or related behaviour likely to occur within area	_

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
Gould's Petrel, Australian Gould's Petrel	*Pterodroma leucoptera leucoptera*	Endangered					Species or species habitat may occur within area	Species or species habitat may occur within area
		National Recovery Plan for *Pterodroma leucoptera leucoptera* (Gould's Petrel) (DEC NSW 2006). No relevant threats identified.						
Grey-headed Albatross	*Thalassarche chrysostoma*	Endangered	Migratory	Migratory Marine Birds	Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Indian Yellow-nosed Albatross	*Thalassarche carteri*	Vulnerable	Migratory	Migratory Marine Birds	Listed	Foraging	Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Northern Buller's Albatross, Pacific Albatross	*Thalassarche bulleri platei*	Vulnerable			Listed (as *Thalassarche* sp. nov.)		Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Northern Giant Petrel	*Macronectes halli*	Vulnerable	Migratory	Migratory Marine Birds	Listed		Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Northern Royal Albatross	*Diomedea sanfordi*	Endangered	Migratory	Migratory Marine Birds	Listed		Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Salvin's Albatross	*Thalassarche salvini*	Vulnerable	Migratory	Migratory Marine Birds	Listed		Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Shy Albatross	*Thalassarche cauta*	Endangered	Migratory	Migratory Marine Birds	Listed	Foraging likely	Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Soft-plumaged Petrel	*Pterodroma mollis*	Vulnerable			Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
		Approved Conservation Advice for *Pterodroma mollis* (Soft-plumaged Petrel) (TSSC 2015a). No relevant threats identified.						

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
Sooty Albatross	*Phoebetria fusca*	Vulnerable	Migratory	Migratory Marine Birds	Listed		Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Southern Giant-Petrel, Southern Giant Petrel	*Macronectes giganteus*	Endangered	Migratory	Migratory Marine Birds	Listed		Foraging, feeding or related behaviour likely to occur within area	Species or species habitat may occur within area
Southern Royal Albatross	*Diomedea epomophora*	Vulnerable	Migratory	Migratory Marine Birds	Listed		Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Wandering Albatross	*Diomedea exulans*	Vulnerable	Migratory	Migratory Marine Birds	Listed	Foraging	Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian)	*Fregetta grallaria grallaria*	Vulnerable					Species or species habitat likely to occur within area	_
White-capped Albatross	*Thalassarche steadi*	Vulnerable	Migratory	Migratory Marine Birds	Listed		Foraging, feeding or related behaviour known to occur within area	Foraging, feeding or related behaviour known to occur within area
White-faced Storm-Petrel	*Pelagodroma marina*				Listed	Breeding, Foraging	Breeding known to occur within area	_
Terns and Shearwaters								
Australian Fairy Tern	*Sternula nereis nereis*	Vulnerable					Species or species habitat known to occur within area	Foraging, feeding or related behaviour likely to occur within area

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
		Approved Conservation Advice for *Sternula nereis nereis* (Australian fairy Tern) (DSEWPaC 2011). Threats identified relevant to the Project: Marine pollution - Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented. National Recovery Plan for the Australian Fairy Tern (*Sternula nereis nereis*) (CoA 2020). Threats identified relevant to the Project: Habitat degradation Climate variability Pollution No actions specific to the Project were identified.						
Caspian Tern	*Hydroprogne caspia*		Migratory	Migratory Marine Birds	Listed (as *Sterna caspia*)		Breeding known to occur within area	_
Fairy Tern	*Sternula nereis*				Listed (as *Sterna nereis*)		Breeding known to occur within area	_
Flesh-footed Shearwater, Fleshy-footed Shearwater	*Ardenna carneipes*		Migratory	Migratory Marine Birds	Listed (as *Puffinus carneipes*)		Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour likely to occur within area
Greater Crested Tern	*Thalasseus bergii*		Migratory	Migratory Wetlands Species	Listed (as *Sterna bergii*)		Breeding known to occur within area	_
Little Tern	*Sternula albifrons*		Migratory	Migratory Marine Birds	Listed (as *Sterna albifrons*)		Breeding known to occur within area	_
Short-tailed Shearwater	*Ardenna tenuirostris*		Migratory	Migratory Marine Birds	Listed (as *Puffinus tenuirostris*)	Breeding, Foraging	Breeding known to occur within area	-
Sooty Shearwater	*Ardenna grisea*	Vulnerable	Migratory	Migratory Marine Birds	Listed (as *Puffinus griseus*)		Species or species habitat may occur within area	Species or species habitat may occur within area

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
		Conservation Advice for *Ardenna grisea* (sooty shearwater) (DCCEEW 2023d). No relevant threats identified.						
Sooty Tern	*Onychoprion fuscatus*				Listed (as *Sterna fuscata*)		Breeding known to occur within area	_
White-fronted Tern	*Sterna striata*				Listed		Foraging, feeding or related behaviour likely to occur within area	Migration route may occur within area
Other								
Australasian Bittern	*Botaurus poiciloptilus*	Endangered					Species or species habitat known to occur within area	_
		Approved Conservation Advice for *Botaurus poiciloptilus* (Australasian Bittern) (TSSC 2019). National Recovery Plan for the Australasian Bittern (CoA 2022b). No relevant threats identified.						
Australasian Gannet	*Morus serrator*				Listed	Aggregation, Foraging	Breeding known to occur within area	_
Australian Painted Snipe	*Rostratula australis*	Endangered			Listed - overfly marine area (as *Rostratula benghalensis* (sensu lato))		Species or species habitat known to occur within area	_
		Approved Conservation Advice for *Rostratula australis* (Australian Painted Snipe) (DSEWPaC 2013a). No relevant threats identified. National Recovery Plan for the Australian Painted Snipe (CoA 2022a). Threats identified relevant to the Project: Deterioration of water quality, human disturbance.						

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
Bar-tailed Godwit	*Limosa lapponica*		Migratory	Migratory Wetlands Species	Listed		Species or species habitat known to occur within area	_
Black Currawong (King Island)	*Strepera fuliginosa colei*	Vulnerable					Breeding likely to occur within area	_
Black-eared Cuckoo	*Chalcites osculans*				Listed - overfly marine area (as *Chrysococcyx osculans*)		Species or species habitat known to occur within area	_
Black-faced Cormorant	*Phalacrocorax fuscescens*				Listed	Breeding, Foraging	Breeding known to occur within area	_
Black-faced Monarch	*Monarcha melanopsis*		Migratory	Migratory Terrestrial Species	Listed - overfly marine area		Species or species habitat known to occur within area	_
Black-tailed Godwit	*Limosa limosa*	Endangered	Migratory	Migratory Wetlands Species	Listed - overfly marine area		Roosting known to occur within area	_
		Conservation Advice for *Limosa limosa* (Black-tailed Godwit) (DCCEEW 2024f) Threats relevant to the Project: Chronic and acute pollution						
Blue-winged Parrot	*Neophema chrysostoma*	Vulnerable			Listed - overfly marine area		Species or species habitat known to occur within area	_
		Conservation Advice for *Neophema chrysostoma* (Blue-winged Parrot) (DCCEEW 2024h). No relevant threats identified.						
Broad-billed Sandpiper	*Limicola falcinellus*		Migratory	Migratory Wetlands Species	Listed - overfly marine area		Roosting known to occur within area	-

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
Brown Skua	*Stercorarius antarcticus*				Listed (as *Catharacta skua*)		Species or species habitat may occur within area	Species or species habitat may occur within area
Brown Treecreeper (south-eastern)	*Climacteris picumnus victoriae*	Vulnerable					Species or species habitat may occur within area	_
Cape Gannet	*Morus capensis*				Listed		Breeding known to occur within area	_
Cattle Egret	*Bubulcus ibis*				Listed - overfly marine area (as *Ardea ibis*)		Species or species habitat may occur within area	_
Common Greenshank, Greenshank	*Tringa nebularia*	Endangered	Migratory	Migratory Wetlands Species	Listed - overfly marine area		Species or species habitat known to occur within area	_
Common Noddy	*Anous stolidus*		Migratory	Migratory Marine Birds	Listed		Species or species habitat likely to occur within area	_
Common Sandpiper	*Actitis hypoleucos*		Migratory	Migratory Wetlands Species	Listed		Species or species habitat known to occur within area	Species or species habitat may occur within area
Curlew Sandpiper	*Calidris ferruginea*	Critically Endangered	Migratory	Migratory Wetlands Species	Listed - overfly marine area		Species or species habitat known to occur within area	Species or species habitat may occur within area
		Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (DoE 2015f). Threats identified relevant to the Project: Habitat degradation/ loss (oil pollution)						
Diamond Firetail	*Stagonopleura guttata*	Vulnerable					Species or species habitat known to occur within area	_

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
		Conservation Advice for *Stagonopleura guttata* (diamond firetail) (DCCEEW 2023e). No relevant threats identified.						
Double-banded Plover	*Charadrius bicinctus*		Migratory	Migratory Wetlands Species	Listed - overfly marine area		Roosting known to occur within area	_
Eastern Curlew, Far Eastern Curlew	*Numenius madagascariensis*	Critically Endangered	Migratory	Migratory Wetlands Species	Listed		Species or species habitat known to occur within area	Species or species habitat may occur within area
		Conservation Advice for *Numenius madagascariensis* (Far Eastern Curlew) (DCCEEW 2023f). Threats identified relevant to the Project: Habitat degradation/ loss (oil pollution)						
Eastern Hooded Plover, Eastern Hooded Plover	*Thinornis cucullatus cucullatus*	Vulnerable			Listed - overfly marine area (as *Thinornis rubricollis rubricollis*)		Species or species habitat known to occur within area	_
Fairy Prion	*Pachyptila turtur*				Listed		Species or species habitat known to occur within area	Species or species habitat may occur within area
Fairy Prion (southern)	*Pachyptila turtur subantarctica*	Vulnerable					Species or species habitat known to occur within area	Species or species habitat may occur within area
		Approved Conservation Advice for *Pachyptila subantarctica* (Fairy Prion (southern)) (TSSC 2015b). No relevant threats identified.						
Fork-tailed Swift	*Apus pacificus*		Migratory	Migratory Marine Birds	Listed - overfly marine area		Species or species habitat likely to occur within area	_
Gang-gang Cockatoo	*Callocephalon fimbriatum*	Endangered					Species or species habitat known to occur within area	_

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
Great Knot	*Calidris tenuirostris*	Vulnerable	Migratory	Migratory Wetlands Species	Listed - overfly marine area		Roosting known to occur within area	_
		Conservation Advice for *Calidris tenuirostris* (great knot) (DCCEEW 2024l). Threats identified relevant to the Project: Chronic and acute pollution						
Greater Sand Plover, Large Sand Plover	*Charadrius leschenaultii*	Vulnerable	Migratory	Migratory Wetlands Species	Listed		Species or species habitat known to occur within area	_
		Conservation Advice for *Charadrius leschenaultia* (Greater sand Plover) (TSSC 2016b). Threats identified relevant to the Project: Habitat degradation/ loss (oil pollution)						
Green Rosella (King Island)	*Platycercus caledonicus brownii*	Vulnerable					Species or species habitat known to occur within area	_
Grey Falcon	*Falco hypoleucos*	Vulnerable					Species or species habitat likely to occur within area	_
Grey Plover	*Pluvialis squatarola*	Vulnerable	Migratory	Migratory Wetlands Species	Listed - overfly marine area		Roosting known to occur within area	_
		Conservation Advice for *Pluvialis squatarola* (grey plover) (DCCEEW 2024k). Threats identified relevant to the Project: Chronic and acute pollution						
Grey-tailed Tattler	*Tringa brevipes*		Migratory	Migratory Wetlands Species	Listed (as *Heteroscelus brevipes*)		Roosting known to occur within area	_
Hooded Plover, Hooded Dotterel	*Thinornis cucullatus*				Listed - overfly marine area (as *Thinornis rubricollis*)		Species or species habitat known to occur within area	_

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
Kelp Gull	*Larus dominicanus*				Listed		Breeding known to occur within area	_
King Island Brown Thornbill, Brown Thornbill (King Island)	*Acanthiza pusilla magnirostris*	Endangered					Species or species habitat known to occur within area	_
King Island Scrubtit, Scrubtit (King Island)	*Acanthornis magna greeniana*	Critically Endangered					Species or species habitat known to occur within area	_
Latham's Snipe, Japanese Snipe	*Gallinago hardwickii*	Vulnerable	Migratory	Migratory Wetlands Species	Listed - overfly marine area		Species or species habitat known to occur within area	_
		Conservation Advice for *Gallinago hardwickii* (Latham's snipe) (DCCEEW 2024j). No relevant threats identified.						
Lesser Sand Plover, Mongolian Plover	*Charadrius mongolus*	Endangered	Migratory	Migratory Wetlands Species	Listed		Roosting known to occur within area	_
Little Curlew, Little Whimbrel	*Numenius minutus*		Migratory	Migratory Wetlands Species	Listed - overfly marine area		Roosting likely to occur within area	_
Little Penguin	*Eudyptula minor*				Listed	Breeding, Foraging	Breeding known to occur within area	_
Magpie Goose	*Anseranas semipalmata*				Listed - overfly marine area		Species or species habitat may occur within area	_

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
Marsh Sandpiper, Little Greenshank	*Tringa stagnatilis*		Migratory	Migratory Wetlands Species	Listed - overfly marine area		Roosting known to occur within area	_
Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit	*Limosa lapponica baueri*	Endangered					Species or species habitat known to occur within area	_
		Conservation Advice for *Limosa lapponica baueri* (Bar-tailed Godwit (western Alaskan)) (TSSC 2016a). Threats identified relevant to the Project: Habitat degradation/ loss.						
Orange-bellied Parrot	*Neophema chrysogaster*	Critically Endangered			Listed - overfly marine area		Migration route known to occur within area	Migration route likely to occur within area
		National Recovery Plan for the *Neophema chrysogaster* (Orange-bellied Parrot) (DELWP 2016). Threats identified relevant to the Project: Illuminated boats and structures: evaluate risk of lighting on vessels and offshore structures.						
Osprey	*Pandion haliaetus*		Migratory	Migratory Wetlands Species	Listed		Species or species habitat known to occur within area	_
Pacific Golden Plover	*Pluvialis fulva*		Migratory	Migratory Wetlands Species	Listed		Roosting known to occur within area	_
Pacific Gull	*Larus pacificus*				Listed		Breeding known to occur within area	_
Painted Honeyeater	*Grantiella picta*	Vulnerable					Species or species habitat may occur within area	_

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
Pectoral Sandpiper	*Calidris melanotos*		Migratory	Migratory Wetlands Species	Listed - overfly marine area		Species or species habitat known to occur within area	Species or species habitat may occur within area
Pied Stilt, Black-winged Stilt	*Himantopus himantopus*				Listed - overfly marine area		Roosting known to occur within area	_
Pilotbird	*Pycnoptilus floccosus*	Vulnerable					Species or species habitat may occur within area	_
Pin-tailed Snipe	*Gallinago stenura*		Migratory	Migratory Wetlands Species	Listed - overfly marine area		Roosting likely to occur within area	_
Plains-wanderer	*Pedionomus torquatus*	Critically Endangered					Species or species habitat may occur within area	_
Rainbow Bee-eater	*Merops ornatus*				Listed - overfly marine area		Species or species habitat may occur within area	_
Red Knot, Knot	*Calidris canutus*	Vulnerable	Migratory	Migratory Wetlands Species	Listed - overfly marine area		Species or species habitat known to occur within area	Species or species habitat may occur within area
		Conservation Advice for *Calidris canutus* (Red Knot) (DCCEEW 2024m). Threats identified relevant to the Project: Marine pollution - Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.						
Red-capped Plover	*Charadrius ruficapillus*				Listed - overfly marine area		Roosting known to occur within area	_
Red-necked Avocet	*Recurvirostra novaehollandiae*				Listed - overfly marine area		Roosting known to occur within area	_

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
Red-necked Phalarope	*Phalaropus lobatus*		Migratory	Migratory Wetlands Species	Listed		Roosting known to occur within area	_
Red-necked Stint	*Calidris ruficollis*		Migratory	Migratory Wetlands Species	Listed - overfly marine area		Roosting known to occur within area	_
Regent Honeyeater	*Anthochaera phrygia*	Critically Endangered					Foraging, feeding or related behaviour likely to occur within area	_
Ruddy Turnstone	*Arenaria interpres*	Vulnerable	Migratory	Migratory Wetlands Species	Listed		Roosting known to occur within area	_
		Conservation Advice for *Arenaria interpres* (ruddy turnstone) (DCCEEW 2024d). Threats identified relevant to the Project: Chronic and acute pollution						
Rufous Fantail	*Rhipidura rufifrons*				Listed - overfly marine area		Species or species habitat known to occur within area	_
Sanderling	*Calidris alba*		Migratory	Migratory Wetlands Species	Listed		Roosting known to occur within area	_
Satin Flycatcher	*Myiagra cyanoleuca*				Listed - overfly marine area		Breeding known to occur within area	_
Sharp-tailed Sandpiper	*Calidris acuminata*	Vulnerable	Migratory	Migratory Wetlands Species	Listed		Roosting known to occur within area	Species or species habitat may occur within area
		Conservation Advice for *Calidris acuminata* (sharp-tailed sandpiper) (DCCEEW 2024g). Threats identified relevant to the Project: Chronic and acute pollution						

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Area	Present in Planning Area	Present in Project Area
Silver Gull	*Chroicocephalus novaehollandiae*				Listed (as Larus novaehollandiae)		Breeding known to occur within area	_
South-eastern Hooded Robin, Hooded Robin (south-eastern)	*Melanodryas cucullata cucullata*	Endangered					Species or species habitat may occur within area	_
South-eastern Red-tailed Black-Cockatoo	*Calyptorhynchus banksii graptogyne*	Endangered					Species or species habitat likely to occur within area	_
Southern Whiteface	*Aphelocephala leucopsis*	Vulnerable					Species or species habitat may occur within area	_
		Conservation Advice for *Aphelocephala leucopsis* (southern whiteface) (DCCEEW 2023g). No relevant threats identified.						
Swift Parrot	*Lathamus discolor*	Critically Endangered			Listed - overfly marine area		Species or species habitat known to occur within area	_
		Conservation advice *Lathamus discolor* Swift Parrot (TSSC 2015f) National Recovery Plan for the Swift Parrot *Lathamus discolour* (DCCEEW 2024n). No relevant threats identified.						
Swinhoe's Snipe	*Gallinago megala*		Migratory	Migratory Wetlands Species	Listed - overfly marine area		Roosting likely to occur within area	_
Tasmanian Azure Kingfisher	*Ceyx azureus diemenensis*	Endangered					Species or species habitat known to occur within area	_

Common Name	**Scientific Name**	**Threatened Category**	**Migratory Status**	**Migratory Category**	**Marine Status**	**Biologically Important Area**	**Present in Planning Area**	**Present in Project Area**
Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian)	*Aquila audax fleayi*	Endangered					Species or species habitat may occur within area	_
Terek Sandpiper	*Xenus cinereus*	Vulnerable	Migratory	Migratory Wetlands Species	Listed - overfly marine area		Roosting known to occur within area	_
		Conservation Advice for *Xenus cinereus* (terek sandpiper) (DCCEEW 2024i). Threats relevant to the Project: Chronic and acute pollution						
Whimbrel	*Numenius phaeopus*		Migratory	Migratory Wetlands Species	Listed		Roosting known to occur within area	_
White-bellied Sea-Eagle	*Haliaeetus leucogaster*				Listed		Breeding known to occur within area	-
White-throated Needletail	*Hirundapus caudacutus*	Vulnerable	Migratory	Migratory Terrestrial Species	Listed - overfly marine area		Species or species habitat known to occur within area	_
Yellow Wagtail	*Motacilla flava*		Migratory	Migratory Terrestrial Species	Listed - overfly marine area		Species or species habitat may occur within area	_

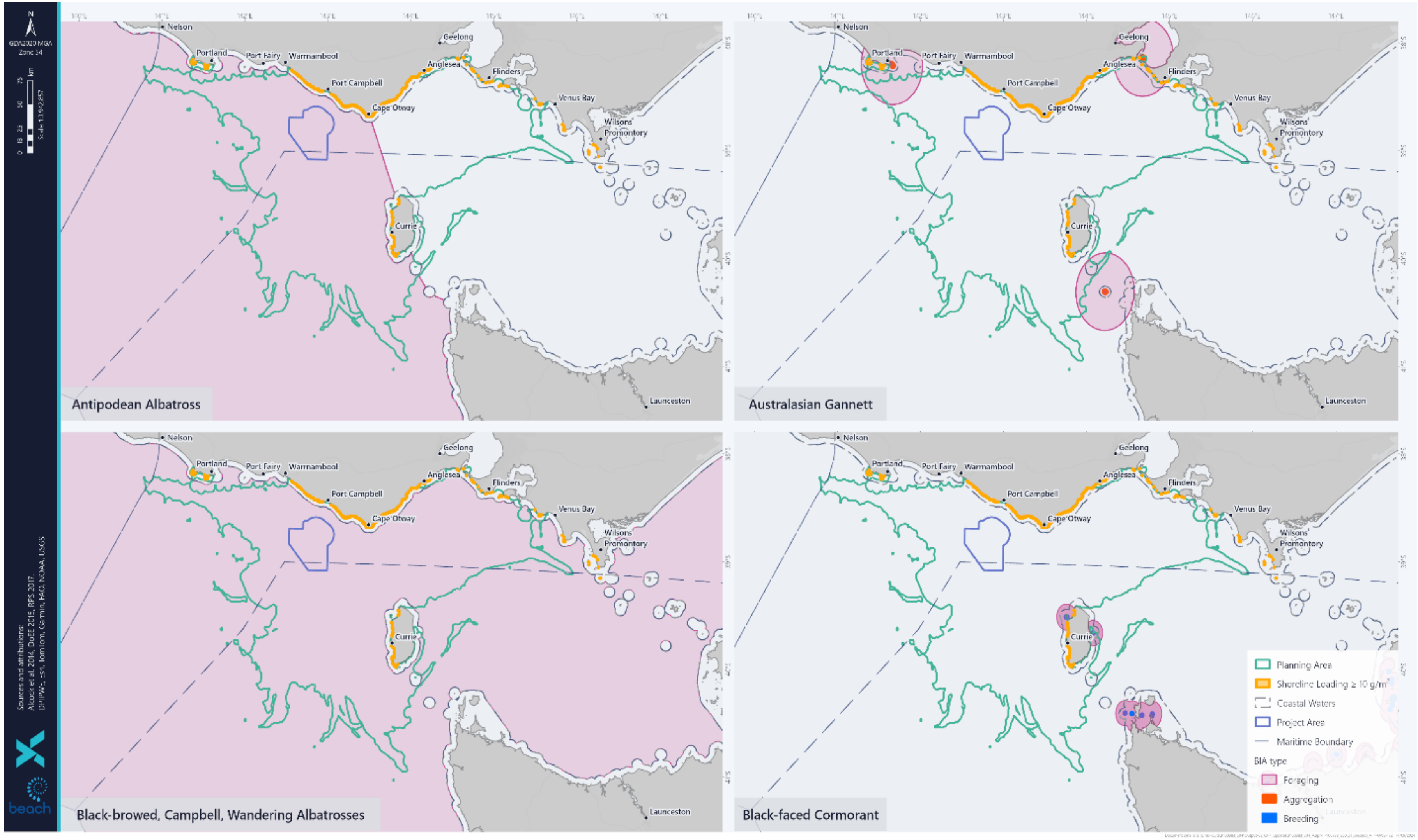


Figure 4-39: BIAs for Antipodean Albatross, Australasian Gannett, Black-browed/Campbell/Wandering Albatross and Black-faced Cormorant within the Project and Planning Areas

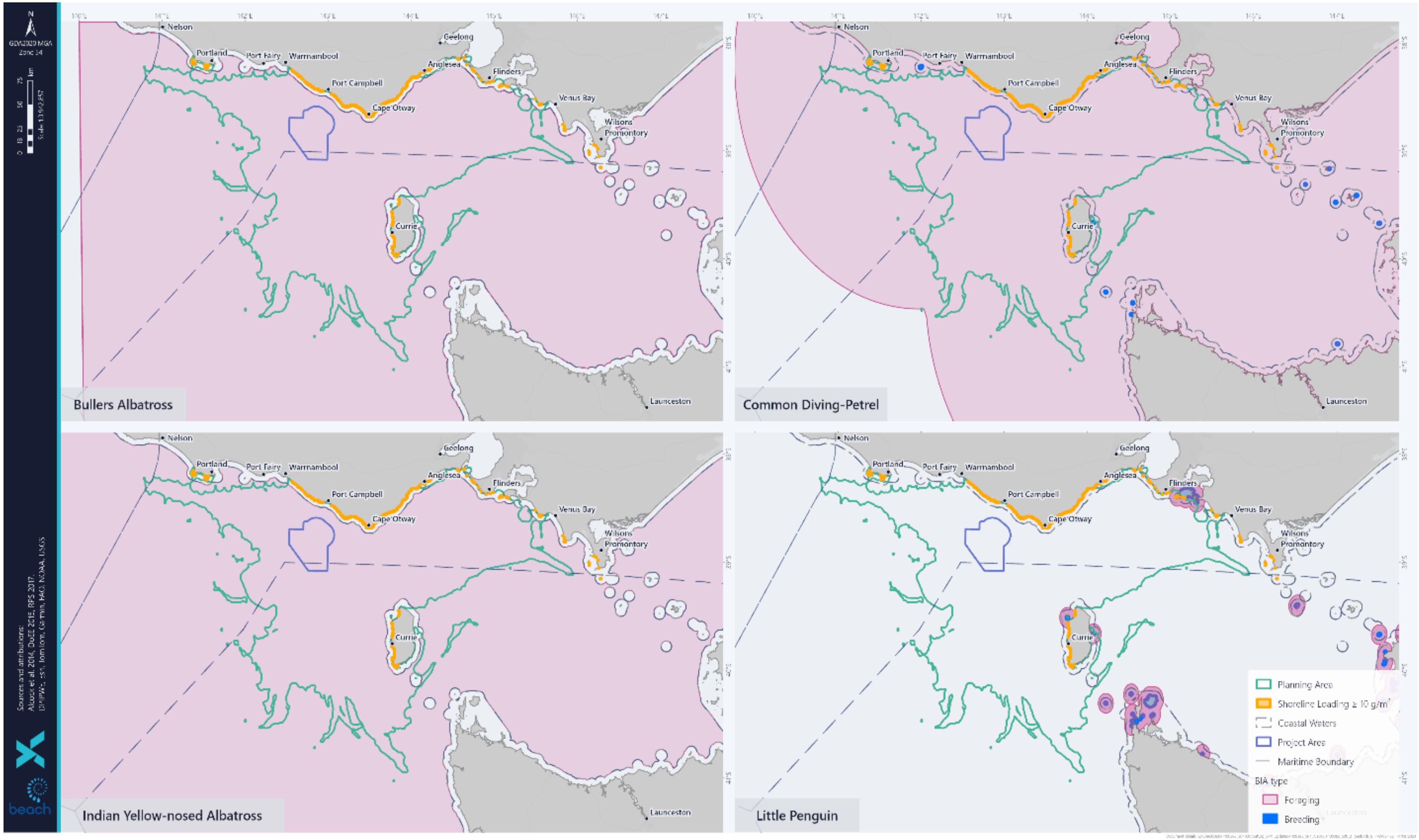


Figure 4-40: BIAs for Bullers Albatross, Common Diving-petrel, Indian Yellow-nosed Albatross and Little Penguin within the Project and Planning Areas

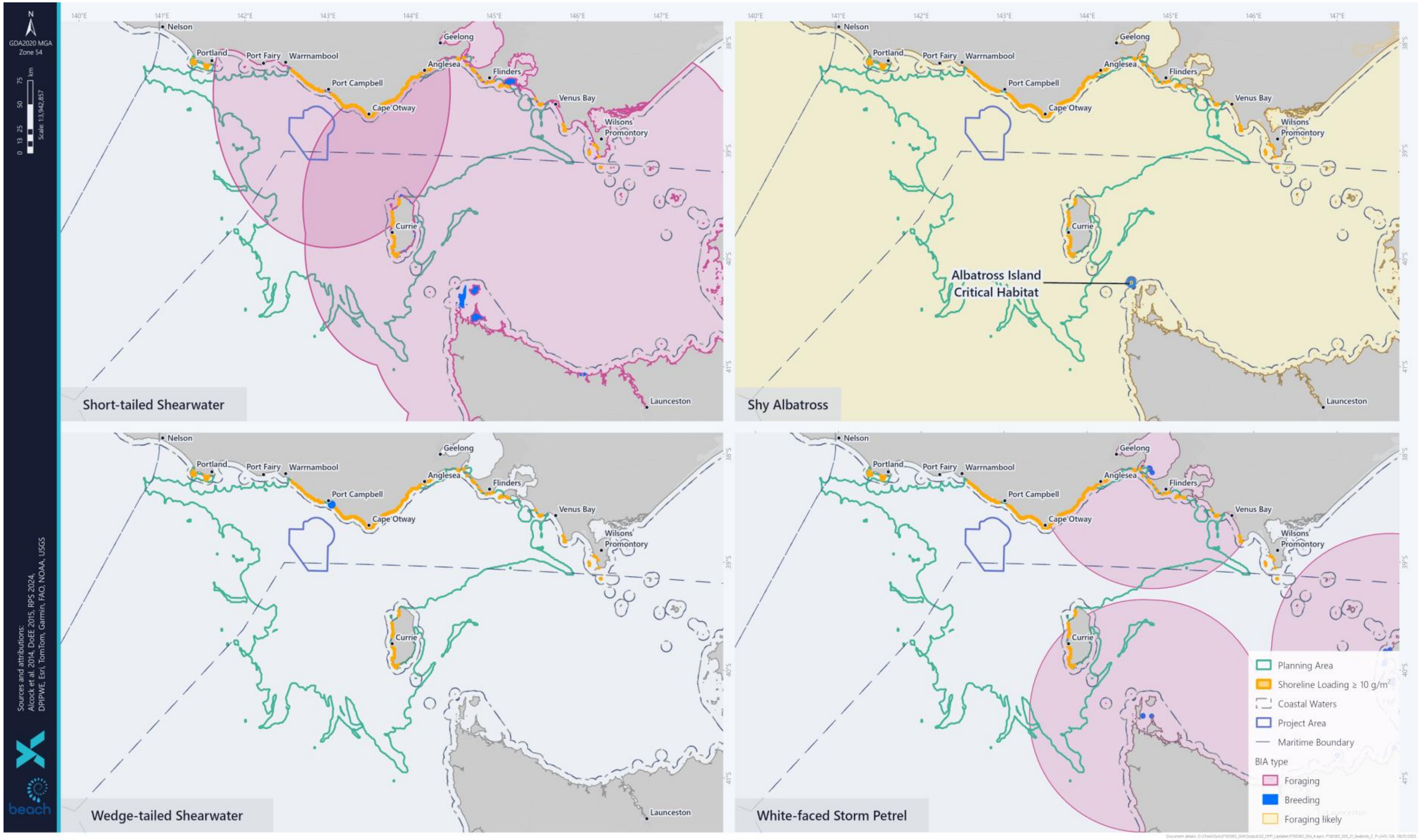


Figure 4-41: BIAs for Short-tailed Shearwater, Shy Albatross, Wedge-tailed Shearwater and White-faced Storm Petrel within the Project and Planning Areas

1. Albatross and Petrels

Albatross and giant-petrels are among the most dispersive and oceanic of all birds, spending more than 95% of their time foraging at sea in search of prey and usually only returning to land (remote islands) to breed (CoA 2022). Only seven species of Albatross and the Southern and Northern Giant Petrel are known to breed within Australia, which are protected under The National Recovery Plan for Albatross and Petrels (CoA 2022). Breeding within Australian territory occurs on the isolated islands of Antarctica (Giganteus Island, Hawker Island and Frazier islands) and the Southern Ocean (Heard Island, McDonald Island, Macquarie Island, Bishop and Clerk Islands), as well as islands off the south coast of Tasmania and Albatross Island off the north-west coast of Tasmania in Bass Strait (CoA 2022). There are no islands with colonies of threatened marine seabirds within the Project Area. Albatross Island, defined as habitat critical to the survival of the Shy Albatross (*Thallassarche cauta*), supports a breeding population of approximately 5,000 pairs and is 184 km south-east of the Project Area outside of the Planning Area. No habitats critical to the survival of threatened albatross or petrel species occur within the Project Area or Planning Area, this includes known nesting or migrating sites.

A critical life phase for birds is termed “fledging”. Fledging occurs when juvenile birds begin taking their first flights. Unlike albatross species which forage most actively during daylight and are less active at night because their ability to see and capture prey from the air is reduced (Phalan et al. 2007), many petrels are known to be nocturnal at their breeding places, increasing the species susceptibility to light emissions, particularly during fledging (Chevillion et al. 2022). Survival rates during the first few weeks as a fledging are the lowest as there is no parental care and young petrels will need to learn how to fly, forage, and maintain plumage alone (Menkhorst 2010). Fledging typically occurs within the first two hours after sunset during the fledging period (Chevillion et al. 2022). Therefore this biologically sensitive period can be impacted by light at night and result in groundings or fallout events, sometimes leading to mortality (Atchoi et al. 2024). Impacts to fledglings from light emissions are assessed in Section 6.3.3.2.

Albatross and Giant Petrel species exhibit a broad range of diets and foraging behaviours; hence their at-sea distributions are diverse. Combined with their ability to cover vast oceanic distances, all waters within Australian jurisdiction can be considered foraging habitat, however the most critical foraging habitat is those waters south of 25° where most species spend most of their foraging time (CoA 2022). Therefore, albatross and petrel species are likely to fly through and forage sporadically within the Project Area and Planning Area year-round.

The Antipodean Albatross, Black-browed Albatross, Campbell Albatross, Wandering Albatross, Buller’s Albatross, Indian yellow-nosed Albatross and Shy Albatross have BIAs for foraging that overlap the Project Area and Planning Area (Figure 4-39; Figure 4-40; Figure 4-41).

Both the Common Diving-petrel and the White-faced Storm Petrel are not listed as threatened species under the EPBC Act, and have large populations within Australia, accounting for 5% and 25% respectively of the global population (CoA 2015). The Common Diving-petrel breeds on islands off south-east Australia and Tasmania; there are 30 sites with significant breeding colonies (defined as more than 1,000 breeding pairs) known in Tasmania, and 12 sites in Victoria (including Seal Island, Wilson’s Promontory and Lady Julia Percy Island) (DCCEEW 2023a). Common diving-petrels are thought to be fairly sedentary, remaining more or less in the area of their breeding colony year-round, however, there are instances where individuals have been recorded venturing into the open ocean to forage outside of the breeding season and may migrate to more tropical climates (Brooke 2004). Within the Bass Strait the common diving-petrels has shown high foraging efforts compared to other populations (with foraging trips averaging 71 ± 3 km). This is believed to potentially be due to the sparse distribution of prey such as krill (Formant et al. 2021). There are 15 sites with significant breeding colonies for the White-faced Storm Petrel in Tasmania and 3 sites within Victoria (CoA 2015). The Project Area and Planning Area overlap a foraging BIA for the Common Diving-petrel which is expected to be utilised year-round by the species (Figure 4-40). While the closest breeding BIA for the Common Diving-petrel is located 70 km from the Project Area, within the Planning Area (Table 4-19).

Southern Royal Albatross forage from 36° to 63°. They range over the waters off southern Australia at all times of the year but especially from July to October (CoA 2022). The Northern Royal Albatross is regularly recorded throughout the year around Tasmania and South Australia at the continental shelf edge and feeds frequently in these waters. Despite breeding colonies in New Zealand, the White Capped and the Chatham Albatross are common off the coast of south-east Australia throughout the year (CoA 2022). During the non-breeding season, the Salvin's Albatross occur over continental shelves around continents with a small number of non-breeding adults flying regularly across the Tasman Sea to south-east Australian waters (CoA 2022). Sooty Albatrosses although rare are likely regular migrants to Australian waters mostly in the autumn to winter months and have been observed foraging in southern Australia (Thiele 1977; Pizzey and Knight 1999). The Pacific Albatross (equivalent to the Northern Buller's Albatross) is a non-breeding visitor to Australian waters mostly limited to the Tasman Sea and Pacific Ocean, occurring over inshore, offshore, and pelagic waters and off the east-coast of Tasmania (CoA 2022). Gibson's Albatross has breeding colonies in New Zealand but has been known to forage in the Tasman Sea and South Pacific Ocean with individuals occurring offshore from Coffs Harbour in the north to Wilson's Promontory in the south (CoA 2022; Marchant and Higgins 1990). Therefore, it is likely that these species along with the Tasmanian Shy Albatross will be present throughout the year and forage within the Project Area and Planning Area.

The White-bellied Storm Petrel breed on small offshore islets and rocks in Lord Howe Island and has been recorded over near-shore waters off Tasmania (Baker et al. 2002). The Great-winged Petrel breeds in the Southern Hemisphere between 30° and 50° south, outside of the breeding season they are widely dispersed.

2. Terns and Shearwaters

Four species of shearwater (flesh-footed shearwater (*Ardenna carneipes*), short-tailed shearwater (*Ardenna tenuirostris*), sooty shearwater (*Ardenna grisea*), wedge-tailed shearwater (*Ardenna pacifica*)) may occur within the Planning Area. All of the shearwater species listed are managed under the Wildlife Conservation Plan for Seabirds (CoA 2020a). There are a range of anthropogenic threats that affect the shearwater family which may vary based on species, stocks and life history stage.

Like petrels, shearwaters are also considered to be primarily nocturnal at their breeding places making them susceptible to light emissions when they commute from breeding colonies to forage out at sea (Chevillion et al. 2022). Therefore, like petrels, the fledging phase, a biologically sensitive period, can be impacted by light at night and result in groundings or fallout events, sometimes leading to mortality (Atchoi et al. 2024). The fledging season may vary between species; however it is known to occur over a short period of time with the first flight typically occurring within the first two hours after sunset (Chevillion et al. 2022). The wedge-tailed shearwater, for example, has a very synchronized breeding regime with all fledglings leaving nests within a very short period of time (less than one lunar cycle) (Chevillion et al. 2022). While the fledging period of the short-tailed shearwater is believed to occur between the third week of April and the first week of May each year (Skira 1991; Rodriguez et al. 2014; Price 2022). The short-tailed shearwater fledglings in particular, appear to have an increased sensitivity to artificial light although fewer than 1% of fledglings produced annually are thought to be affected by mortality (DCCEEW 2020). Impacts to fledglings from light emissions are assessed in Section 6.3.3.2.

Flesh-footed shearwater may forage in the Project Area and Planning Area. The species is a trans-equatorial migrant widely distributed across the south-western Pacific during breeding season (early September to early May) and is a common visitor to the waters of the continental shelf/slope and occasionally inshore waters (DoE 2023b). The species breeds in burrows on sloping ground in coastal forest, scrubland, or grassland. Thirty-nine of the 41 islands on which the species breeds lie off the coast of southern Western Australia, with the remaining two islands being Smith Island (SA) and Lord Howe Island (DoE 2023b), all of which are located outside of the Project Area and Planning Area. The flesh-footed shearwater feeds on small fish, cephalopod molluscs (squid, cuttlefish, nautilus and argonauts), crustaceans (barnacles and shrimp), other soft-bodied invertebrates (such as *Velella*) and offal (DoE 2023b). The species forages almost entirely at sea and very rarely on land. It obtains most of its food by surface plunging or pursuit plunging. It also regularly forages by settling on the surface of the ocean and snatching prey from the surface ('surface seizing'), momentarily submerging onto prey beneath the surface ('surface diving') or diving and pursuing prey beneath the surface by swimming ('pursuit diving'). Birds have also been observed flying low over the ocean and pattering the water with their feet while picking food items from the surface (termed 'pattering') (DoE 2023b). This species is likely to visit and forage within the Project and Planning Areas outside of the breeding season.

The Short-tailed Shearwater has a foraging BIA (September to May) within the Project Area and breeding BIAs that overlap the Planning Area (Figure 4-41). The short-tailed shearwater migrates to the Northern hemisphere for the austral winter and is generally only present in Australian waters from September to May. Huge numbers arrive along the south and south-east coast of Australia from wintering grounds in the North Pacific and are observed in large numbers foraging the surrounding coastal and offshore waters (Marchant and Higgins 1990). They are common in the South-east Marine Region and largely found on numerous islands off Victoria and Tasmania during the breeding season (Baker and Hamilton 2013, Skira et al. 1996). Though not designated as BIAs, breeding has been recorded at additional locations such as Middle Island and Griffiths Island which are located over 50 km from the Project Area within the Planning Area (Baker and Hamilton 2013). During breeding the short-tailed shearwater conducts a bimodal feeding strategy, alternating short foraging trips to local waters with long foraging trips (up to 17 days) to the Polar Frontal Zone (Berlincourt and Arnould. 2015). Short trips allow greater chick provisioning at the sacrifice of body condition, which is then recovered in richer subantarctic waters. Diet includes fish (particularly myctophids), crustaceans and squid (Weimerskirch and Cherel 1998). Short-tailed shearwaters have been identified as a conservation value in the temperate east and south-west marine areas. Therefore, considering the presence of breeding islands within proximity of the Project the short-tailed shearwater is likely to be present in the Project Area and Planning Area between September and May each year.

The Sooty Shearwater may occur within the Project Area. The Sooty shearwater is migratory and breeds in summer around southern Australia in New South Wales and Tasmania. The Australian breeding population is estimated to be 6,500 pairs (DCCEEW 2023d). In Australian territory, the sooty shearwater breeds on offshore islands off New South Wales and Tasmania. Breeding populations within Tasmania are known on Tasman Island, Hippolyte Rock, Maatsuyker Island and Courts Island, all of which occur outside of the Project Area and Planning Area. The species forages mainly in subtropical (open ocean), sub-Antarctic and Antarctic waters. No BIAs have been identified to overlap with the Project Area or Planning Area. It has been recorded in areas with sea surface temperature of 8.7-22.0 ^{0}C (Reid et al. 2002). The species takes most food by pursuit-plunging and other methods and feeding concentrations are often observed over thermal fronts at edges of upwellings at boundaries of cool and warm water-masses. Although this species may occur and forage opportunistically within the Project and Planning Areas the absence of defined BIAs and the distance to breeding colonies reduce the chance of interaction.

The Wedge-tailed Shearwater has a breeding BIA 18 km north of the Project Area (Figure 4-41). A review of the DCCEEW Species Profile and Threats Database (SPRAT), Atlas of Living Australia and South-east Marine Region Profile did not provide any information on the Victorian Muttonbird Island Wedge-tailed Shearwater colony. The DCCEEW SPRAT profile does not show any locations for the Wedge-tailed Shearwater in Victoria and Beaver (2022) details Montague Island in NSW was the southernmost known colony, however, in 2017 breeding individuals of Wedge-tail Shearwaters were discovered a couple of hundred kilometres further south on Gabo Island Lighthouse Reserve, Victoria near the NSW border. Movement patterns of the wedge-tailed shearwater are poorly known but populations at the northern and southern extremities of the known range are migratory, departing nests in early April to early May and spending the non-breeding season in the tropics (DoE 2025). The species have been recorded to predominantly forage during the day and form large aggregations referred to as "rafts" just offshore from their breeding colony just on dusk and enter and leave the colony at night to avoid predators (Warham 1996). Although this species may occur and forage opportunistically within the Project and Planning Areas during the breeding season (November to April) the absence of defined BIAs and the distance to known breeding colonies reduce the chance of interaction.

The Australian Fairy Tern occurs along the coastline of Victoria, South Australia, Western Australia and Tasmania. Breeding habitat for the Caspian, Little Tern and Australian Fairy Tern vary from terrestrial wetlands, rocky islets or banks, low islands, beaches, cays and spits. Nests are present in the open sparse vegetation such as tussocks and other sand binding plants to sometimes near bushes and driftwood. Their diet also consists primarily of fish along with aquatic invertebrates, insects, and eggs and the young of other birds (Higgins and Davis 1996; Taylor and Roe 2004; Van de Kam et al. 2004).

The Caspian Tern is the largest tern in Australia, they inhabit both coastal and inland regions and breeding occurs widespread throughout Australia. In Victoria breeding sites are mostly along coastal regions with three significant regular breeding colonies at Corner Inlet, Mud Island and Mallacoota (Minton and Deleyev 2001). Breeding occurs between September to December are resident and occur throughout the year at breeding sites (Minton and Deleyev 2001).

The Little Tern species is also widespread in Australia with three major sub populations, the northern population that breeds from Broome to Northern Territory. The eastern subpopulation breeds on the eastern and south-eastern coast extending as far as western Victoria and the south-eastern parts of South Australia, to the northern and eastern coast of Tasmania. The third population migrate from breeding grounds in Asia to spend the spring and summer in Australia. The Little Tern has a naturally high rate of breeding failure due to the ground nets being exposed to adverse weather conditions, and native predators.

The Sooty Tern has a much larger foraging range, encompassing open shelf waters, shelf edge and deep water (DSEWPaC 2012c). Main breeding colonies occur off Australia's west and east coast. Like the Crested Tern where distribution is widespread in Australia, but breeding occurs off islands in large colonies off Queensland and NSW (Higgins and Davis 1996). Foraging diet consists of pelagic fish, cephalopods, crustaceans and insects. Sooty Terns were observed amongst mixed flocks of seabirds (such as Albatross and Shearwaters) during drilling activities within the Project Area in April 2021.

3. Osprey and white bellied sea eagle

No BIAs were identified for Osprey or white bellied sea eagles (*Haliaeetus leucogaster*) within the Project or Planning Areas. The White-bellied Sea Eagle is a large raptor generally seen singly or in pairs, distributed along the coastline of mainland Australia and Tasmania (Threatened Species Section 2023). Breeding records are patchily distributed mainly along the coastline especially the eastern coast extending from Victoria and Tasmania to Queensland. There are recorded breeding sites as far inland as the Murray, Murrumbidgee and Lachlan River in norther Victoria (Marchant and Higgins 1993). There is no quantitative data available on area of occupancy, but it is believed that there could be a decline due to increased development of coastal areas. Estimations of 500 or more pairs in Australia account for 10-20% of the global population (Marchant and Higgins 1993). Recorded decline in numbers have been recorded across Australia, with a decline in Victoria's Gippsland Lakes, Phillip Island and the Sunraysia district (Bilney and Emison 1983; Quinn 1969). White-bellied sea eagle feed on a variety of fish, birds, reptiles, mammals and crustaceans. They hunt from a perch and while in flight (circling slowly). Described as a breeding resident throughout much of its range in Australia, breeding is generally sedentary, and the home range can be up to 100 km^2 (Marchant and Higgins 1993). White-bellied sea eagle are sensitive to disturbance particularly in the early stages of nesting, human activity may cause nests and young to be abandoned (Debus et al. 2014).

The Osprey (*Pandion haliaetus)* is a medium sized raptor extending around the northern coast of Australia from Albany, Western Australia to Lake Macquarie in NSW with an isolated breeding population on the coast of South Australia. Listed as migratory under the EPBC Act they are resident around breeding territories. They are found along coastal habitats and terrestrial wetlands and require open fresh or saltwater for foraging (Marchant and Higgins 1993). Osprey feed mainly on fish, occasionally molluscs, crustaceans, mammals, birds, reptiles, and insects. Generally, they search or prey by soaring, circling, and quartering above water and dive directly into the water at their target prey (Clancy 2005). This species is likely to be an uncommon visitor to the Project and Planning Areas.

4. Orange-bellied Parrot

The Orange-bellied parrot (*Neophema chrysogaster*) (listed as critically endangered under the EPBC Act) breeds in south-west Tasmania during summer (November to March), migrates north across Bass Strait in autumn and spends winters (April to October) on the coast of south-east mainland Australia (DELWP 2016). The migration route includes the west coast of Tasmania and King Island (Figure 4-42). Birds depart the mainland for Tasmania from September to November (Green 1969). The southward migration is rapid (Stephenson 1991), so there are few migration records. The northward migration across western Bass Strait is more prolonged (Higgins and Davies 1996); but typically occurs late-February to early-April (Australian Museum 2020). Migration activities are known to occur within the Planning Area based on PMST Report and reputable peer-review literature (Appendix B). The Orange-bellied parrot is protected under the National Recovery Plan for the Orange-bellied parrot (DELWP 2016). The parrot's breeding habitat is restricted to south-west Tasmania, where breeding occurs from November to mid-January mainly within 30 km of the coast.

The species forage on the ground or in low vegetation (Loyn et al. 1986). During winter, on mainland Australia, Orange-bellied Parrots are found mostly within 3 km of the coast. In Victoria, they mostly occur in sheltered coastal habitats, such as bays, lagoons and estuaries. They are also found in low samphire herbland dominated by beaded glasswort (*Sarcocornia quinqueflora*), Sea Heath (*Frankenia pauciflora*) or Sea-Blite (*Suaeda australis*), and in taller shrubland dominated by Shrubby Glasswort (*Sclerostegia arbuscula*). There are also non-breeding Orange-bellied Parrots on mainland Australia, between Goolwa in Australia and Corner Inlet in Victoria. The west coast of King Island and coastal Victoria has been identified as resting and feeding areas, however, parrots rarely land or forage out at sea.

The Orange bellied Parrot may overfly the Project Area on its migrations to and from breeding grounds between March and April and October and November each year. The Project Area overlaps a small portion of the probable migration route and where the species is likely to occur. The Planning Area overlaps the migration route in the Bass Strait as well as habitat on the coast of King Island (Figure 4-42).

5. Little Penguin

The little penguin is recognised as a conservation value in the South-east Marine Region (CoA 2015). It is the smallest species of penguin in the world and are permanent residents on a number of inshore and offshore islands. The Australian population is large but not thought to exceed one million birds (CoA 2015). Despite the colony of little penguins at Manly, Sydney Harbour, being protected as an endangered population, the Australian population is considered stable (Birdlife Australia 2025). Bass Strait has the largest proportion (approximately 60%) of the known breeding colonies in Australia. Individuals exhibit strong site fidelity, returning to the same breeding colony each year to breed in the winter and spring months (Gillanders et al. 2013). Breeding typically occurs from September to February. The diet of a little penguin includes small school fish, squid and krill. Prey is typically caught with rapid jabs of the beak and swallowed whole. Little penguins are also an important component of the Australian and New Zealand fur-seals' diet (Parliament of South Australia 2011). The species is known to exhibit a wide foraging range, with individuals able to spend weeks away at sea foraging (McCutcheon et al. 2011). The closest foraging BIA to the Project area is surrounding Christmas Island located off of nearby King Island, approximately 74 km from the Project Area (see Figure 4-40).

The closest breeding BIA to the Project Area correlates with the foraging BIA at Christmas Island, approximately 83 km from the Project Area (see Figure 4-40). However, additional breeding sites which are not designated BIAs have been recorded at Middle Island, the Twelve Apostles and Port Campbell (Norman et al. 2017). Therefore, considering the occurrence of a number of breeding sites within the region it is considered that the little penguin is likely to transit and forage within the Project and Planning Areas.

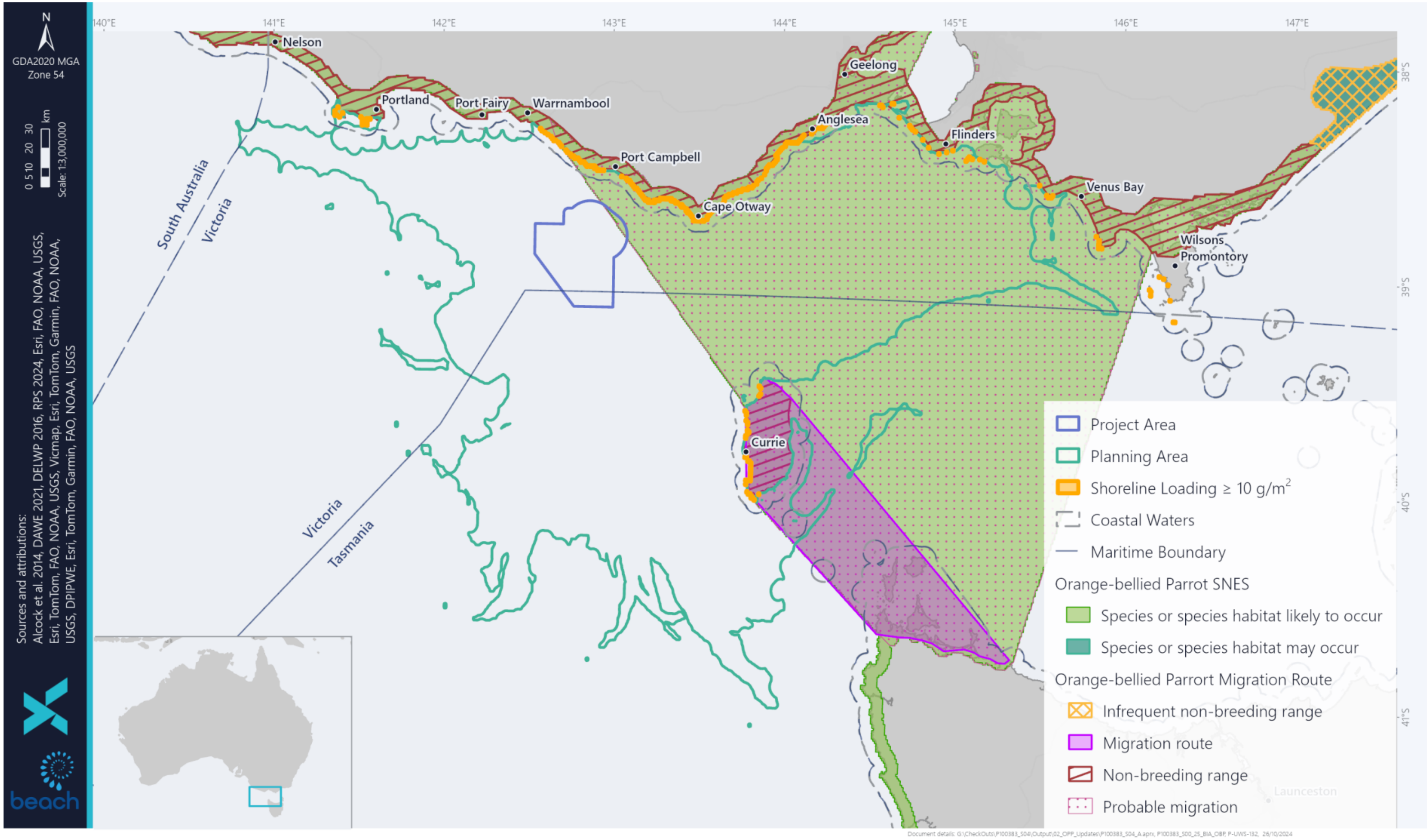


Figure 4-42: Distribution of the Orange-bellied Parrot within the Project and Planning Areas

6. Other Shorebirds

A number of species listed in Table 4-22 use coastal shoreline habitats such as Australasian Gannet, Fairy Prion, Red Knot, Pectoral Sandpiper, Fork-tailed Swift, Sharp-tailed Sandpiper, Curlew Sandpiper, Eastern Curlew, Little Curlew, Yellow Wagtail, and species of plover. These species are commonly found on coastal shores including beaches and rocky shores and either feed at low tide on worms, crustaceans and molluscs or fish species or feed on aquatic biota (Parks Victoria 2016). These species are unlikely to be present in the Project Area due to the distance offshore but are likely to be present in the Planning Area.

Many sandpipers including the Broad-billed, Common, Marsh and Terek are widespread through Australia's coastline inhabiting saltwater and freshwater ecosystems. They migrate from the Northern Hemisphere in non-breeding months, favouring estuaries, saltmarshes, intertidal mudflats, swamps, and lagoons and foraging on worms, molluscs, crustaceans, insects, seeds and occasionally rootlets and other vegetation (Marchant and Higgins 1993; Higgins and Davies 1996).

The Australian Painted Snipe is a stocky wading bird most commonly in eastern Australian wetlands. Feeding on vegetation, insects, worms, molluscs, crustaceans, and other invertebrates. Latham's, Swinhoe's and Pin-tailed Snipe is a non-breeding visitor to Australia occurring at the edges of wetlands, shallow swamps, ponds, and lakes (Marchant and Higgins 1993). The Grey-tailed Tattler migrate from the Northern hemisphere and inhabit rocky coasts with reefs and platforms, offshore islands, and intertidal mudflats. Foraging on polychaete worms, molluscs and crustaceans and roosting on branches of mangroves and rocks and boulders close to water. The Bar-tailed Godwit and Black-tailed Godwit are large waders, migrating from the Northern hemisphere in the noon-breeding months to coastal habitat in Australia. The large waders are commonly found in sheltered bays, estuaries, intertidal mudflats, and occasionally on rocky coasts (Higgins and Davies 1996).

Hooded and Eastern Hooded Plovers are small beach nesting birds. They predominantly occur on wide beaches and are easily disturbed by human activity. The Lesser Sand and Greater Sand Plover are migratory and inhabits intertidal sand and mudflats, forage on invertebrates and breed in areas characterised by high elevation. Breeding occurs outside Australia, but roosting occurs near foraging areas on beaches, banks, spits and banks (Pegler 1983). The Pacific Golden and Grey Plover are widespread in coastal regions foraging on sandy beaches, spits, rocky points, exposed reef and occasional low saltmarsh and mangroves. Roosting usually occurs near foraging areas while breeding occurs in dry tundra areas away from the coast (Bransbury 1985; Pegler 1983; Marchant and Higgins 1993). The Double-banded Plover is found in both coastal and inland areas with greatest numbers in Tasmania and Victoria. It breeds only in New Zealand and migrates to Australia.

Other waders including Common Noddy, Ruddy Turnstone, Sanderling, Red-necked Stint, Whimbrel, Common Greenshank, Pied Stilt, White-throated Needletail, Red-necked Phalarope, Ruff, Red-necked Avocet, Rufous Fantail and Black-faced Cormorant are common along Australia's coastline. Many are migratory travelling from the Northern Hemisphere in non-breeding months. Most inhabit intertidal mudflats, rocky islets, sand beaches, mangroves, rocky coastline, and coral reefs. Roosting occurs in similar habitats and species are found feeding on fish, crustaceans, aquatic insects, as well as plants and seeds (Higgins and Davies 1996). These species are unlikely to be present in the Project Area due to the distance offshore. The Plains Wanderer is a unique bird that lives predominantly in grasslands in Victoria, South Australia, New South Wales, and Queensland. The Swift Parrot is a small parrot breeding in colonies in Tasmania. The entire population migrates to the mainland during winter. The Great Knot is listed as vulnerable and migratory, arriving in large numbers in Australia occurring in sheltered coastal habitats with large intertidal mudflats. Typically, they roost in large open areas at the water's edge to in shallow water close to foraging grounds (Higgins and Davies 1996). These species are critically endangered and may occur within the Planning Area.

4.4.9.5 Marine Reptiles

The PMST reports identified three marine turtle species with potential to occur in the Project Area and/or Planning Area (Table 4-23). All three species of marine turtles are protected by the Recovery Plan for Marine Turtles in Australia (CoA 2017a). Foraging, feeding or related behaviours are known to occur within the Planning Area for two of the identified marine turtle species. No BIAs or habitat critical to the survival of marine turtles overlap the Project Area or Planning Area.

1. Green turtle

Green Turtles (*Chelonia mydas*) nest, forage and migrate across tropical northern Australia. They usually occur between the 20°C isotherms, although individuals can stray into temperate waters as vagrant visitors. Green turtles spend their first 5 to 10 years drifting on ocean currents. During this pelagic (ocean-going) phase, they are often found in association with drift lines and floating rafts of Sargassum. Green Turtles are predominantly found in Australian waters off the Northern Territory, Queensland, and Western Australian coastlines, with limited numbers in New South Wales, Victoria, and South Australia. There are no known nesting or foraging grounds for Green Turtles offshore Victoria; they occur only rarely in these waters (DoE 2023m) therefore it is expected they would only be occasional visitors in the Project Area and Planning Area.

2. Leatherback turtle

The Leatherback Turtle (*Dermochelys coriacea*) is a pelagic feeder found in tropical, sub-tropical and temperate waters throughout the world. Unlike other marine turtles, the leatherback turtle utilises cold water foraging areas, with the species most commonly reported foraging in coastal waters between southern Queensland and central NSW, south-east Australia (Tasmania, Victoria, and eastern SA), and southern WA (CoA 2017a). This species is an occasional visitor to the Otway shelf and has been sighted on a number of occasions during aerial surveys undertaken by the Blue Whale Study Group (Gill 2020), particularly to the south-west of Cape Otway. It is mostly a pelagic species, and away from its feeding grounds is rarely found inshore (CoA 2017a). Adults feed mainly on soft-bodied organisms such as jellyfish, which occur in concentrations at the surface in areas of convergence and upwelling (Bone 1998; Cogger 1992). Bass Strait is one of three of the largest concentrations of feeding Leatherback Turtles (DoE 2023n).

No major nesting has been recorded in Australia, with isolated nesting recorded in Queensland and the Northern Territory. The Leatherback turtle is expected to be only an occasional visitor in the Project Area and Planning Area.

3. Loggerhead turtle

The Loggerhead Turtle (*Caretta caretta*) is globally distributed in tropical, sub-tropical and temperate waters. The loggerhead is a carnivorous turtle, feeding primarily on benthic invertebrates in habitat ranging from nearshore to 55 m depth (Plotkin et al. 1993).

The main Australian breeding areas for Loggerhead Turtles are generally confined to southern Queensland and Western Australia (Cogger et al. 1993). Loggerhead Turtles will migrate over distances in excess of 1,000 km but show a strong fidelity to their feeding and breeding areas (Limpus 2008).

Loggerhead Turtles forage in all coastal states and the Northern Territory, but are uncommon in South Australia, Victoria, and Tasmania (CoA 2017a). Due to water depths, it is unlikely Loggerhead Turtles would be present in the Project Area but may be occasional visitors to the Planning Area.

Table 4-23: Listed Turtle Species or Species Habitat identified in the Project and/or Planning Areas

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Areas	Present in Planning Area	Present in Project Area
Green Turtle	*Chelonia mydas*	Vulnerable	Migratory	Migratory Marine Species	Listed		Species or species habitat may occur within area	Species or species habitat may occur within area
Leatherback Turtle, Leathery Turtle	*Dermochelys coriacea*	Endangered	Migratory	Migratory Marine Species	Listed		Foraging, feeding or related behaviour known to occur within area	Species or species habitat likely to occur within area
		Approved Conservation Advice for *Dermochelys coriacea* (leatherback turtle) (DEWHA 2008). Threats identified relevant to the Project are as per the recovery plan.						
Loggerhead Turtle	*Caretta caretta*	Endangered	Migratory	Migratory Marine Species	Listed		Foraging, feeding or related behaviour known to occur within area	Species or species habitat likely to occur within area

4.4.9.6 Marine Mammals – Pinnipeds

The PMST Report and reputable peer-reviewed literature identified three pinniped species with potential to occur in the Planning Area (Table 4-24). Two of these were also identified within the Project Area. The Project and Planning Areas do not overlap any BIAs for pinnipeds. Breeding and haul-out sites for Australian fur seals and New Zealand fur seals are displayed in Figure 4-43.

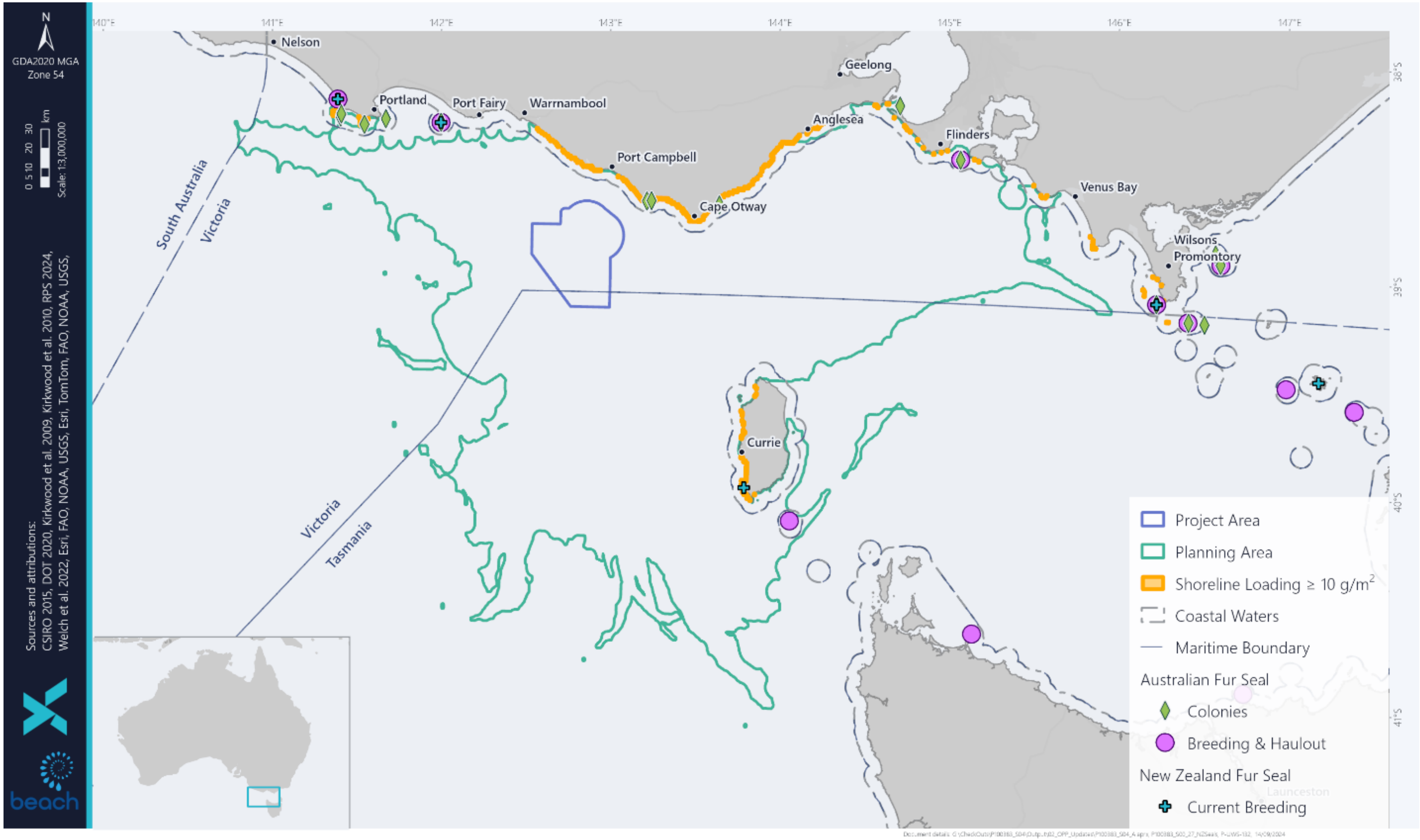


Figure 4-43: Australian Fur-seal and New Zealand Fur-seal Breeding and Haul-out Sites within the Planning Area (Kirkwood et al. 2010)

Table 4-24: Listed Pinniped Species or Species Habitat identified in the Project and/or Planning Areas

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Areas	Presence in Planning Area	Presence in Project Area
Australian Fur-seal, Australo-African Fur-seal	*Arctocephalus pusillus*				Listed		Breeding known to occur within area	Species or species habitat may occur within area
Australian Sea-lion, Australian Sea Lion	*Neophoca cinerea*	Endangered			Listed		Species or species habitat may occur within area	–
		Conservation advice *Neophoca cinerea* Australian sea lion (TSSC 2020x). Threats relevant to the Project are: • Habitat degradation and pollution – Oil spills • Require all vessels to have oil spill mitigation measures in place, and implement jurisdictional oil spill response strategies as required • Human disturbance – Noise • Monitor and mitigate impacts (including cumulative impacts) of human interactions on Australian Sea Lion colonies Recovery Plan for the Australian sea-lion (*Neophoca cinerea*) (DSEWPaC, 2013d). Threats relevant to the Project are: • Habitat degradation - No explicit relevant management actions • Vessel strike - Collect data on direct killings and confirmed vessel strikes • Pollution (oil spills, toxins) - implement jurisdictional oil spill response strategies as required Climate change - No explicit relevant management actions						
Long-nosed Fur-seal, New Zealand Fur-seal	*Arctocephalus forsteri*				Listed		Species or species habitat may occur within area	Species or species habitat may occur within area

1. Australian Fur-seal

Australian Fur-seals (*A. pusillus*) breed on islands of the Bass Strait but range throughout waters off the coasts of South Australia, Tasmania, Victoria, and NSW. Numbers of this species are believed to be increasing as the population recovers from historic hunting (Hofmeyr et al. 2008). The species is endemic to south-eastern Australian waters.

Australian Fur-seals are present in the region all year, with breeding taking place during November and December. In Victorian State waters they breed on offshore islands, including Lady Julia Percy Island, Seal Rocks in Westernport Bay, Kanowna, and Rag Islands off the coast of Wilson's Promontory and The Skerries off Wingan Inlet in Gippsland. Within the Planning Area, there are breeding colonies at Cape Bridgewater, Cape Volney, Judgement Rocks, Kanowna Island, Lady Julia Percy Island, Rag Island, Reid Rocks, Seal Rocks and West Moncoeur Island (Figure 4-43). There are important breeding sites on Lady Julia Percy Island and Seal Rocks, with 25% of the population occurring at each of these islands. Their preferred breeding habitat is a rocky island with boulder or pebble beaches and gradually sloping rocky ledges.

Haul-out sites with occasional pup births are located at Cape Bridgewater, at Moonlight Head, on various small islands off Wilsons Promontory and Marengo Reef near Apollo Bay. Within the Planning Area, haul-out sites include Maatsuyker Island and Walker Island (Figure 4-43).

Research being undertaken at Lady Julia Percy Island indicates that adult females feed extensively in the waters between Portland and Cape Otway, out to the 200 m bathymetric contour. Seal numbers on the island reach a maximum during the breeding season in late October to late December. By early December, large numbers of lactating females are leaving for short feeding trips at sea and in late December there is an exodus of adult males. Thereafter, lactating females continue to alternate between feeding trips at sea and periods ashore to suckle their pups. Even after pups begin to venture to sea, the island remains a focus, and at any time during the year groups may be seen ashore resting (Robinson et al. 2008; Hume et al. 2004; Arnould and Kirkwood 2007).

During the summer months, Australian Fur-seals travel between northern Bass Strait islands and southern Tasmania waters following the Tasmanian east coast, however, lactating female fur-seals and some territorial males are restricted to foraging ranges within Bass Strait waters. Lactating female Australian Fur-seals forage primarily within the shallow continental shelf of Bass Strait and Otway on the benthos at depths of between 60 to 80 m and generally within 100 to 200 km of the breeding colony for up to five days at a time.

Male Australian Fur-seals are bound to colonies during the breeding season from late October to late December, and outside of this they time forage further afield (up to several hundred kilometres) and are away for long periods, even up to 9 days (Kirkwood et al. 2009; Hume et al. 2004).

Within the Planning Area, a breeding colony is located at Cape Bridgewater and haul out sites identified at Marengo Reefs and New Chinaman's Hat. Additional colonies were identified at Reid Rocks and Seal Rocks (Figure 4-43). As there are colonies, breeding and haul out sites within the Planning Area it is expected that Australian Fur-seals would be present in the Planning Area. During Beach's Otway drilling campaign in 2021, 394 Australian Fur-seal detections were made, spread across the year.

Australian Sea Lion

The Australian Sea Lion is the only endemic, and least abundant, pinniped that breeds in Australia (DoE 2013b). All current breeding populations are outside of the Planning Area and are located from the Abrolhos Islands (Western Australia) to the Pages Islands (South Australia). The Australian Sea Lion uses a variety of shoreline types but prefer the more sheltered side of islands and typically avoid rocky exposed coasts (Shaughnessy 1999). The nearest BIA is for male foraging off the South Australian coast, 100 km to the west of the Planning Area and over 250 km west of the Project Area.

The Australian Sea Lion is a specialised benthic forager, i.e. it feeds primarily on the sea floor (DSEWPaC 2013d). The Australian Sea Lion feeds on the continental shelf, most commonly in depths of 20–100 m, with adult males foraging further and into deeper waters (DSEWPaC 2013d). They typically feed on a range of prey including fish, cephalopods (squid, cuttlefish and octopus), sharks, rays, rock lobster and penguins (DSEWPaC 2013d) They typically forage up to 60 km from their colony but can travel up to 190 km when over shelf waters (Shaughnessy 1999).

2. New Zealand Fur-seal

New Zealand Fur-seal (*Arctocephalus forsteri*) are found in the coastal waters and offshore islands of South Australia, Western Australia, Victoria, NSW and New Zealand. Population studies for New Zealand Fur-seal in Australia carried out in 1990 estimated an increasing population of about 35,000. The species breeds in southern Australia at the Pages Islands and Kangaroo Island, which produces about 75% of the total pups in Australia. Small populations are established in Victorian coastal waters including at Cape Bridgewater near Portland, Lady Julia Percy Island near Port Fairy, Kanowna Island (near Wilsons Promontory) and The Skerries in eastern Victoria.

Figure 4-43 shows the current and historic distribution of New Zealand Fur-seal colonies (Kirkwood et al. 2009). These colonies are typically found in rocky habitat with jumbled boulders. Colonies are typically occupied year-round, with greater activity during breeding seasons. Pups are born from mid-November to January, with most pups born in December (Goldsworthy 2008). No known breeding sites or colonies for the New Zealand Fur-seal were identified within the Planning Area (Figure 4-43).

4.4.9.7 Marine Mammals - Cetaceans

The PMST Reports and reputable peer-reviewed literature identified several cetaceans with potential to occur in the Project and Planning Areas (Table 4-25). Threatened or migratory species that are likely or known to occur or have a BIA that overlaps the Project and/or Planning Areas are discussed in more detail in the following sections.

The Bass Strait and the Otway Basin are considered an important migratory path for Humpback, Blue, Southern Right, and to some extent the Fin and Sei Whales. The whales use the Otway region to migrate to and from the north-eastern Australian coast and the sub-Antarctic. Of environmental importance in the Otway Basin is the Bonney coast upwelling, the eastward flow of cool nutrient rich water across the continental shelf of the southern coast of Australia that promotes blooms of krill and attracts baleen whales during the summer months.

Table 4-25: Listed Cetacean Species or Species Habitat Identified in the Project and/or Planning Areas

Common Name	Scientific Name	Threatened Category	Migratory Status	Migratory Category	Marine Status	Biologically Important Areas	Presence in Planning Area	Presence in Project Area
Andrew's Beaked Whale	*Mesoplodon bowdoini*						Species or species habitat may occur within area	Species or species habitat may occur within area
Antarctic Minke Whale, Dark-shoulder Minke Whale	*Balaenoptera bonaerensis*		Migratory	Migratory Marine Species			Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Arnoux's Beaked Whale	*Berardius arnuxii*						Species or species habitat may occur within area	Species or species habitat may occur within area
Blainville's Beaked Whale, Dense-beaked Whale	*Mesoplodon densirostris*						Species or species habitat may occur within area	Species or species habitat may occur within area
Blue Whale	*Balaenoptera musculus*	Endangered	Migratory	Migratory Marine Species		Foraging, Distribution,	Foraging, feeding or related behaviour known to occur within area	Foraging, feeding or related behaviour known to occur within area
	Conservation Management Plan for the Blue Whale (CoA 2015b). The long-term recovery plan objective for Blue Whales is to minimise anthropogenic threats to allow for their conservation status to improve. Threats relevant to the Project are: • Noise interference -Evaluate risk of noise impacts and, if required, appropriate mitigation measures are implemented • Vessel disturbance - Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.							
Bottlenose Dolphin	*Tursiops truncatus* s. str.						Species or species habitat may occur within area	Species or species habitat may occur within area

Common Dolphin, Short-beaked Common Dolphin	*Delphinus delphis*				Species or species habitat may occur within area	Species or species habitat may occur within area
Cuvier's Beaked Whale, Goose-beaked Whale	*Ziphius cavirostris*				Species or species habitat may occur within area	Species or species habitat may occur within area
Dusky Dolphin	*Lagenorhynchus obscurus*		Migratory	Migratory Marine Species	Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Dwarf Sperm Whale	*Kogia sima*				Species or species habitat may occur within area	Species or species habitat may occur within area
False Killer Whale	*Pseudorca crassidens*				Species or species habitat likely occur within area	Species or species habitat likely to occur within area
Fin Whale	*Balaenoptera physalus*	Vulnerable	Migratory	Migratory Marine Species	Foraging, feeding or related behaviour known to occur within area	Foraging, feeding or related behaviour likely to occur within area
		Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale) (TSSC 2015d). Threats relevant to the Project are: • Noise interference - Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. • Vessel disturbance - Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.				
Gray's Beaked Whale, Scamperdown Whale	*Mesoplodon grayi*				Species or species habitat may occur within area	_
Hector's Beaked Whale	*Mesoplodon hectori*				Species or species habitat may occur within area	Species or species habitat may occur within area
Humpback Whale	*Megaptera novaeangliae*		Migratory	Migratory Marine Species	Species or species habitat known to occur within area	Species or species habitat likely to occur within area

		Approved Listing Advice for *Megaptera novaeangliae* (Humpback Whale) (TSSC 2022). Listing advice details that the humpback is no longer listed as vulnerable and has been removed from the threatened species list. It will remain a matter of national environmental significance under the EPBC Act as a listed Migratory Species. Threats identified relevant to the Project: • Marine debris • Noise interference • Pollution • Vessel disturbance and strike • No explicit relevant management actions.				
Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	*Tursiops aduncus*				Species or species habitat likely to_ occur within area	
Killer Whale, Orca	*Orcinus orca*		Migratory	Migratory Marine Species	Species or species habitat likely to occur within area	Species or species habitat likely to occur within area
Long-finned Pilot Whale	*Globicephala melas*				Species or species habitat may occur within area	Species or species habitat may occur within area
Minke Whale	*Balaenoptera acutorostrata*				Species or species habitat may occur within area	Species or species habitat may occur within area
Pygmy Right Whale	*Caperea marginata*		Migratory	Migratory Marine Species	Foraging, feeding or related behaviour likely to occur within area	Foraging, feeding or related behaviour may occur within area
Pygmy Sperm Whale	*Kogia breviceps*				Species or species habitat may occur within area	Species or species habitat may occur within area
Risso's Dolphin, Grampus	*Grampus griseus*				Species or species habitat may occur within area	Species or species habitat may occur within area

Sei Whale	*Balaenoptera borealis*	Vulnerable	Migratory	Migratory Marine Species		Foraging, feeding or related behaviour known to occur within area	Foraging, feeding or related behaviour likely to occur within area
		Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC 2015e). Threats identified relevant to the Project: • Noise interference -Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. • Vessel disturbance -Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.					
Shepherd's Beaked Whale, Tasman Beaked Whale	*Tasmacetus shepherdi*					Species or species habitat may occur within area	_
Short-finned Pilot Whale	*Globicephala macrorhynchus*					Species or species habitat may occur within area	Species or species habitat may occur within area
Southern Bottlenose Whale	*Hyperoodon planifrons*					Species or species habitat may occur within area	_
Southern Right Whale	*Eubalaena australis*	Endangered	Migratory (as *Balaena glacialis australis*)	Migratory Marine Species	Migration Reproduction	Breeding known to occur within area	Species or species habitat known to occur within area
		National Recovery Plan for the Southern Right Whale *Eubalaena australis* (DCCEEW 2024o). Threats identified relevant to the Project: • Habitat degradation from coastal and offshore development • Anthropogenic underwater noise • Vessel collision • Actions identified relevant to the Project: • Address habitat degradation impacts from coastal and offshore marine infrastructure developments • Assess, manage and mitigate impacts from anthropogenic noise • Manage, minimise and mitigate the threat of vessel strike					

Southern Right Whale Dolphin	*Lissodelphis peronii*			Species or species habitat may occur within area	Species or species habitat may occur within area
Sperm Whale	*Physeter macrocephalus*	Migratory	Migratory Marine Species	Species or species habitat may occur within area	Species or species habitat may occur within area
Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale	*Mesoplodon layardii*			Species or species habitat may occur within area	Species or species habitat may occur within area
True's Beaked Whale	*Mesoplodon mirus*			Species or species habitat may occur within area	Species or species habitat may occur within area

1. Cultural significance

First Nation’s people around Australia have long had a strong connection to whales, which has significance as totemic ancestors to some groups. The arrival of whales along Australia's coastline marked the arrival of the "elders of the sea", which follows a songline or ancient memory code, that traces the journeys of ancestral spirits as they created the land, animals, and lore.

Indigenous Australians have a long tradition of utilising beached (or stranded) whales as a food source and whale stranding’s were occasions for feasting (Clarke 2001). For example, Ngarrindjeri had gathered to harvest the bodies of stranded whales well before Kringkari (pink-skinned men) arrived in their lands. Runners were sent inland telling others of the arrival of Kondoli, which was a time for ceremony and trade (Paterson and Wilson 2019).

a. Otway Whale Surveys

Gill et al. (2015) summarised cetacean sightings from 123 systematic aerial surveys undertaken over western Bass Strait and the eastern Great Australian Bight between 2002 and 2013. This paper does not include sighting data for Blue Whales, which has previously been reported in Gill et al. (2011).

These surveys recorded 133 sightings of 15 identified cetacean species consisting of seven mysticetes (baleen) whale species, eight odontocete (toothed) species and 384 sightings of dolphins (Table 4-26 and Table 4-27). Survey effort was biased toward coverage of upwelling seasons, corresponding with Pygmy Blue Whales’ seasonal occurrence (November to April; 103 of 123 surveys), and relatively little survey effort occurred during 2008–2011. Cetacean species sighted within the region are described in the following sections.

Gill et al. (2015) encountered Southern Right and Humpback Whales most often from May to September, despite low survey effort in those months. Southern Right Whales were not recorded between October and May. Fin, Sei, and Pilot whales were sighted only from November to May (upwelling season), although this may be an artefact of their relative scarcity overall and low survey effort at other times of year. Dolphins were sighted most consistently across years. The authors caution that few conclusions about temporal occurrence can be drawn because of unequal effort distribution across seasons and the rarity of most species.

Species of cetacean sighted in the period 31 October to 19 December 2010 during the Speculant 3D Transitions Zone Seismic Survey (3DTZSS) undertaken by Origin Energy, recorded species of Common Dolphin (*Delphinus* spp.), Bottlenose Dolphin (*Tursiops* spp.), unidentified small cetaceans and fur-seals.

Origin conducted a survey for cetaceans focused on Origin operations and permits in the Otway basin from June 2012 through to March of 2013. Table 4-28 lists the species present in the area Origin surveyed.

As part of Beach’s Otway drilling campaign, marine fauna observations occurred through most of 2021 (2 February to 31 December 2021) from the MODU and support vessels at the Artisan 1, Geographe 4, Geographe 5 and Thylacine North 1 drilling locations. Table 4-26 provides this cetacean sighting data. For whales, the highest number of detections was for Blue Whales (198), while for dolphins, it was the Common Dolphin (519).

Table 4-26: Cetacean Species Recorded during Aerial Surveys 2002–2013 in Southern Australia

SRW = Southern Right Whales; ROR = rorquals; ODO = other odontocetes; DOL = dolphins

Taxon	**Common name**	**Species group***	**Sightings**	**Individual**	**Mean group size (+/- SD)**
Baleen whales					
Eubalaena australis	Southern Right Whale	SRW	12	52	4.2 +/- 4.2
Caperea marginata	Pygmy Right Whale		1	100	100
Balaenoptera physalus	Fin and like Fin Whale	ROR	7	8	1.1 +/- 0.4
B. borealis	Sei and like Sei Whale	ROR	12	14	1.3 +/- 0.5
B. acutorostrata	Dwarf Minke Whale	ROR	1	1	1
B. bonaerensis	like Antarctic Minke Whale	ROR	1	1	1
Megaptera novaeangliae	Humpback Whale	ROR	10	18	1.8 +/- 1.0
Toothed whales					
Physeter macrocephalus	Sperm Whale	ODO	34	66	1.9 +/- 2.2
Mesoplodon spp.	Unidentified beaked whales	ODO	1	20	20
Orcinus orca	Killer whale	ODO	6	21	3.5 +/- 2.8
Globicephala melas	Long-finned Pilot Whale	ODO	40	1853	46.3 +/- 46.7
Grampus griseus	Risso's Dolphin	ODO	1	40	40
Lissodelphis peronii	Southern Right Whale dolphin	ODO	1	120	120
Tursiops spp.	Bottlenose Dolphin	DOL	4	363	90.8 +/- 140.1
	Dolphins	DOL	384	22169	58 +/- 129.6
Unidentified large whales			3	3	1
Unidentified small whales			2	2	1

Table 4-27: Temporal Occurrence across Months of Cetaceans Sighted during Aerial Surveys from November 2002 to March 2013 in Southern Australia

*Species sighted 2 or fewer times.

Species	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Southern Right Whale	0	0	0	0	0	0	0	0	0.8	3.1	6.8	8.8
Pygmy Right Whale*	0	0	0	0	0	0	0	0	19.8	0	0	0
Fin Whale	0	0.10	0.14	0.07	0.08	0	0	0	0	0	0	0
Sei Whale	0	0.25	0.07	0.04	0.08	0.19	0	0.21	0	0	0	0
Minke Whale*	0	0	0.02	0	0	0	0.12	0	0	0	0	0
Humpback Whale	0	0.05	0.07	0	0	0	0	0.11	0.99	1.0	0	0.35
Sperm Whale	1.7	1.2	0.23	0.53	0.08	0.13	0.75	0.85	0	0	0	0
Unidentified beaked whale*	0	0	0.47	0	0	0	0	0	0	0	0	0
Killer Whale	0	0	0.19	0	0	5.0	0	6.0	0	0.68	0	0
Pilot Whale	0	59.6	7.0	19.3	4.0	39.5	0	26.3	0	0	0	0
Southern Right Whale dolphin*	0	59.6	0	0	0	0	0	0	0	0	0	0
Risso's Dolphin*	0	0	0	0	1.7	0	0	0	0	0	0	0
Bottlenose Dolphin	0	1.5	7.7	0	0	0	0	0	0	0	0	1.1
Dolphins	545.1	120.3	105.0	151.8	105.6	233.4	26.9	257.6	155.8	2.7	0	0

Table 4-28: Observed Cetaceans in the Otway Basin

*September values averaged over two surveys on 1 and 11 September 2012. Totals include individuals from both September surveys

Species	**Jun**	**Jul**	**Aug**	**Sep ***	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Total**
Blue Whale	0	0	0	0	0	23	70	17	8	2	120
Southern Right Whale	2	0	12	13	0	0	0	0	0	0	39*
Humpback Whale	3	2	0	1	0	1	0	0	0	0	7
Sperm Whale	2	0	0	0	4	0	0	3	1	0	10
Pilot Whale	0	0	0	0	0	70	0	0	55	0	125
Dolphins	13	298	0	33	54	620	80	672	1526	21	3317
Southern Right Whale	0	0	0	0	0	120	0	0	0	0	120

Table 4-29: Marine Fauna Observations at Project Locations during the Otway Drilling Project in 2021

Species	Feb	Mar	Apr	May	Jun	July	Aug	Sep*	Oct	Nov	Dec	Total
Whales												
Blue	0	101	66	16	2	0	0	1	0	7	5	198
SRW	0	0	0	0	1	1	1	0	0	0	0	3
Humpback	0	0	7	9	25	4	2	11	14	18	5	95
Minke	0	0	0	3	0	0	0	0	0	0	0	3
Pilot	0	0	0	0	1	0	0	0	0	0	0	1
No ID	0	0	0	3	0	0	0	0	1	2	1	7
Dolphins												
Common	40	103	44	28	16	37	8	21	37	85	100	519
Bottlenose	12	4	1	2	1	3	2	4	3	1	7	40
No ID	32	27	30	10	15	11	11	5	2	2	5	150

b. Antarctic Minke Whale

The Antarctic Minke Whale (*Balaenoptera bonaerensis*) has been found in all Australian states except the Northern Territory and occupies cold temperate to Antarctic offshore and pelagic habitats between 21°S and 65°S (Bannister et al. 1996). In summer the species is found in pelagic waters from 55°S to the Antarctic ice edge. During winter the species retreat to breeding grounds between 10-30°S, occupying oceanic waters exceeding 600 m depth and beyond the continental shelf break (DoE 2023f). They have been observed as far north as 21°S along the east coast of Australia and are presumed to follow the same migration pattern on Australia's west coast (Bannister et al. 1996). Mating occurs from June through December, with a peak in August and September and calving occurs during late May and early June in warmer waters north of the Antarctic Convergence (DoE 2023f). The species primarily feeds in the Antarctic on Antarctic krill during summer and does not appear to feed much while in the breeding grounds of lower latitudes (DoE 2023f).

The Antarctic Minke Whale has been observed within the region, however, there are no BIAs in the Project Area or Planning Area.

c. Blue Whale

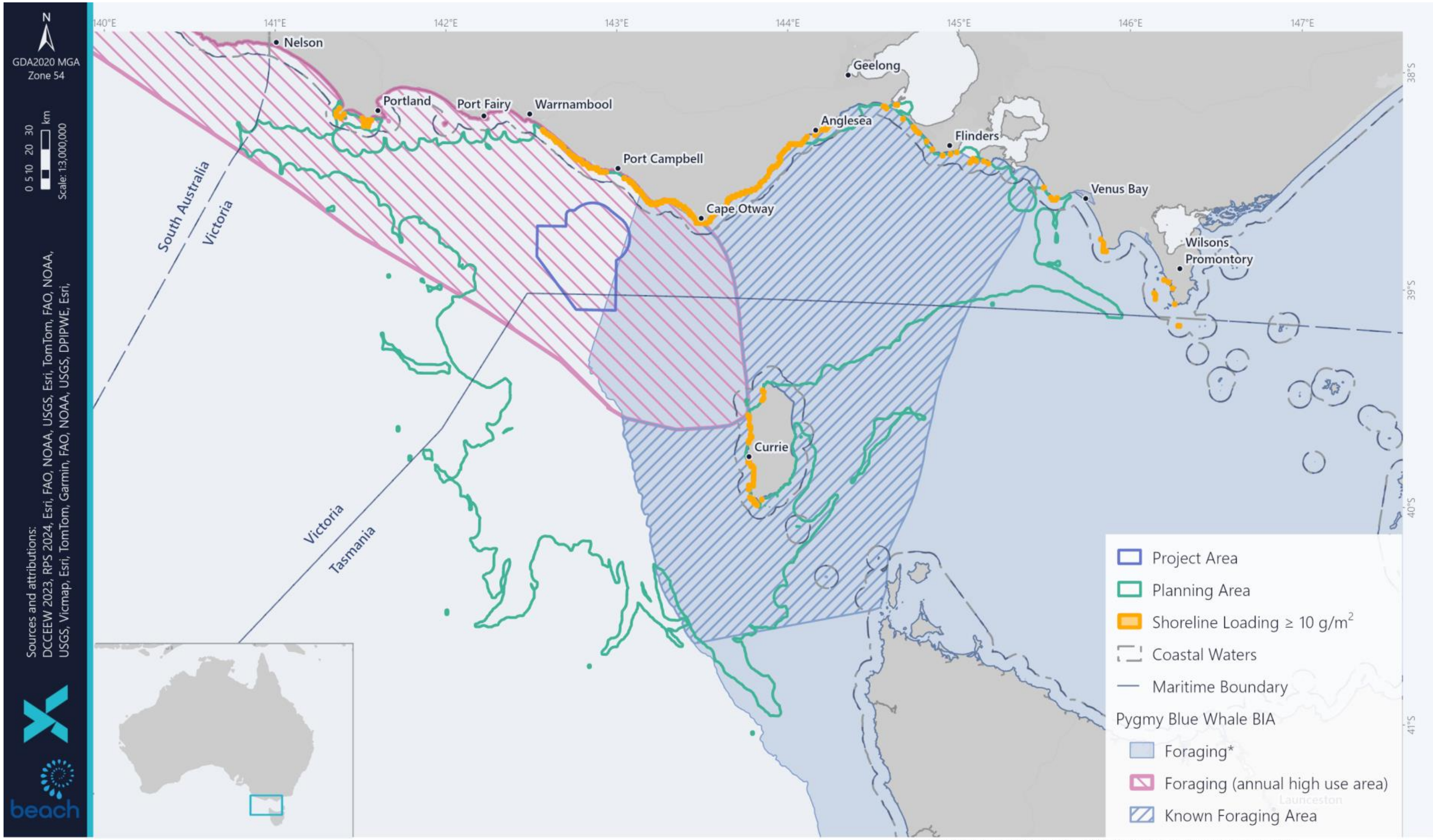
The Pygmy Blue Whale has a foraging (annual high use area) BIA within the Project and Planning Areas (Figure 4-44).

Data, as detailed in this section, suggests that Blue Whales are most likely to first appear during December/January and reach peak number during February/March. The likelihood and extent of the interaction is dependent on broad scale environmental factors affecting the abundance and distribution of Blue Whale feeding resources.

(i) Status

The Blue Whale (*Balaenoptera musculus*) is listed as an endangered species under the EPBC Act (1999) and the IUCN Red List. There are two subspecies of Blue Whales that use Australian waters (including Australian Antarctic waters), the Pygmy Blue Whale (*B. m. brevicauda*) and the Antarctic Blue Whale (*B.*

m. intermedia). Reference to Blue Whale unless otherwise specified is generally synonymous to both species. The Conservation Management Plan for the Blue Whale (CoA 2015b) identifies threats and establishes actions for assisting the recovery of Blue Whale populations using Australian waters (CoA 2015b).



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_S04_A.aprx, P100383_S00_22_BIA_PBW, P-UWS-132, 14/09/2024

Figure 4-44: Pygmy Blue Whale BIAs within the Project and Planning Areas

(ii) Population

The Antarctic Blue Whale was extremely abundant until the early 20th century when they were hunted to near extinction. Approximately 341,830 Blue Whale takes were recorded by commercial whaling in the Antarctic and sub-Antarctic in the 20th century, of which 12,618 were identified as Pygmy Blue Whales (Branch et al. 2004). The current global population of Blue Whales is uncertain but is plausibly in the range of 10,000 to 25,000, corresponding to about 3-11% of the 1911 estimated population size (Reilly et al. 2008). The Antarctic Blue Whale subspecies remains severely depleted from historic whaling and its numbers are recovering slowly. The Antarctic Blue Whale population is growing at an estimated rate of 7.3% per year, but it was hunted to such a low level that it remains at a tiny fraction of pre-whaling numbers (Branch et al. 2004). Recent studies suggest an updated rate of increase in population growth of 12.6 %, consistent with growth rates in waters off the south of Australia (McCauley et al. 2018). The updated abundance estimate uses acoustic chorus squared pressure levels to estimate growth rate off Portland (McCauley et al. 2018). This growth rate considers the number of whales calling assuming the range distribution of whales, source levels, sound propagation and calling behaviour were all similar between years.

Genetic analysis has shown that Pygmy Blue Whales which feed off the Perth Canyon and the Bonney Upwelling constitute the same population (Attard et al. 2010, in Commonwealth of Australia 2015b). Photo identification and genomic studies suggest population exchange between the two feeding grounds of the Bonney coast upwelling and the Perth Canyon (Attard et al. 2018). A Pygmy Blue Whale was tagged in 2014 north of the Perth Canyon and travelled a total distance of 506.3 km in 7.6 days, indicating the vast distances that the large marine mammals can travel in a short amount of time (Owen et al. 2016). While migrating the whale made dives at depths just below the surface which likely reduces energy expenditure but also increases the risk of ship strike greatly for longer periods than previously thought.

Global Pygmy Blue Whale abundance estimates range from 2,000 to 5,000 individuals (Reilly et al. 2018). Abundance estimates based on photo-identification mark-recapture from 1999/2000 to 2004/2005 for Blue Whales in the Perth Canyon were between 532 and 1,754 individuals, which generally agree with acoustic abundance estimates of 662 to 1,559 calling Blue Whales migrating south in 2004 past Exmouth in Western Australia and a 1992/1993 season cruise which estimated 671 (95% interval 289–1,557) individuals offshore of southern Western Australia (35–45^0 South, 115–125^0 East) (CoA 2015b).

(iii) Distribution

The Blue Whale is a cosmopolitan species, found in all oceans except the Arctic, but absent from some regional seas such as the Mediterranean, Okhotsk and Bering seas. Little is known about mating behaviour or breeding grounds. The Pygmy Blue Whale is mostly found north of 55°S, while Antarctic Blue Whales are mainly sighted south of 60°S in Antarctic waters. The presence of Antarctic Blue Whales in the area is considered rare (Gavrilov 2012), however acoustic detection of Antarctic Blue Whales indicates that they occur along the entire southern coastline of Australia (McCauley et al. 2018).

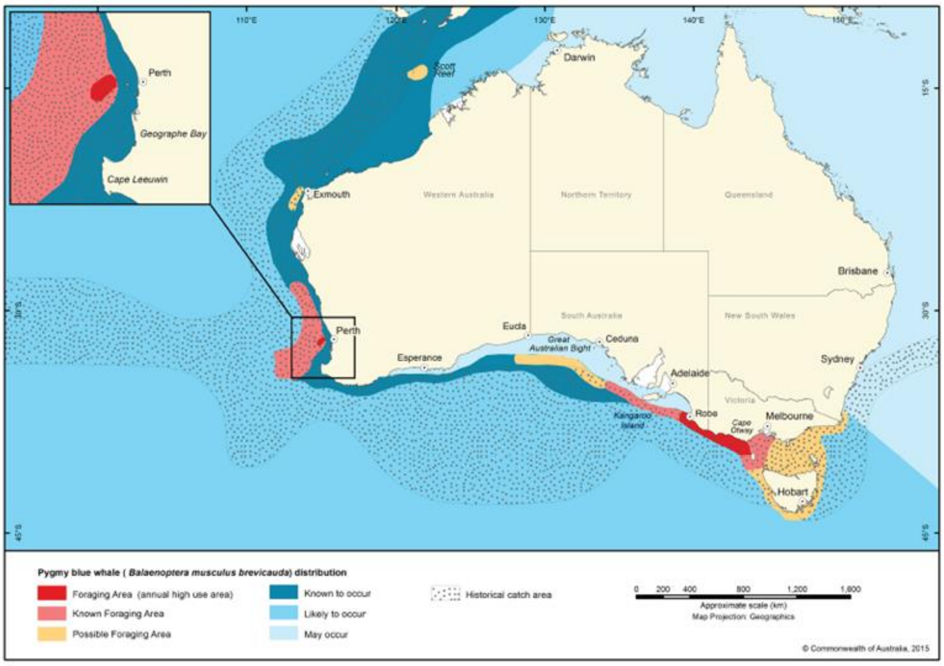
Pygmy Blue Whales are most abundant in the southern Indian Ocean on the Madagascar plateau, and off South Australia and Western Australia, where they form part of a more or less continuous distribution from Tasmania to Indonesia.

Blue Whales are rapid long-distance travellers, and pygmy Blue Whales spend the winter breeding in Indonesian waters, returning to cool temperate waters around November each year, interchanging between these waters and remoter waters of the Southern Ocean during the upwelling 'season' (Gill 2020). Pygmy Blue Whales have three migratory stages around Australia; the "southbound migration stage" is predominantly between October to December (sometimes into January) where whales travel from Indonesian waters down to the WA coast. The "southern Australian stage" between January and June is where whales spread across the southern Australian waters. The "northbound migration stage" is where whales travel back up to Indonesia between April and August. The "southern stage" involves animals searching for feeding sites, feeding and then marking their way north towards June (McCauley et al. 2018).

The distribution of Blue Whales in the Australian region is shown in Figure 4-44. There are two known seasonal feeding aggregations areas in Australia, the Bonney Coast Upwelling KEF and adjacent waters off South Australia and Victoria and the Perth Canyon KEF and adjacent waters in Western Australia. The Otway Offshore Project is located within a Blue Whale BIA – Foraging Area (annual high use area).

McCauley et al. (2018) suggests that acoustic detection of Pygmy Blue Whales indicate they predominantly occur west of Bass Strait. Acoustic detections of Pygmy Blue Whales off Portland Victoria correlated with upwelling indicators in the Bonney coast upwelling in late summer to autumn (February to April) (McCauley et al. 2018). The two Pygmy Blue Whale call types and the Antarctic Blue Whale call have been detected in central Bass Strait. On one occasion all three types were detected between April and June with more commonly two calls present over this period during other years.

The Otway Shelf is squarely within the productive, and to a certain extent predictable, Great Southern Australian Upwelling System. It has been shown to be an important, consistently used Blue Whale foraging area over many years (Gill et al. 2011).



Foraging Area (Annual high use area)	Blue whales are regularly observed feeding on a seasonal basis
Known Foraging Area	Known foraging occurs in these areas but is highly variable both between and within seasons
Possible Foraging Area	Evidence for feeding is based on limited direct observations or through indirect evidence, such as occurrence of krill in close proximity of whales, or satellite tagged whales showing circling tracks. Blue whales travel through on a seasonal basis, possibly as part of their migratory route

Known to occur	Blue whales are known to occur based on direct observations, satellite tagged whales or based on acoustic detections
Likely to occur	Blue whales are likely to occur based on occasional observations in the area and nearby areas
May occur	Evidence for the presence of blue whales through strandings or rare observations
Historical catch area	Blue whales were caught during the whaling period based on whaling data

Figure 4-45: Pygmy Blue Whale Distribution Areas around Australia (CoA 2015b)

(iv) Foraging Ecology

Krill are the key to understanding the ecology and behaviour of Blue Whales. Krill is sensitive to temperature and migrates vertically and horizontally to maintain optimal positioning with respect to nutrients, often being found along thermal fronts and thermoclines. Krill abundance in a given season may be linked to oceanographic conditions of the previous year. Unlike most krill species, *Nyctiphanes australis* frequently swarm at or near the surface, making it easily available to foraging Blue Whales. However, it is often found at depth, when Blue Whales must dive to search for and consume it. Foraging is energetically expensive for these giant mammals, which must regularly find sufficient food to balance their enormous energy requirements (Gill 2020). Blue Whales typically feed during daylight hours when krill is visible to them (Gill 2020).

Between the months of November and April, south-east winds drive upwelling of nutrient-rich water drawn from the continental slope, onto the continental shelf. An upwelling regime known as the Great Southern Australian Upwelling System extends along the shelf from the eastern Great Australian Bight to western Tasmania. Prominent surface upwelling commonly occurs west of Portland where the shelf is narrow (the Bonney Upwelling); whereas on the broader shelf between Portland and King Island, upwelling is usually subsurface, with cooler upwelled water beneath a warmer surface layer (Gill 2020).

Important foraging grounds for Blue Whales include the Great Australian Bight, South Australia and off Portland, Victoria where Blue Whales visit between December and June to forage on the inshore shelf break (Figure 4-45). The time and location of the appearance of Blue Whales in the east generally coincides with the upwelling of cold water in summer and autumn along this coast (the Bonney

Upwelling, see Section 4.3.8) and the associated aggregations of krill that they feed on (Gill and Morrice 2003). The Bonney Upwelling generally starts in the eastern part of the Great Australian Bight in November or December and spreads eastwards to the Otway Basin around February as southward migration of the subtropical high-pressure cell creates upwelling favourable winds. Sighting data indicates that Blue Whales are seasonally distributed (Gill et al. 2011; McCauley et al. 2018).

Diving behaviour of Blue Whales associated with feeding at depth was observed by Gill and Morris (2003) in the Otway region, who note that Blue Whales dived steeply, submerging for 1 to 4 minutes, then returned to the surface. Tagging of a Pygmy Blue Whale at the Perth Canyon identified 1,677 dives over the tag duration (7.6 days) (Owen et al. 2016). The duration of dives was:

- Feeding - mean of 7.6 minutes, maximum of 17.5 minutes;
- Migratory – mean of 5.2 minutes, maximum of 26.7 minutes; and
- Exploratory – mean of 8.6 minutes, maximum of 22.05 minutes.
- Tagging of 13 Pygmy Blue Whales (five of which had tags that monitored dive depth and duration) in the Bonney Upwelling identified (Möller et al. 2015):
- Whales predominantly carried out area-restricted search (presumably foraging) with generally shallow and short dives. However, dives were generally deeper at night compared to during the day.
- Whales performed mostly square shaped dives that were shallow in depth and short in duration.
- Dives recorded to a maximum of 492 m (mean = 59.5 m ± 94.3), and for a maximum duration of 112 minutes (mean = 6.1 minutes ± 5.2).

The seasonal distribution and abundance of Blue Whales is variable across years and influenced by climate variables. The time and location of the appearance of Blue Whales in the Otway region generally coincides with the upwelling of cold water between November and April along the Bonney coast and the associated aggregations of krill that they feed on (Gill and Morrice 2003). The Bonney Upwelling generally starts in the eastern part of the Great Australian Bight in November or December and spreads eastwards to the Otway Basin around February as southward migration of the subtropical high-pressure cell creates upwelling favourable winds. Sighting data indicates that Blue Whales are seasonally distributed (Gill et al. 2011; McCauley et al. 2018).

Foraging of Pygmy Blue Whales is known to occur in Bass Strait and the west coast of Tasmania where they have been recorded diving at depth presumably feeding (DoE 2023a). Blue Whales are known as ‘constant foragers’; their ecology in feeding grounds consists of constantly searching for patchily distributed krill resources, preferably those that reward the effort involved in consuming them (Torres et al. 2020). They are physically well-adapted for rapid movement between widely separated foraging areas (Woodward et al. 2006), but when they enter areas where krill may occur, they carry out zigzagging ‘area-restricted searches’ (ARS) patterns until either they find prey, or exhaust local possibilities, and move on to another possible foraging ground based on past experience (Abrahms et al. 2019). Based on this it is assumed that once blue whales have finished feeding, they will move from the feeding area to commence searching for another area.

(v) The Otway Region

Aerial Surveys (2001-02 to 2006-07)

Seasonal (November to April) aerial surveys between Cape Jaffa and Cape Otway (eastern distribution) over six seasons found that the general pattern of seasonal movement of Blue Whales is from west to east, with whales foraging between the Great Australian Bight and Cape Nelson in November and spreading further east into the Otway Shelf between Portland and Cape Otway around December. Whales were typically widely distributed throughout Otway shelf waters from January through to April (Gill et al. 2011) (Figure 4-46 and Figure 4-47).

The sighting and effort data presented in Figure 4-46and Figure 4-47 was used to calculate an ‘encounter rate’ (NB: key in upper right corner of the November, January and April figures). Dots represent Blue Whale sightings while squares are aerial survey effort (10 km by 10 km squares) represented as minutes flown per grid square. The data was pooled for all seasons. Thick solid lines represent 50% and 95% probability contours for Blue Whale distribution from density kernel analysis. Dashed lines are central and eastern boundaries (Gill et al. 2011). During 2002-11, Blue Whales were twice more likely to be found west of Portland than to its east (Gill et al. 2011).

The Project Area is on the outer edge of the eastern distribution.

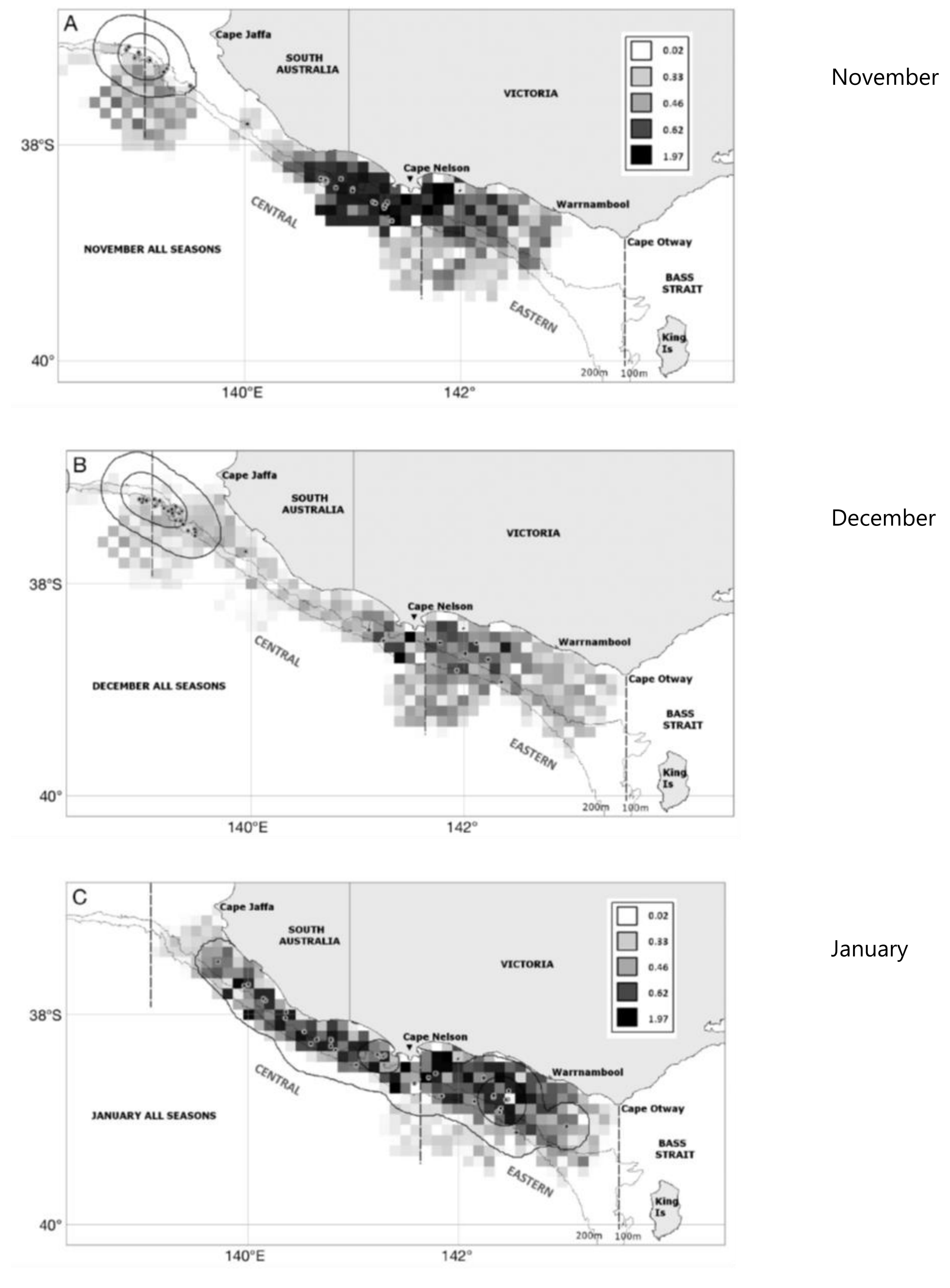


Figure 4-46: Blue Whale Sightings in the Otway Basin (Nov, Dec, Jan) (Gill et al. 2011)

Note: Dots represent Blue Whale sightings while squares are aerial survey effort (10 km by 10 km squares) represented as minutes flown per grid square (key, upper right corner of the November and January figures).

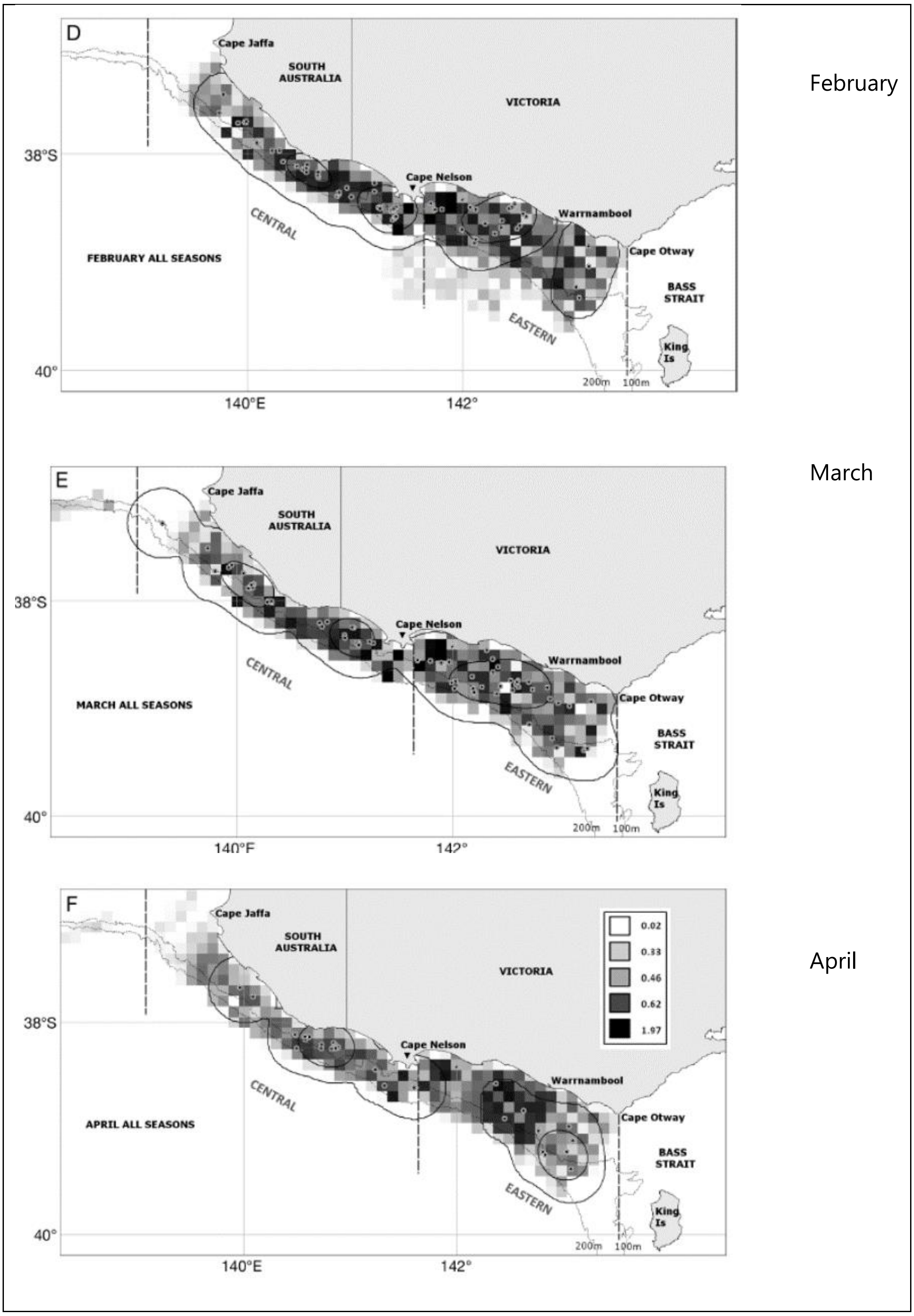


Figure 4-47: Blue Whale sightings in the Otway Basin (Feb, Mar, Apr) (Gill et al. 2011)

Note: Dots represent Blue Whale sightings while squares are aerial survey effort (10 km by 10 km squares) represented as minutes flown per grid square (key, upper right corner of the April figure).

Monthly Blue Whale encounter rates between 2001 and 2007 in the central and eastern study area (Cape Nelson to Cape Otway) are shown in Figure 4-48The encounter rates increased from 1.6 whales per 1,000 km in December, to 9.8 whales per 1,000 km in February, decreased slightly to 8.8 whales per

1,000 km in March, then declined sharply to a single sighting for May (0.4 whales per 1,000 km) (Gill et al. 2011). A mean Blue Whale group size of 1.3±0.6 was observed per sighting with cow-calf pairs observed in 2.5% of the sightings. Gill et al. (2011) also identified that 80% of Blue Whale sightings are encountered in water depths between 50 and 150 m; 93% of sightings occurred in water depths <200 m and 10% of sightings occurred within 5 km of the 200 m isobath in the eastern and central zones (Gill et al. 2011).

Gill et al. (2011) found that across the eastern zone (Cape Nelson to Cape Otway), there were no Blue Whale sightings in November (2001-2007) despite significant effort (Figure 4-48).

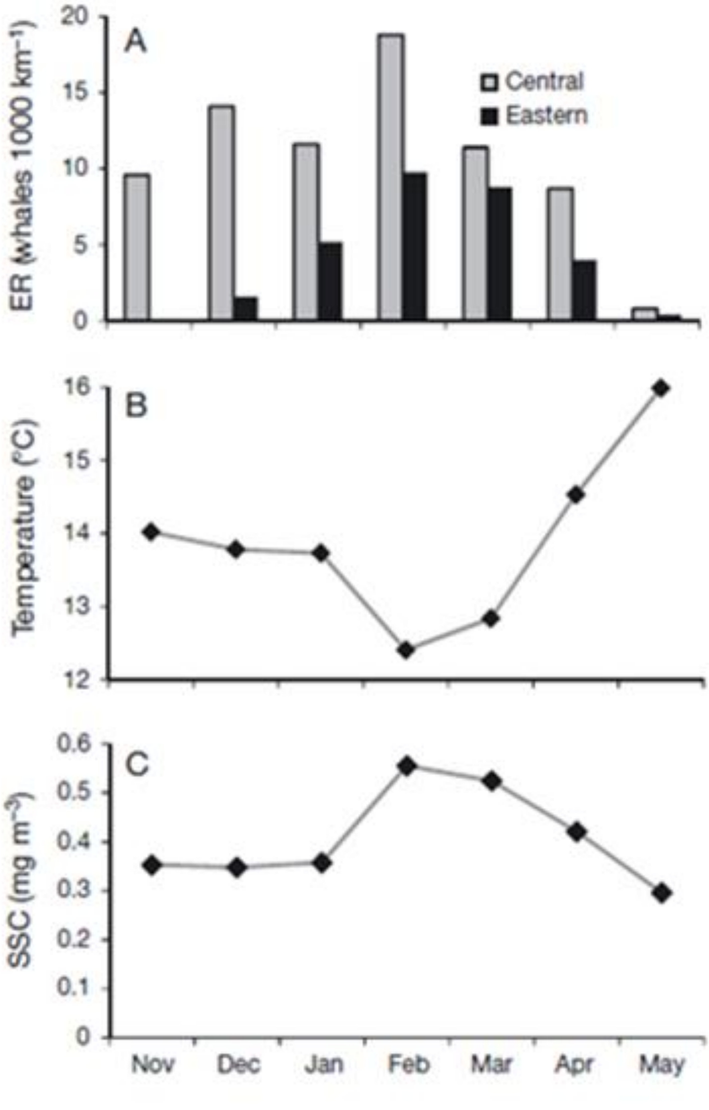


Figure 4-48: Blue Whale Encounter Rates in the Central and Eastern Study (Cape Nelson to Cape Otway) Area by Month (Gill et al. 2011)

- Blue Whales are typically widely distributed throughout central and eastern areas shelf waters from January through to April.
- Blue Whale numbers are significantly lower in November, December and January in the eastern area compared to the central area.

- No Blue Whales were sighted in the eastern area (Cape Nelson to Cape Otway) during November for any season despite significant effort.
- Encounter rates in central and eastern zones peaked in February, coinciding with peak upwelling intensity and primary productivity.

Origin Energy Surveys (2010-2014)

There were no confirmed sightings of Blue Whales during Origin's Speculant 3D Transition Zone marine seismic survey in November and December 2010, the Astrolabe 3D seismic survey undertaken in early November 2013 (RPS 2014) or during the Enterprise 3D seismic survey undertaken in late October and early November 2014 (RPS 2014).

From February to October 2011 Origin located an array of marine loggers east of the Thylacine platform to document nearby ambient marine noise, detect cetaceans and measure acoustics associated with the Origin 3D Bellerive Marine Seismic Survey. Pygmy and Antarctic Blue Whales were acoustically detected in the monitored area (east of the Thylacine A wellhead platform). Pygmy Blue Whales were observed from early February to early June being abundant from March to mid-May. Rare calls from Antarctic Blue Whales were observed in June.

Aerial surveys were commissioned by Origin and undertaken during 2011 and 2012 by the Blue Whale Study (Gill 2020). During five aerial surveys between 8 and 25 February 2011, 56 Blue Whales were sighted. Most of the sightings were at inshore areas between Moonlight Head to Port Fairy with whales apparently aggregating along and offshore of the boundary between the runoff plume from major flooding prevalent at the time and adjacent seawater. Figure 4-49 shows sightings from 14 February 2011 (Gill 2020).

The 2012 aerial surveys found that Blue Whales were common in the eastern upwelling zone during November and December 2012 (Figure 4-50). In November, an estimated 21 individual Blue Whales were sighted, with most sightings near the 100 m isobath or deeper. December 2012 surveys identified 70 Blue Whales foraging along the edge of the continental shelf west of King Island. This was the largest recorded aggregation of Blue Whales during any aerial surveys of the Bonney coast upwelling since 1999 (Gill 2020).

The large numbers of whales found in this area during November and December indicated high productivity, although the krill was too deep to be seen from the air. Subsequent surveys in the same area for Origin Energy in early 2013 resulted in 17 Blue Whales sighted in January, eight in February, and two (a cow and calf) in March 2013, despite the extremely warm surface conditions. The high productivity of this area seen in November to December 2012 evidently tailed off during the next few months (Gill 2020).

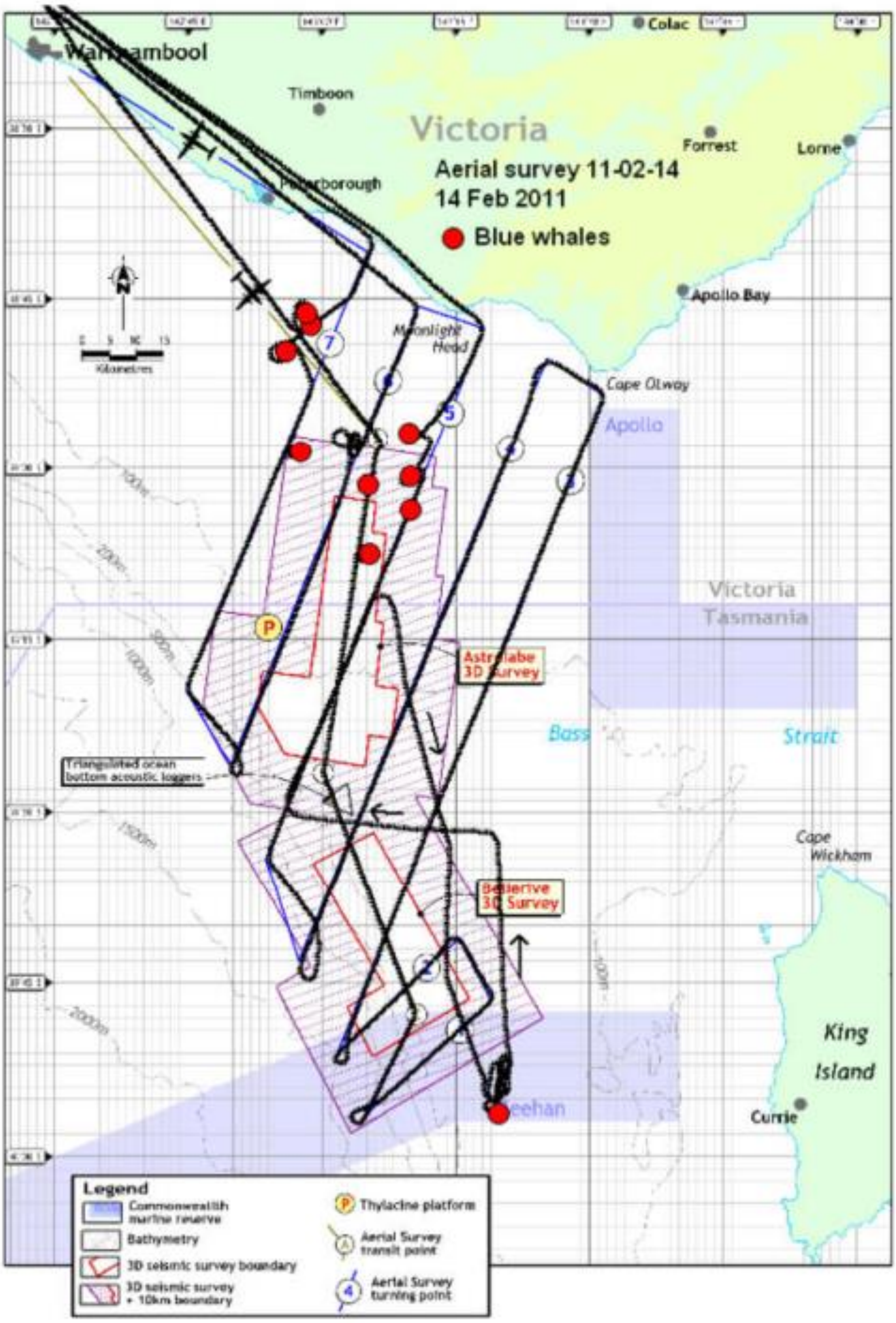


Figure 4-49: Blue Whale Sightings During an Aerial Survey for Origin Energy in February 2011 (Gill 2020)

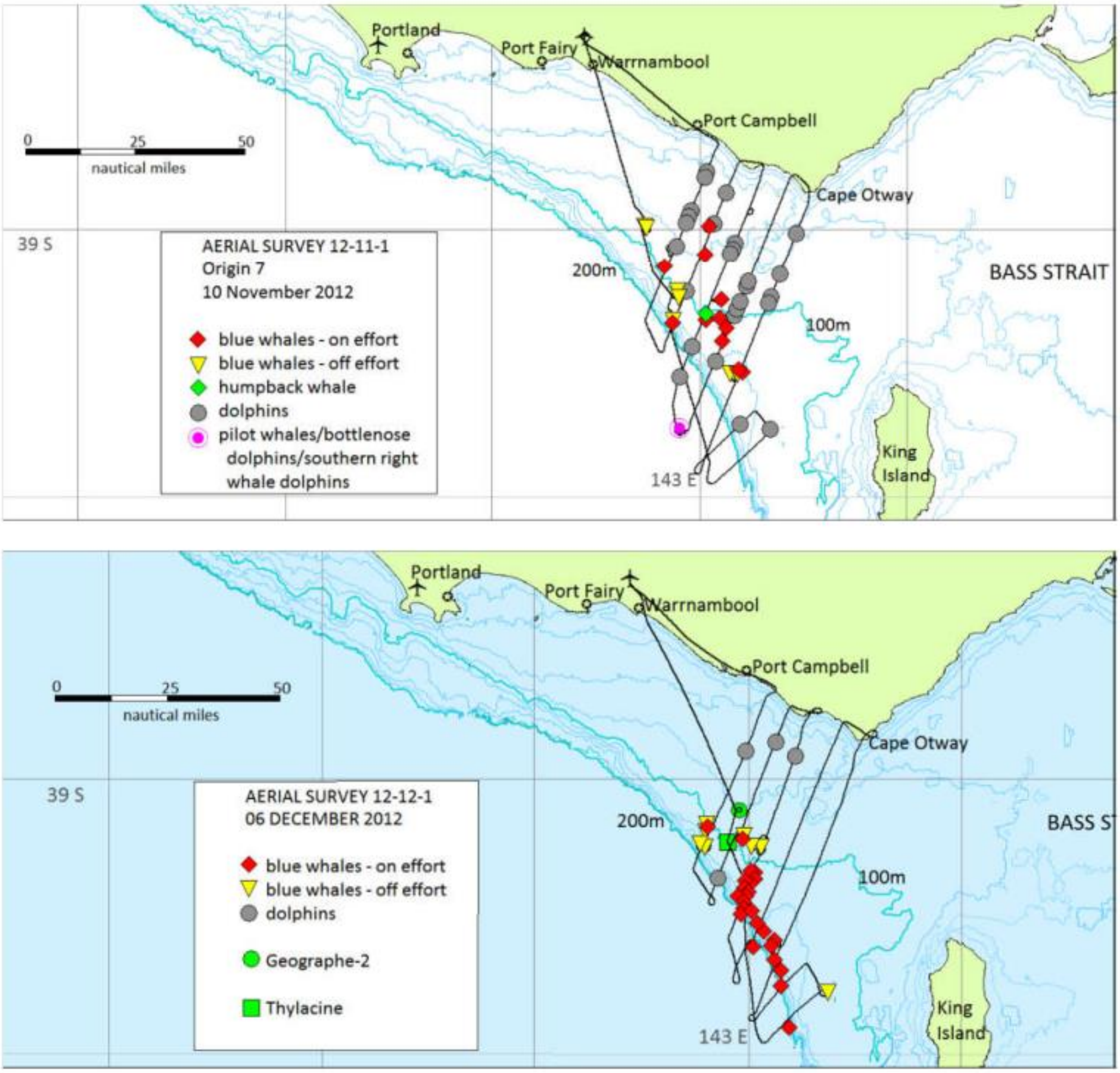


Figure 4-50: Blue Whale Sightings During an Aerial Survey for Origin Energy in November and December 2012 (Gill 2020).

Tagging Study (2015-2016)

Möller et al. (2020) analysed data from 13 Pygmy Blue Whales tagged in the Bonney Upwelling region in January 2015 with tags transmitting up to March 2016 (Figure 4-51). In summary:

- the whales' movements in the Great Southern Australian Coastal Upwelling System (GSACUS) ranged mostly from eastern South Australia, over the continental shelf south of Kangaroo Island, to between mainland Australia and Tasmania), with a few whales performing some movements to the continental slope and the deep-sea.
- in the GSACUS, most tagged whales remained over the continental shelf, utilising this region from at least January to July. This was the area of highest occupancy by the whales, with one whale returning to the Bonney Upwelling in January the year after and remaining there for at least three

months. This timing coincides with the upwelling season, which generally occurs from November to March each year.

- a low probability of area restricted search (ARS) behaviour (i.e. high probability of transiting behaviour) was mainly observed between April and June, and then between November and December, suggesting that the Pygmy Blue Whales were mainly migrating during those times.
- seascape correlates of ARS behaviour for these whales suggested the importance of sea surface temperature, sea surface height anomaly, wind speed and chlorophyll a concentration as proxies of upwelling productivity and presence of krill patches.

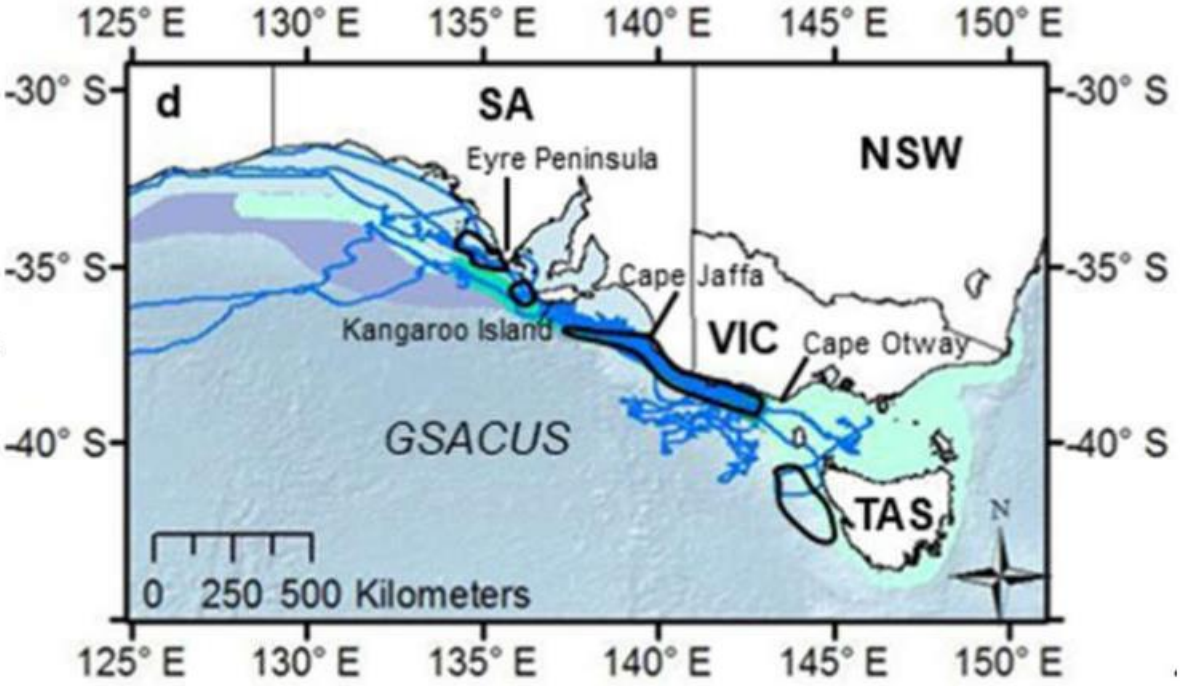


Figure 4-51: Tracks of 13 Pygmy Blue Whales in the GSACUS (Möller et al. 2020)

Passive Acoustic Recorders (2009-2017)

Between 2009 and 2016 the Integrated Marine Observing System (IMOS) recorded underwater sound south of Portland. McCauley et al. (2018) analysed the data from to look at Blue Whale presence, distribution, and population parameters.

Antarctic Blue Whale calls were received via deep sound channel propagation south of Portland and the maximum chorus levels occurred from late February to late June with yearly increases in chorus levels (McCauley et al. 2018).

In 2009 and 2011, Pygmy Blue Whales arrived in November or December whereas in other years, calls were not detected until January or February (Figure 4-52). There was substantial variation in presence within a season, with some whales remaining in the Portland detection area until mid-June each year with no consistent trend other than a peak in presence somewhere over February to June.

McCauley et al. (2018) noted it is difficult to predict numbers within a season but when correlated across seasons, the strength and persistence of the Bonney Coast Upwelling, given by time integrated water temperature, significantly correlates with time integrated number of individual whales calling from the same site (Figure 4-52). The upwelling index explains 83% of the variability in Blue Whale calling presence across seasons when using seasonal whale counts (not corrected for population growth). When a growth rate of 4.3% is applied a correlation of 90% of the variance in seasonal occurrence is predicted by the upwelling index. McCauley et al. (2018) also noted that the number of Pygmy Blue Whales calling in Portland could be expected in increase yearly with whale population growth.

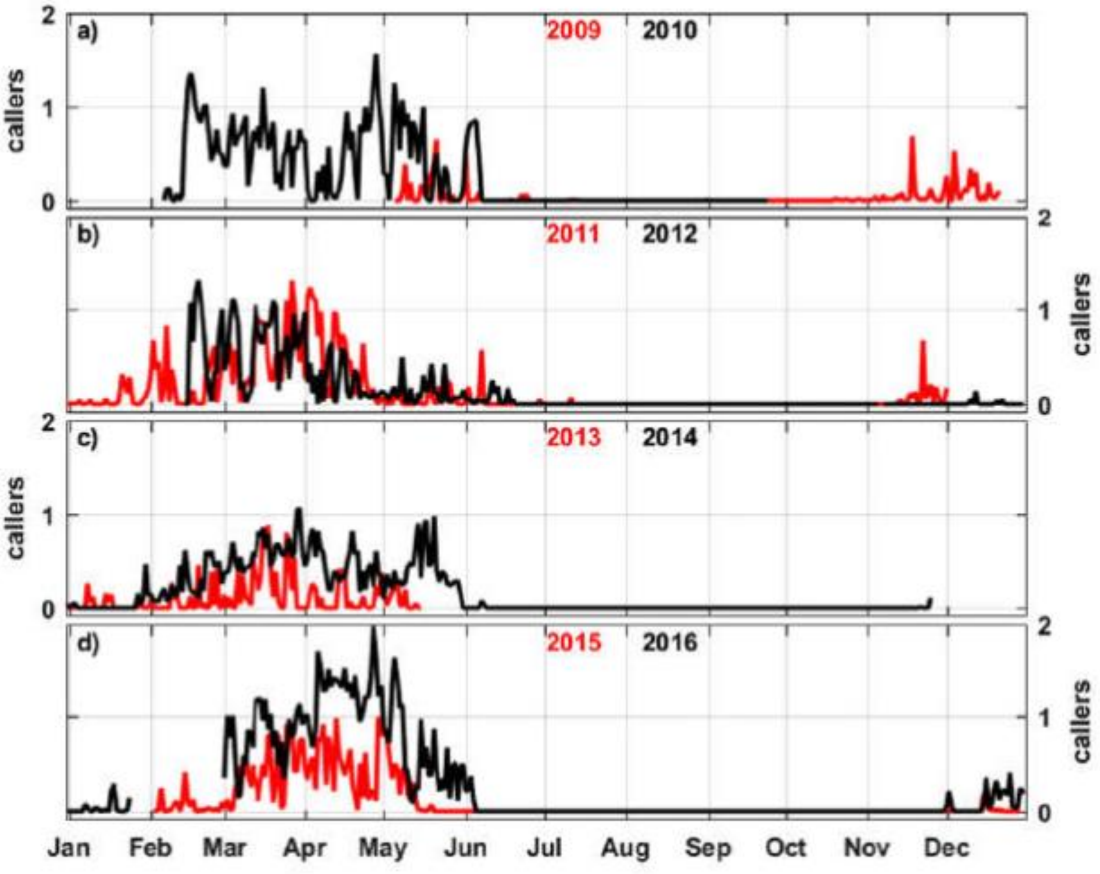


Figure 4-52: Mean Number of Individual Pygmy Blue Whales Calling (McCauley et al. 2018)

<u>Beach Surveys (2019-2022)</u>

During the Beach Otway Development Seabed Survey there were 4 sightings of Blue Whales within 3.5 km of the Thylacine Platform in November 2019 and one sighting in January 2020 about 1 km from the Artisan well location. The whales were identified as swimming.

JASCO completed a monitoring study for Beach in relation to exploration drilling activities at the Artisan 1 well from the 1 February to 6 April 2021 (McPherson et al. 2021). Songs of Pygmy Blue Whales were detected sporadically through February and the first half of March. By the end of March, the signals were present in almost every hour of recording. This pattern of occurrence was reflected across all recording stations. The data were too sparse to confirm anything about animal movements.

Beach commenced its Otway drilling program in February 2021 in the Project Area, including:

- Exploration drilling at the Artisan 1 location (2 February 2021 – 27 March 2021)
- Development drilling, well abandonment, subsea installation, and commissioning activities in the Geographe field (27 March 2021 – 13 November 2021)
- Development drilling of the Thylacine North 1 well (16 November 2021 – 11 January 2022)
- Development drilling of the Thylacine West wells (23 January 2022 – 30 April 2022)

Drilling was undertaken by a mobile offshore drilling unit (MODU), the Ocean Onyx. The Blue Whale Study (Gill 2020) was engaged to undertaken aerial surveys from February to May 2021 to identify Blue Whale and krill surface swarms within the Project Area and outside of this area. A preliminary data summary provided to Beach detailed:

- Nine aerial surveys were undertaken from 25 February to 21 May 2021
- There were 34 Blue Whale sightings consisting of 43 individuals
- The highest number of Blue Whale sightings was on 7 April 2021, with 19 Blue Whales sighted
- The first Blue Whale was sighted 25 February 2021and the final Blue Whale was sighted 7 April 2021
- Blue Whales and krill surface swarms were distributed throughout the area surveyed

Throughout the drilling campaign, Marine Fauna Observers (MFOs) were employed (January 2021 to April 2022) to ensure activities complied with Beach's Whale Management Standard Operating Procedure (WMSOP) (Document No.: S4000AF726092). The data collected includes the numbers of Blue Whales observed at varying distances from the MODU, based on the WMSOP management zones, during different MODU activities, along with information on whether the whale was observed to be approaching the MODU or moving away from it. They also collect additional data whilst in transit, or at distances outside of the zones specified in the WMSOP. Observations are based on distances of:

- 0 – 500 m
- 501 – 1,500 m
- 1,501 – 2,000 m
- 2,001 – 3,000 m
- 3,000 m

The total number of Blue Whales sighted by the aerial surveys and by MFOs was 324 individuals (Figure 4-53), with a peak of 102 whales in March 2021 (note that the period February – May 2021 includes aerial survey data). Over this period, whales were observed in most months apart from July, August, and October.

Figure 4-54 shows all whale sightings by MFOs between 2 February 2021 and 31 March 2022 across all well location. Figure 4-55 shows Blue Whale sightings within the Thylacine field between 16 November 2021 and 31 March 2022. Note that many observations were made whilst in transit.

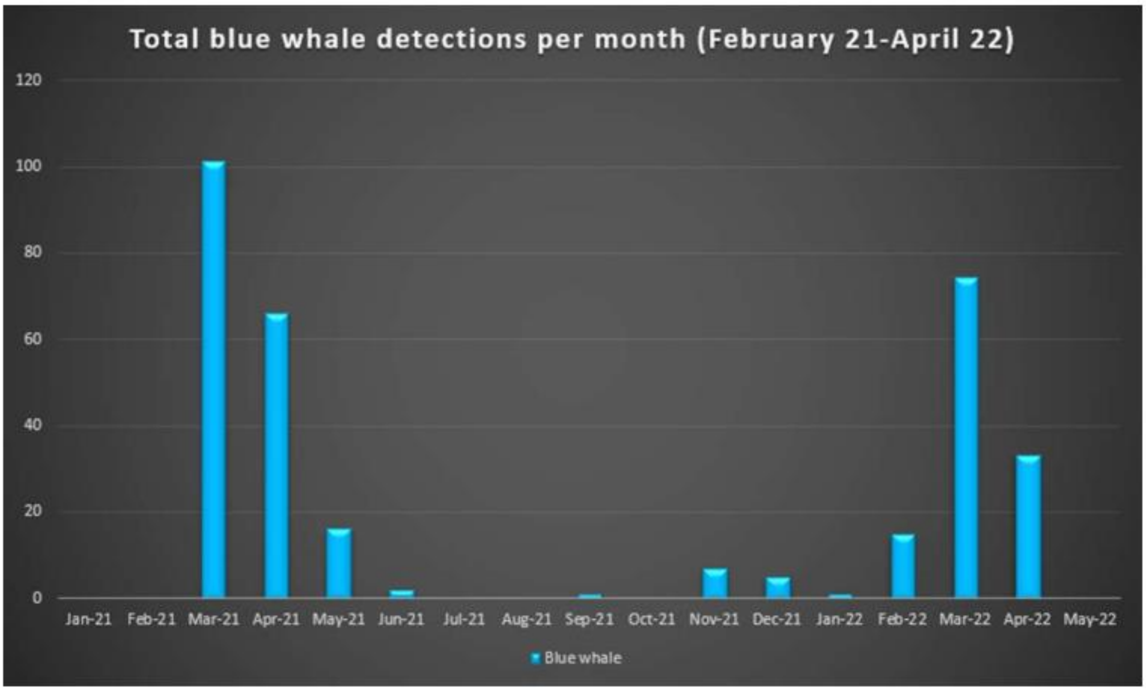
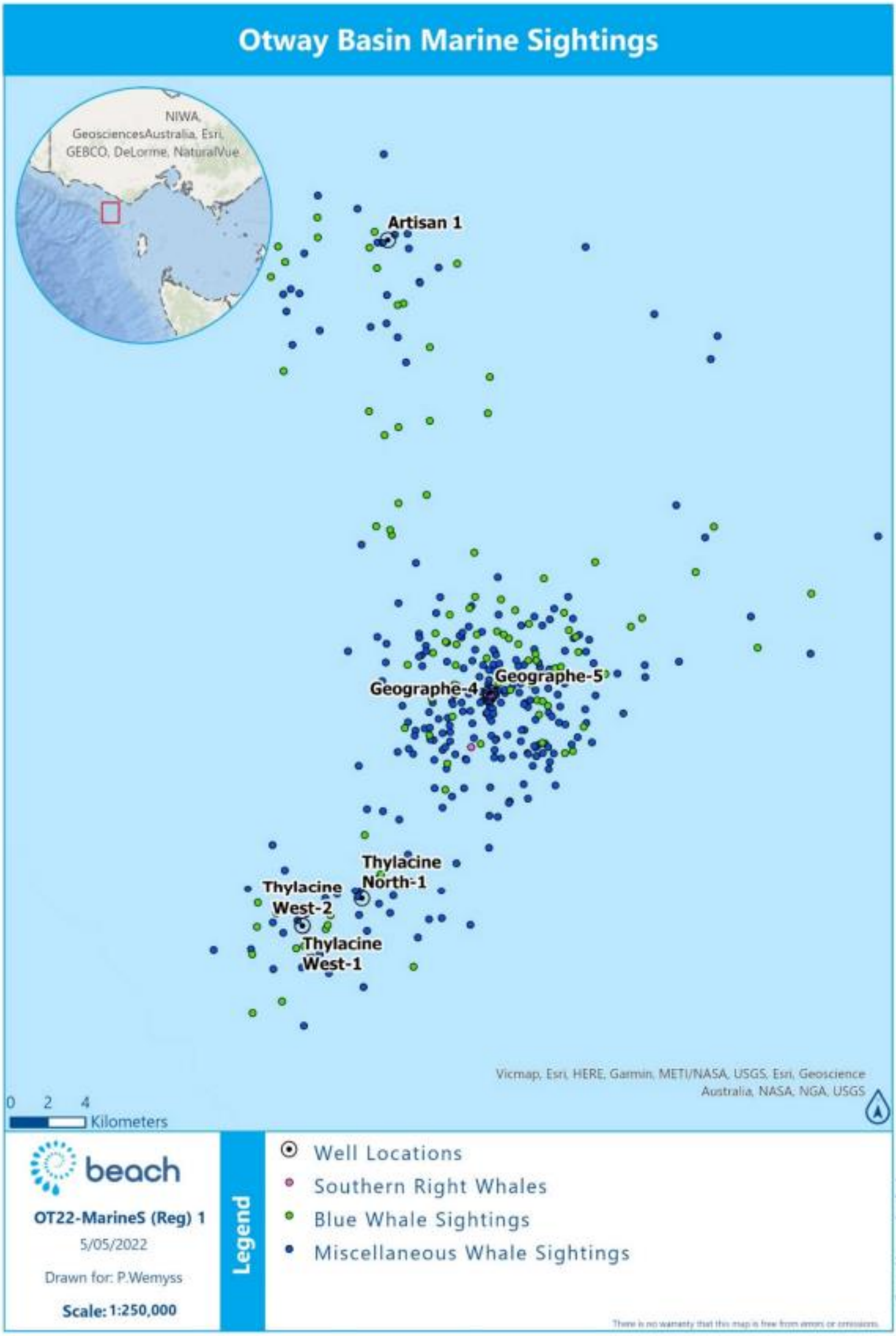


Figure 4-53: Blue Whale Observations during the Otway Offshore Drilling Campaign



4-54: Whale Sightings between 2 February 21 – 31 March 22.

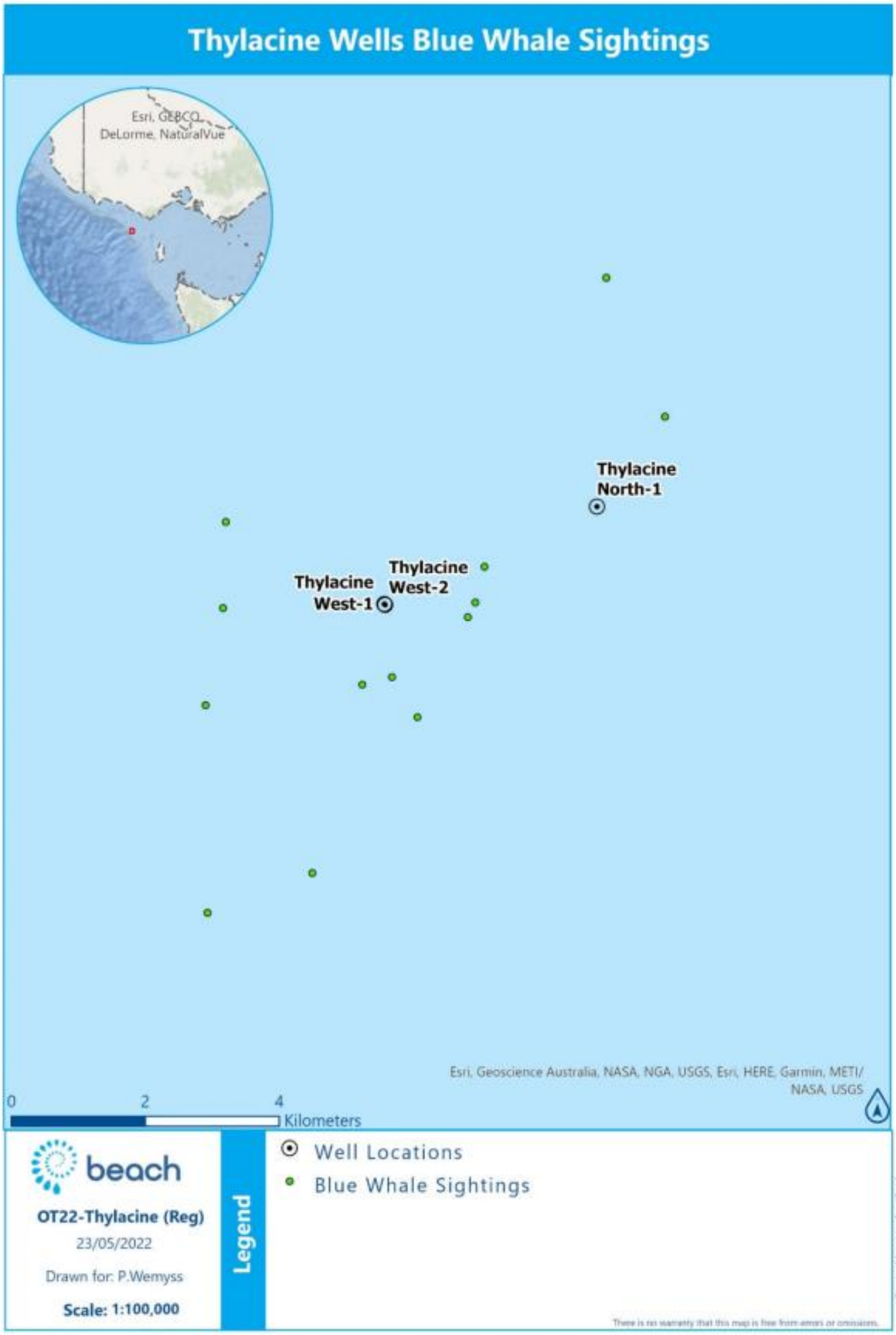


Figure 4-55: Blue Whale Sightings in the Thylacine field TN-1 (16 Nov 21 – 11 Jan 22); TW (23 Jan 22 – 31 Mar 22)

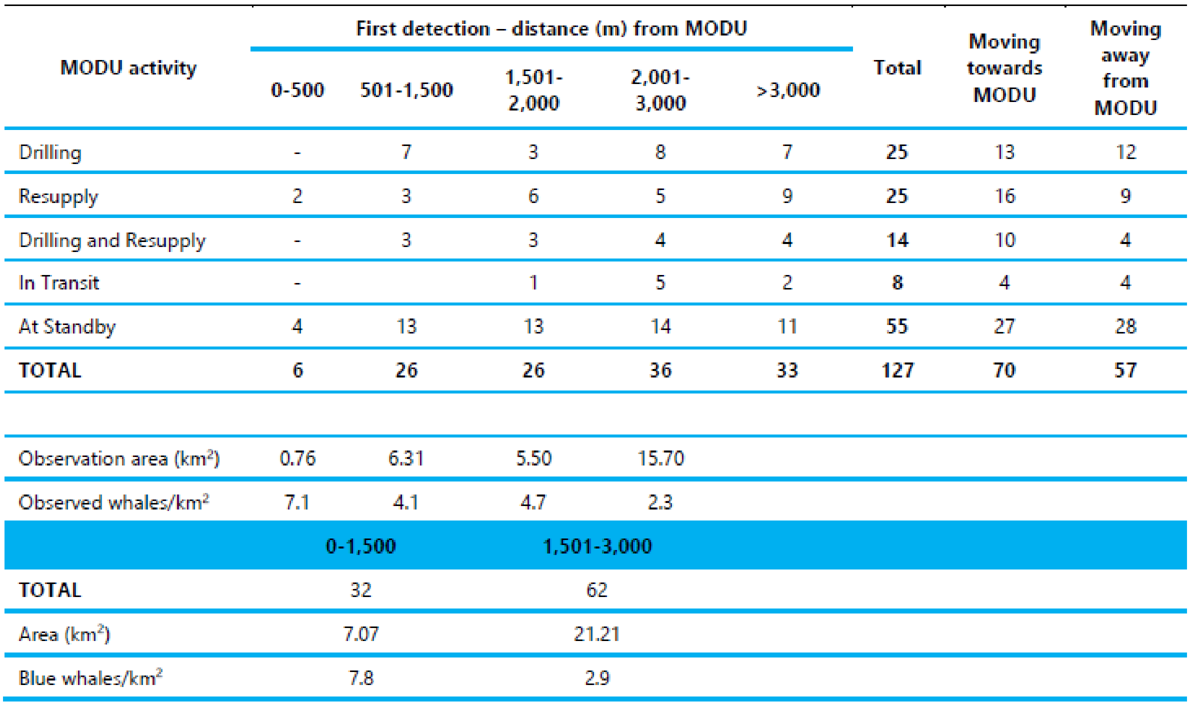
The Lead MFO provided summary data collected under the WMSOP for the period between 2 February 2021 and 31 March 2022. This was reviewed and a brief analysis undertaken.

During this period, 127 blue whales were observed within 3 km of the MODU (Table 4-30). Thirty-two whales were first detected within 1,500 m of the MODU. Sixty-two were first detected at 1,501 to 3,000 m. Thirty-three were first observed to be further than 3 km from the MODU before moving towards it. The total number of blue whales observed to move towards the MODU (following first detection) was 70 (55%); 57 were observed to move away from the MODU (45%).

Of the 94 whales first detected within 3,000 m of the MODU, 32 were observed within 1,500 m and 62 observed between 1,501 and 3,000 m. The number of blue whales/km^2 observed was 2.7x higher in the 0-1,500 m zone (7.8 whales/km^2) than in the 1,501 to 3,000 m zone (2.9 whales/km^2) (Table 4-30).

It would be expected that the number of blue whales/km^2 would be the same in all zones if underwater noise was not displacing blue whales from the area. Alternatively, if whales are being displaced then it would be expected that the number of blue whales/km^2 would increase with increasing distance from the MODU. The apparent increased density of whales within 1,500 m of the MODU in Table 4-30 can be explained by the fact that it is harder to detect whales at greater distances (i.e., the probability of detection is inversely related to distance). To correct for this a detection function is needed. The data collection methods employed by the MFOs were not designed to enable detection functions to be generated so surrogate detection functions were applied.

Table 4-30: Blue Whale Observations within 3,000 m of the MODU (2 February 2021 and 31 March 2022)



MODU activity	First detection – distance (m) from MODU					Total	Moving towards MODU	Moving away from MODU
	0-500	501-1,500	1,501-2,000	2,001-3,000	>3,000			
Drilling	-	7	3	8	7	**25**	13	12
Resupply	2	3	6	5	9	**25**	16	9
Drilling and Resupply	-	3	3	4	4	**14**	10	4
In Transit	-		1	5	2	**8**	4	4
At Standby	4	13	13	14	11	**55**	27	28
TOTAL	**6**	**26**	**26**	**36**	**33**	**127**	**70**	**57**
Observation area (km^2)	0.76	6.31	5.50	15.70				
Observed whales/km^2	7.1	4.1	4.7	2.3				
	0-1,500		**1,501-3,000**					
TOTAL	32		62					
Area (km^2)	7.07		21.21					
Blue whales/km^2	7.8		2.9					

Williams et al. (2016) collected 3,262 vessel-based observations from 2008 to 2015 of humpback whales in and near Glacier Bay National Park, Alaska, which is a site of a regionally important feeding aggregation of humpback whales. They analysed this data (85% truncated at 4,565 m) to generate detection functions to understand the probability of whale detection and how it varies with distance under different environmental and biological characteristics. Figure 4-56 shows the detection function for all data; Figure 4-57 shows the detection functions under different visibility conditions; Figure 4-58 shows the detection functions for different group sizes. Shaded areas show 95% confidence intervals. Arrows identify detection probability at 1,000 m reference distance.

Detection probability of surfacing whales decreased markedly with increasing distance from the ship. They found visibility and group size to be the most important variables influencing detection. The worst visibility conditions reduced detection probability to near 0 at 1000 m. Compared to detecting a single whale, a group of 2 or 3 whales almost doubled detection probability at 1000 m. Surface active behaviour increased detection compared to spouting while showing no flukes. In south-eastern Alaska, single whales that spouted during excellent visibility conditions were most commonly encountered and had a detection probability of 0.569 at 1000 m (Williams et al. 2016).

The Lead MFO for the Otway drilling program advised that they were only able to detect whales further than 3 km on 25% of occasions. The detection function from Williams et al. (2016) which best matches the MFOs advice was the curve showing '4+ group size' in Figure 4-58. Detection probabilities for this case, along with those for 'excellent visibility' conditions (Figure 4-57) and 'all' data (Figure 4-56) were extracted to provide probabilities in 500 m increments (Table 4-31). To allow these probabilities to be applied to the management zones shown in Table 4-30, the average probability for each management zone was calculated and expected numbers and densities calculated for the three scenarios (Table 4-32).

The total expected number of blue whales is 158.6 for the '4+ group size' scenario, 437.9 for the 'excellent visibility' scenario and 530.7 for the 'all data' scenario. The total observed blue whales was 127.

The expected densities for each management zone for the three scenarios are shown in Figure 4-59. The data shows that for the '4+ group size' there is no significant difference in expected blue whale densities between any of the four management zones, with highest expected densities in the 0–500 m zone. The 'excellent visibility' and 'all data' scenarios show significant expected differences between the 0 to 1,500 m and 1,501 to 3, 000 m management zones, however no significant differences between the 0–500 and 501 –1,500 m zones.

All the scenarios presented show similar expected densities for the 0 to 1,500 m zone. All three scenarios show that there is no increase in expected densities between the 0–500 and 501–1,500 m zones which implies that blue whales are not being displaced within 1,500 m. The '4+ group size' scenario (which most closely matches the Lead MFOs advice) implies that there is no displacement of blue whales within 3,000 m.

The '4+ group size' scenario has a mean expected density of 6.21 blue whales/km^2 across all zones, which (if correct) should apply to the wider area beyond observations. If whales are being displaced beyond 1,500 m as implied by the 'excellent visibility' and 'all data' scenarios, then the minimum mean expected densities for the wider area should be calculated using the observations between 1,501 and 3,000 m. These expected minimum mean densities are 18.70 blue whales/km^2 and 22.91 blue whales/km^2 for the 'excellent visibility' and 'all data' scenarios, respectively.

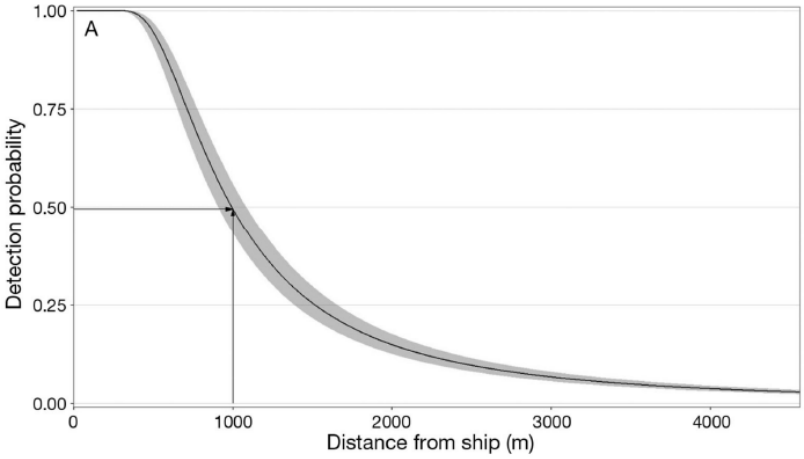


Figure 4-56: Detection Probability as it Varies with Distance between Ships and Whales in and near Glacier Bay National Park from 2008 to 2015 (Williams et al. 2016)

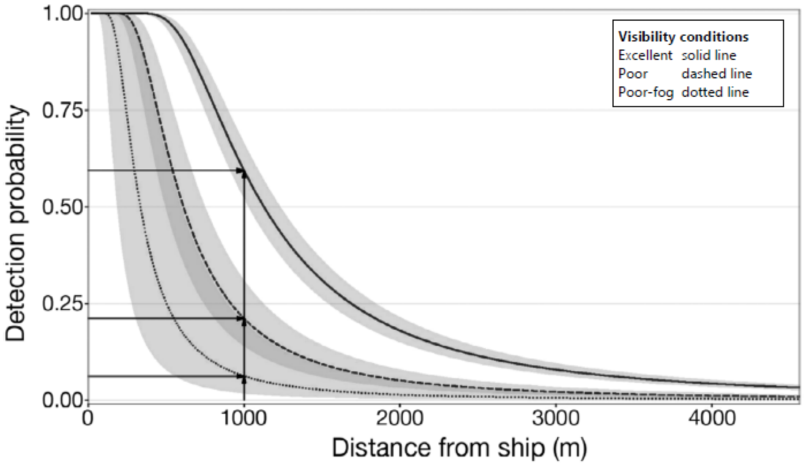


Figure 4-57: Detection Probability of Humpback Whales under Different Visibility Conditions (Williams et al. 2016)

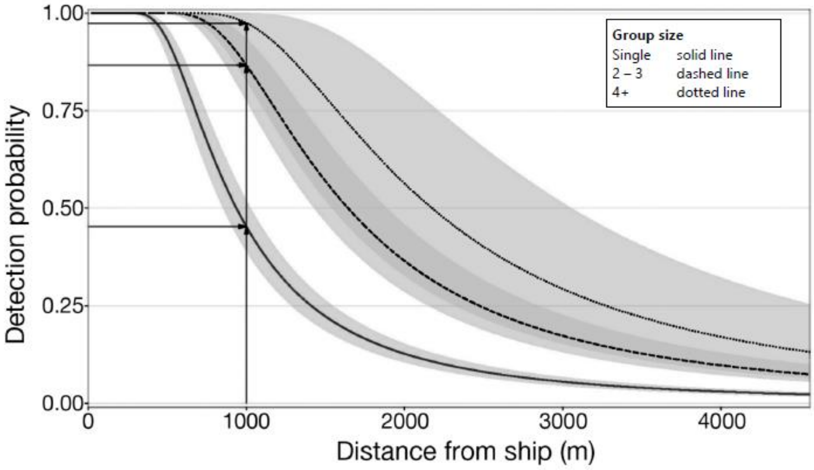
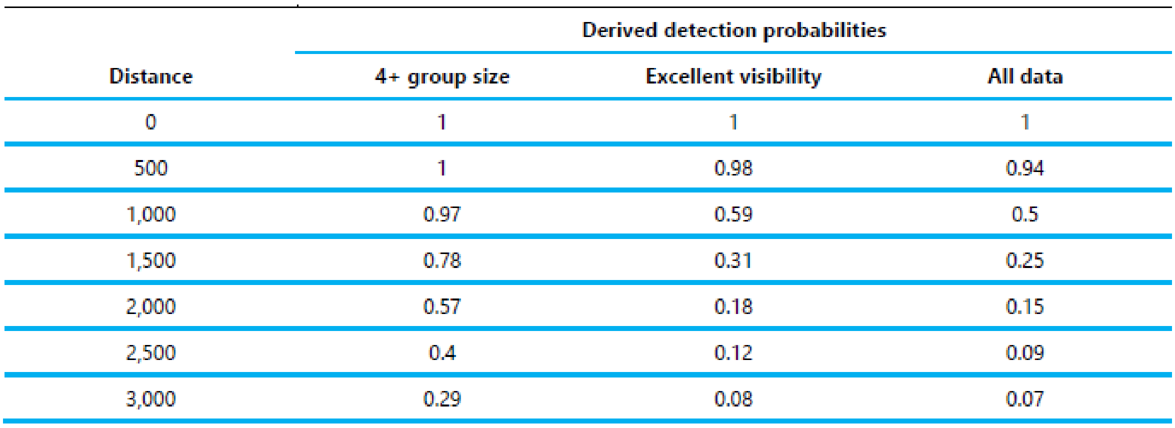


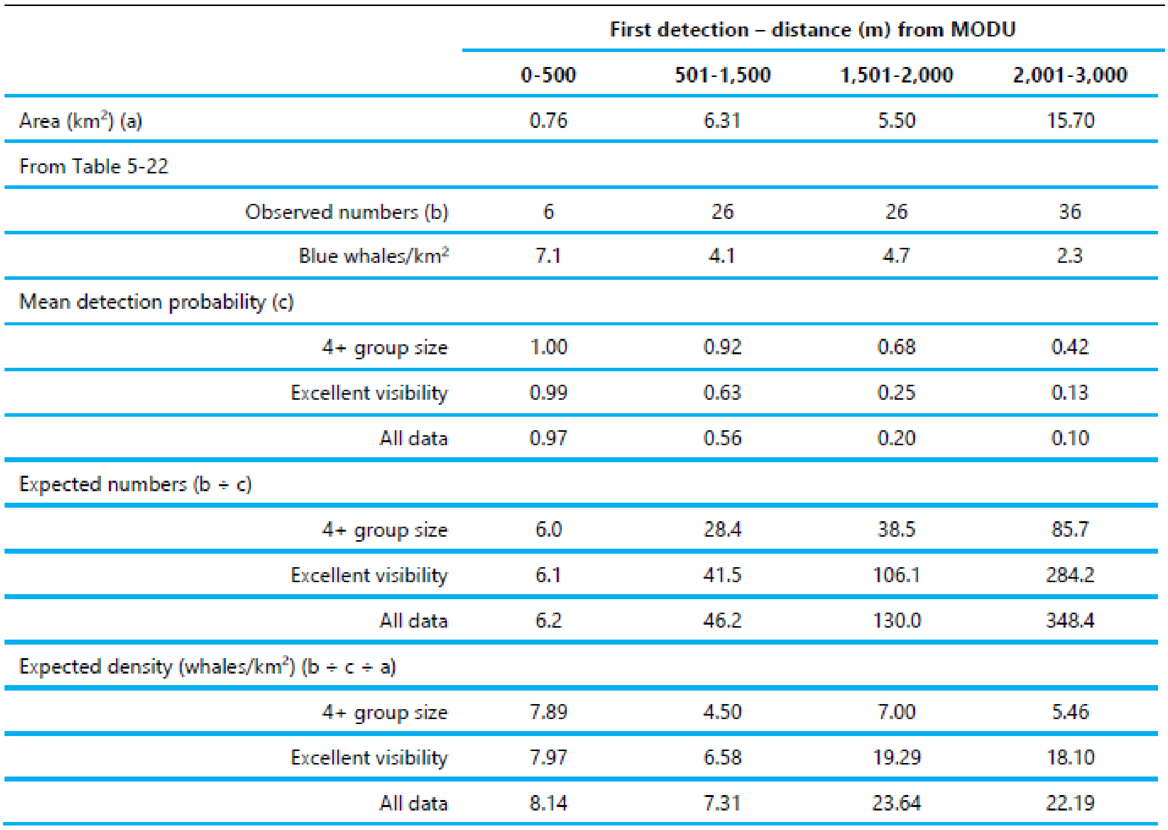
Figure 4-58: Probability of Detecting Whale Groups of Different Sizes of Humpback Whales (Williams et al. 2016)

Table 4-31: Detection Probabilities derived from Williams et al. (2016)



	Derived detection probabilities		
Distance	**4+ group size**	**Excellent visibility**	**All data**
0	1	1	1
500	1	0.98	0.94
1,000	0.97	0.59	0.5
1,500	0.78	0.31	0.25
2,000	0.57	0.18	0.15
2,500	0.4	0.12	0.09
3,000	0.29	0.08	0.07

Table 4-32: Estimated Blue Whale Abundance and Density based on MFO data from 2 Feb. 2021 and 31 Mar. 2022. Note that the reference to Table 5-22 is Table 4-30 in this OPP.



	First detection – distance (m) from MODU			
	0-500	**501-1,500**	**1,501-2,000**	**2,001-3,000**
Area (km^2) (a)	0.76	6.31	5.50	15.70
From Table 5-22				
Observed numbers (b)	6	26	26	36
Blue whales/km^2	7.1	4.1	4.7	2.3
Mean detection probability (c)				
4+ group size	1.00	0.92	0.68	0.42
Excellent visibility	0.99	0.63	0.25	0.13
All data	0.97	0.56	0.20	0.10
Expected numbers (b ÷ c)				
4+ group size	6.0	28.4	38.5	85.7
Excellent visibility	6.1	41.5	106.1	284.2
All data	6.2	46.2	130.0	348.4
Expected density (whales/km^2) (b ÷ c ÷ a)				
4+ group size	7.89	4.50	7.00	5.46
Excellent visibility	7.97	6.58	19.29	18.10
All data	8.14	7.31	23.64	22.19

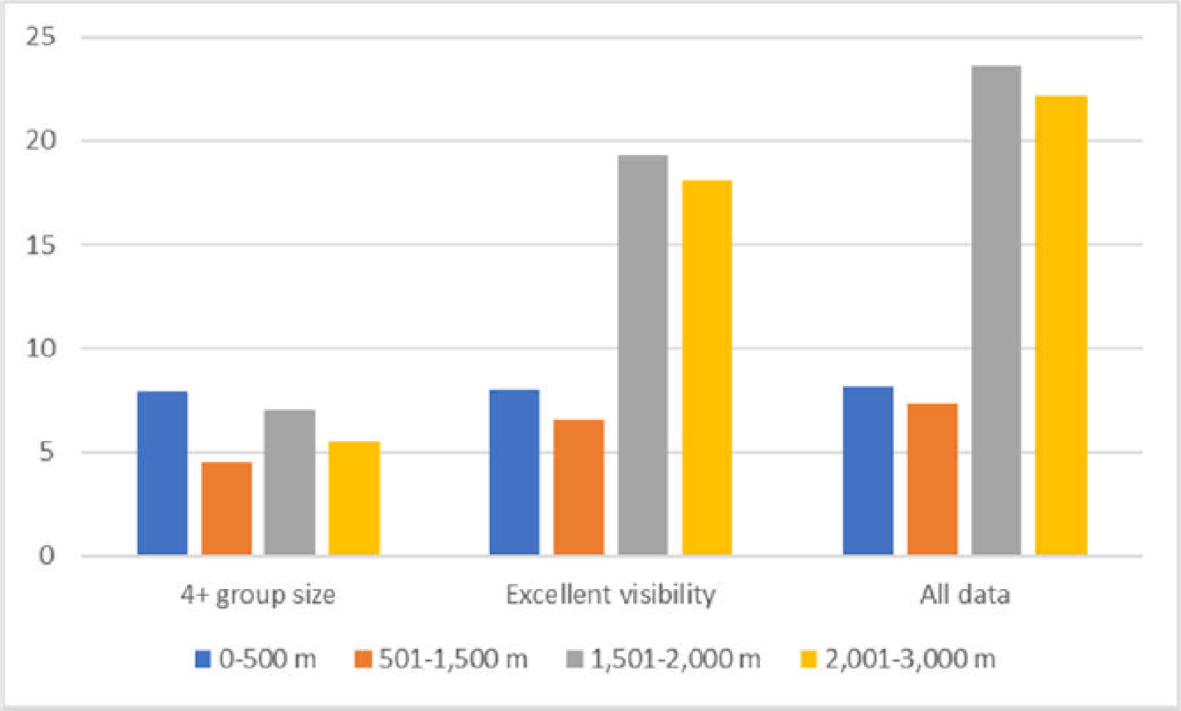


Figure 4-59: Expected Density (blue whales/km^2) for each Management Zone

d. Fin Whale

Fin Whales are listed as Vulnerable and Migratory under the EPBC Act considered a cosmopolitan species and occur from polar to tropical waters and are rarely in inshore waters. They show well defined migratory movements between polar, temperate, and tropical waters. Migratory movements are essentially north–south with little longitudinal dispersion. Fin Whales regularly enter polar waters. Unlike Blue Whales and Minke Whales, Fin Whales are rarely seen close to ice, although recent sightings have occurred near the ice edge of Antarctica.

There are stranding records of this species from most Australian states, but they are considered rare in Australian waters (Bannister et al. 1996). The fin whale has been infrequently recorded between November and February during aerial surveys in the region (Gill et al. 2015). Fin Whales have been sighted inshore in the proximity of the Bonney Upwelling, Victoria, along the continental shelf in summer and autumn months (Gill 2002). Fin Whales in the Bonney Upwelling are sometimes seen in the vicinity of Blue Whales and Sei Whales.

Fin Whales were sighted, and feeding was observed between November-May (upwelling season) during aerial surveys conducted between 2002 and 2013 in South Australia (Gill et al. 2015). This is one of the first documented records these whales feeding in Australian waters, suggesting that the region may be used for opportunistic baleen whale feeding (Gill et al. 2015). Fin Whales have also been acoustically detected south of Portland, Victoria (Erbe et al. 2016). Aulich et al. (2019) recorded infrequent presence of Fin Whales in Portland between 2009 to 2016. This suggests that the area may not be a define migratory route however, calls recorded in July may be from whales migrating northward towards the east coast of NSW. Calls detected in late August and September may be indication of the presence of whales on their migration route back to Antarctica waters.

The sighting of a cow and calf in the Bonney Upwelling in April 2000 and the stranding of two Fin Whale calves in South Australia suggest that this area may be important to the species' reproduction, perhaps as a provisioning area for cows with calves (Morrice et al. 2004). However, there are no defined mating or calving areas in Australia waters.

e. Humpback Whale

Humpback Whales (*Megaptera novaeangliae*) are listed as Vulnerable and Migratory under the EPBC Act and are present around the Australian coast in winter and spring. Humpbacks undertake an annual migration between the summer feeding grounds in Antarctica to their winter breeding and calving grounds in northern tropical waters (DoE 2023i). Along the south-east coast of Australia, the northern migration starts in April and May while the southern migration peaks around November and December (DoE 2023i). A discrete population of humpback whales have been observed to migrate along the west coast of Tasmania and through Bass Strait, and these animals may pass through the Project Area and Planning Area. The exact timing of the migration period varies between years in accordance with variations in water temperature, extent of sea ice, abundance of prey, and location of feeding grounds (DoE 2023i). Feeding occurs where there is a high krill density, and during the migration this primarily occurs in Southern Ocean waters south of 55°S (DoE 2023i).

Humpback Whales satellite-tagged off Australia's east coast were tracked during three austral summers in 2008/2009, 2009/2010 and 2010/2011 (Andrews-Goff et al. 2018). Of the 30 tagged Humpbacks, 21 migrated south along the coastline across into Bass Strait during October. In November the whales then migrated along the east coast (12 whales) and west coast (1 whale) of Tasmania to Antarctic feeding grounds. The state space model used shows both search and transit behaviour revealing new temperate feeding grounds in Bass Strait, the east coast of Tasmania and in the eastern Tasman Sea.

There is no known feeding, resting or calving grounds for Humpback Whales in the Project Area or Planning Area, although feeding may occur opportunistically where sufficient krill density is present DoE 2023i). The nearest BIA which is important habitat for migrating humpback whales is Twofold Bay, a resting area off the NSW coast (DCCEEW 2024).

During Origin's Enterprise 3D seismic survey undertaken during early November 2014, 16 Humpback Whales were sighted (RPS 2014).

The recovery of Humpback Whale populations following whaling has been rapid. The Australian east coast Humpback Whale population, which was hunted to near-extinction in the 1950s and early 1960s, had increased to 7,090±660 (95% CI) whales by 2004 with an annual rate of increase of 10.6±0.5% (95% CI) between 1987–2004 (Noad et al. 2011). The available estimates for the global population total more than 60,000 animals, and global population is categorised on the IUCN Red List as Least Concern.

f. Killer Whale

Killer Whales (*Orcinus orca*) are listed as Migratory under the EPBC Act and thought to be the most cosmopolitan of all cetaceans and appear to be more common in cold, deep waters; however, they have often been observed along the continental slope and shelf particularly near seal colonies (Bannister et al. 1996). The killer whale is widely distributed from polar to equatorial regions and has been recorded in all Australian waters with concentrations around Tasmania. The only recognised key locality in Australia is Macquarie Island and Heard Island in the Southern Ocean (Bannister et al. 1996).

The habitat of Killer Whales includes oceanic, pelagic and neritic (relatively shallow waters over the continental shelf) regions, in both warm and cold waters (DoE 2023l).

Killer Whales are top-level carnivores. Their diet varies seasonally and regionally. The specific diet of Australian Killer Whales is not known, but there are reports of attacks on dolphins, young Humpback Whales, Blue Whales, Sperm Whales, dugongs and Australian sea-lions (Bannister et al. 1996). In Victoria, sightings peak in June/July, where they have been observed feeding on sharks, sunfish, and Australian Fur-seals (Morrice et al. 2004; Mustoe 2008).

The breeding season is variable, and the species moves seasonally to areas of food supply (Bannister et al. 1996; Morrice et al. 2004). Killer Whales are frequently present in Victorian waters with sightings recorded along most of Victoria's coastline. Mustoe (2008) describes between 2002 and 2008 web-based casual sightings had an average of 13 Killer Whales sighted per year in Victoria and NSW, more than half in Victorian waters. This combined with the Atlas of Victorian Wildlife indicates a peak in killer whale sightings in June to July and September to November (Mustoe 2008).

The Killer Whale has been observed within the region however there are no BIAs in the Project Area and Planning Area.

g. Pygmy Right Whale

The Pygmy Right Whale (*Caperea marginata*) is a little-studied baleen whale species that is found in temperate and sub-Antarctic waters in oceanic and inshore locations and listed as migratory under the EPBC Act. The species, which has never been hunted commercially, is thought to have a circumpolar distribution in the Southern Hemisphere between about 30°S and 55°S. Distribution appears limited by the surface water temperature as they are almost always found in waters with temperatures ranging from 5° to 20°C (Baker 1985) and staying north of the Antarctic Convergence. There are few confirmed sightings of Pygmy Right Whales at sea (Reilly et al. 2008). The largest reported group was sighted (100+) just south-west of Portland in June 2007 (Gill et al. 2008).

Species distribution in Australia is found close to coastal upwellings and further offshore it appears that the Subtropical Convergence may be important for regulating distribution (Bannister et al. 1996). Key locations include south-east Tasmania, and Kangaroo Island and southern Eyre Peninsula in South Austalia close to upwelling habitats rich in marine life and zooplankton upon which it feeds (Bannister et al. 1996).

The Pygmy Right Whale has been observed in surveys in the region, however, Origin did not observe it during the 2010 Speculant MSS and 2014 Enterprise MSS. There are no BIAs identified in the Project Area or Planning Area.

h. Sei Whale

Sei Whales (*Balaenoptera borealis*) are listed as Vulnerable and Migratory under the EPBC Act, and are considered a cosmopolitan species, ranging from polar to tropical waters, but tend to be found more offshore than other species of large whales. They show well defined migratory movements between polar, temperate, and tropical waters. Migratory movements are essentially north-south with little longitudinal dispersion. Sei Whales do not penetrate the polar waters as far as the Blue, Fin, Humpback and Minke Whales (Horwood 1987), although they have been observed very close to the Antarctic continent.

Sei Whales move between Australian waters and Antarctic feeding areas; sub-Antarctic feeding areas (e.g. Subtropical Front); and tropical and subtropical breeding areas. The proportion of the global population in Australian waters is unknown as there are no estimates for Sei Whales in Australian waters.

Sei Whales feed intensively between the Antarctic and subtropical convergences and mature animals may also feed in higher latitudes. Sei Whales feed on planktonic crustaceans, in particular copepods and amphipods. Below the Antarctic convergence Sei Whales feed exclusively upon Antarctic krill (*Euphausia superba*).

In the Australian region, Sei Whales occur within Australian Antarctic Territory waters and Commonwealth waters, and have been infrequently recorded off Tasmania, NSW, Queensland, the Great Australian Bight, Northern Territory and Western Australia (Parker 1978; Bannister et al. 1996; Chatto and Warneke 2000; Bannister 2008).

Sightings of Sei Whales within Australian waters includes areas such as the Bonney Coast Upwelling off South Australia (Miller et al. 2012), where opportunistic feeding has been observed between November and May (Gill et al. 2015).

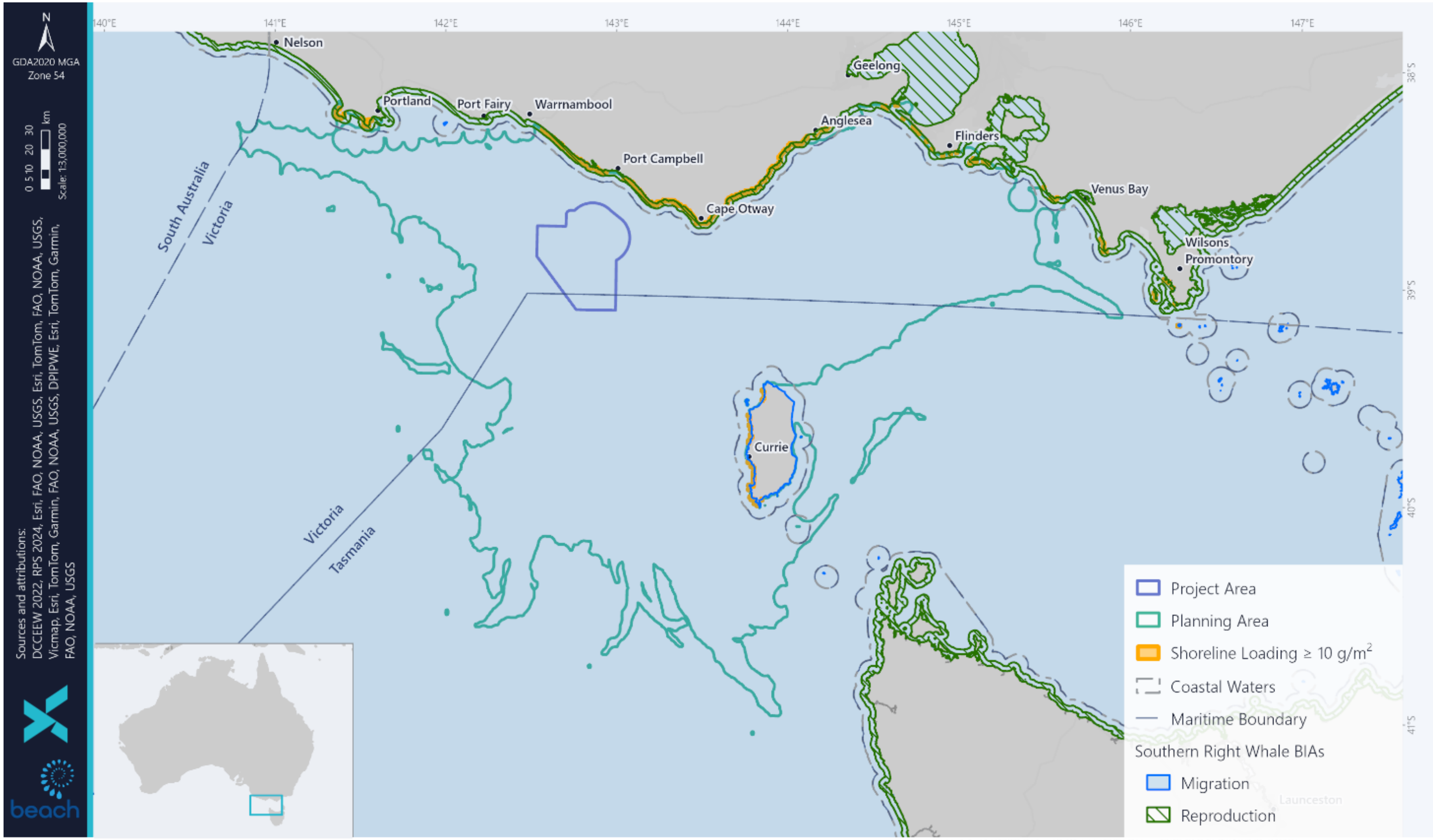
There are no known mating or calving areas in Australian waters.

i. Southern Right Whale

The southern right whale (*Eubalaena australis*) is listed as Endangered under the EPBC Act in Australia and as Endangered on the Victorian Threatened Species Advisory List.

The National Recovery Plan for the Southern Right Whale (DCCEEW 2024o) contains Biologically Important Areas, as displayed in Figure 4-60 (DCCEEW 2024).

The Project Area overlaps the southern right whale migration BIA and the Planning Area overlap the southern right whale reproduction and migration BIAs (Figure 4-60).



Sources and attributions: DCCEEW 2022, RPS 2024, Esri, FAO, NOAA, USGS, Esri, TomTom, FAO, NOAA, USGS, Vicmap, Esri, TomTom, Garmin, FAO, NOAA, USGS, DPIPWE, Esri, TomTom, Garmin, FAO, NOAA, USGS

Figure 4-60: Project and Planning Areas and Southern Right Whale BIAs

(vi) Population

Southern right whales were depleted to less than 300 individuals globally due to commercial whaling in the 19th and 20th centuries (Tormosov et al. 1998). They were protected from whaling in 1935 however, due to illegal whaling in the 1970s and because southern right whales have a slow rate of increase compared to other marine mammals, their numbers remain low (IWC 2013). Global abundance estimates are 13,000 for the species, across key wintering grounds in South Africa, Argentina, Australia, and New Zealand.

The Australian population of southern right whales is divided into two sub-populations due to genetic diversity (Carroll et al. 2011; Baker et al. 1999) and different rates of increase (DCCEEW 2024o; DSEWPaC 2012a). The western sub-population occurs predominantly between Cape Leeuwin, Western Australia (WA) and Ceduna, South Australia (SA) This sub-population comprises most of the Australian population and is estimated at 3,200 individuals increasing at an annual rate of approximately 6% p.a. (Smith et al. 2019). The eastern sub-population can be found along the south-eastern coast, including the region from Tasmania to Sydney, with key aggregation areas in Portland and Warrnambool in Victoria. The eastern sub-population is estimated at less than 300 individuals and is showing no signs of increase (Bannister, 2017). A rate of around 7% p.a. is considered the maximum biological rate of increase for southern right whales (IWC 2013). Connectivity between the two populations is unknown however, some limited movement between the two areas has been recorded (Burnell 2001, Charlton 2017, Pirzl et al. 2009).

(vii) Distribution

Southern right whales are distributed in the Southern Hemisphere with a circumpolar distribution between latitudes of 16°S and at least 65°S. They migrate from southern feeding grounds in sub-Antarctic waters to Australia in between May and November to calve, mate and rest (Bannister et al. 1996; DCCEEW 2024o). They are distributed across thirteen primary aggregation areas along the southern coast of Australia (Figure 4-61) (DCCEEW 2024o; DSEWPaC 2012a). In Australian coastal waters, they occur along the southern coastline of the mainland and Tasmania and generally extend as far north as Sydney on the east coast and Perth on the west coast (DCCEEW 2024o; DSEWPaC 2012a). There are occasional sightings further north, with the extremities of their range recorded at Hervey Bay and Exmouth (DCCEEW 2024o; DSEWPaC 2012a).

The largest established calving areas in Australia include Head of Bight in SA, and Doubtful Island Bay and Israelite Bay in WA. Smaller but established aggregation areas regularly occupied by southern right whales include Yokinup Bay in WA, Fowlers Bay in SA and the Warrnambool and Portland in Victoria. Emerging aggregation areas include Flinders Bay, Hassell Beach, Cheyne/Wray Bays, and Twilight Cove in WA, and sporadically occupied areas include Encounter Bay in SA (DCCEEW 2024o; DSEWPaC 2012a) Southern right whales generally occupy shallow sheltered bays within 2 km of shore and within water depths of less than 20 m (Charlton et al. 2019). A number of additional areas for southern right whales are emerging that might be of importance, particularly to the south-eastern population. In these areas, small but growing numbers of non-calving whales regularly aggregate for short periods of time. These areas include coastal waters off Peterborough, Port Campbell, Port Fairy, and Portland in Victoria (DCCEEW 2024o; DSEWPaC 2012a) (Figure 65).

There is variation in annual abundance on the coast of Australia due to the 3-year calving cycles (Charlton 2017). Female and calf pairs generally stay within the calving ground for 2–3 months (Burnell 2001). Peak periods for mating in Australian coastal waters are from mid-July through August

(DCCEEW 2024o; DSEWPaC 2012a). Pregnant females generally arrive during late May/early June and calving/nursery grounds are generally occupied until October (occasionally as early as April and as late as December) (Charlton et al. 2019). A study conducted by Stamation et al. (2020) shows that despite an increase in breeding females sighted in south-eastern Australian between 1985 and 2017, there is no evidence of an increase in annual numbers of mother-calf pairs.

As a highly mobile migratory species, southern right whales travel thousands of kilometres between habitats used for essential life functions. Movements along the Australian coast are reasonably well understood, but little is known of migration travel, non-coastal movements and offshore habitat use. Exactly where southern right whales approach and leave the Australian coast from, and to, offshore areas remain unknown (DCCEEW 2024o; DSEWPaC 2012a). The Victorian and Tasmania coastal waters are known to include migrating habitat and southern right whales are known to arrive at the south eastern Australian coastline and travel west to established aggregation areas in South Australia such as the Head of the Great Australian Bight (Watson et al. 2021). There is one established calving ground for female and calf pairs in south-eastern Australian at Logans Beach, Warrnambool, Victoria (Watson et al. 2021). A predominance of westward movements amongst long-range photo-identification re-sightings may indicate a seasonal westward movement in coastal habitat (Burnell 2001). Direct approaches and departures to the coast have also been recorded through satellite telemetry studies (Mackay et al. 2015).

Aerial surveys of western Bass Strait and eastern Great Australian Bight undertaken by Gill et al. (2015) detected southern right whales between May and September. A survey in early November 2010 did not observe any whales in the Warrnambool area and it was assumed that cows and calves had already left the calving and aggregation areas (M. Watson pers. comm. 2010). No southern right whales were encountered during Origin's Enterprise 3D seismic survey undertaken during November 2014 (RPS 2014), or during spotter flights of the coastline undertaken prior to the survey in late October 2014. Aerial surveys between Ceduna, SA and Sydney NSW (and included Tasmania) were undertaken in August of 2013 and 2014 and recorded a total of 34 southern right whale individuals (17 breeding females) in 2013 and 39 (11 breeding females) in 2014, respectively (Watson et al. 2015).

Marine mammal observer data from January 2021 to April 2022 for the drilling program in the Otway Development Area identified three southern right whales consisting of a single individual in June and August., and two in July (Figure 4-62).

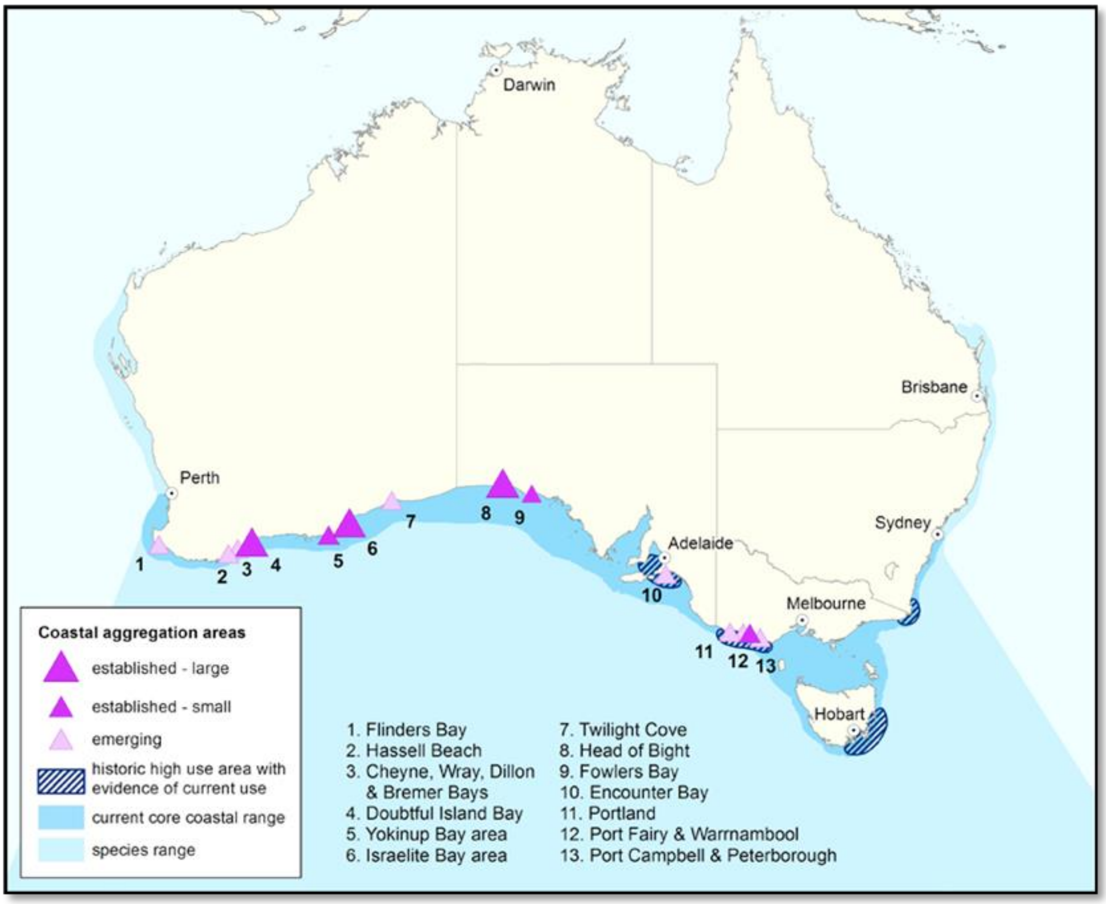
The National Recovery Plan for the Southern Right Whale (DCCEEW 2024) reports that known and potential threats that may have individual or population level impacts to southern right whales include entanglement in fishing gear, habitat degradation from coastal and offshore developments, anthropogenic underwater noise, vessel interactions and disturbance, whaling, prey depletion and pollution as well as cumulative impacts from these threats.

(viii) Cultural significance

The National Recovery Plan for the Southern Right Whale (DCCEEW 2024o) provides information on the cultural significance of southern right whales to Indigenous Australians. The plan details:

At the Great Australian Bight in South Australia, the Mirning People are whale people, and the white whale Jeedara is their totem and part of the Dreaming, which tells how the Mirning and southern right whales are connected (Burgoyne 2000). Mirning Country is the sacred place of the Mirning People, and the Yinyila Nation of Mirning clans forms a huge yerrambai, or rainbow arch, spanning the length of the coastal area of the Great Australian Bight from Point Culver in Western Australia to near Streaky Bay in South Australia (Burgoyne 2000). The Far West Coast Aboriginal Corporation (FWCAC) manages the Far West Coast Land, which belongs to the Far West Coast Aboriginal Peoples. FWCAC represents six distinct cultural groups of Aboriginal people: Mirning Peoples, the descendants of Edward Roberts, Wirangu Peoples, Yalata Peoples, Kokatha Peoples and Maralinga Tjaratja (Oak Valley) Peoples.

In Victoria, Koontapool (southern right whales) occur along the coastlines of south-west Victoria in Gunditjmara Sea Country to feed and birth. These Koontapool Woorrkngan Yakeen (Whale Birthing Dreaming Sites), are in coastal bay areas from Port Campbell to Portland, including Warrnambool. These places on Gunditjmara Country are known resting and feeding sites for mothers and calves and are directly related to Gunditjmara Neeyn (midwives), explaining why Gunditjmara is a Matrilineal Nation.



▪

Figure 4-61: Aggregation Areas for Southern Right Whales (DSEWPaC 2012a)

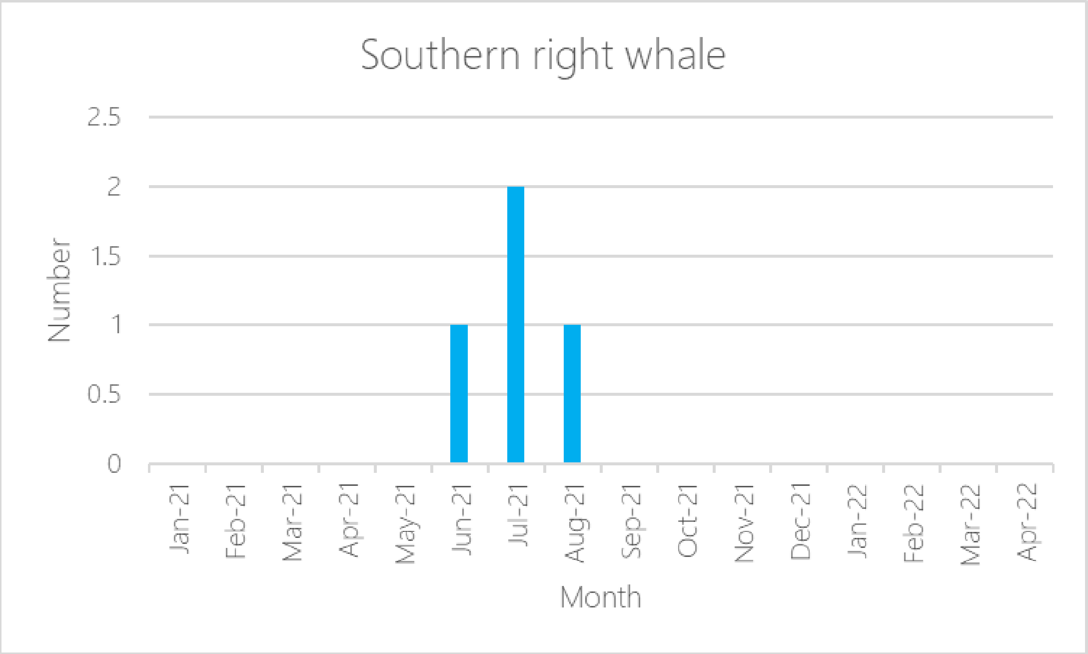


Figure 4-62: Southern Right Whale Sightings for the Otway Drilling Campaign

j. Sperm Whale

The Sperm Whale (*Physeter macrocephalus*) is listed as migratory under the EPBC Act and has a worldwide distribution, having been recorded in all Australian states. Sperm Whales tend to inhabit offshore areas with a water depth of 600 m or greater and are uncommon in waters less than 300 m deep (DoE 2023j). Key locations for the species include the area between Cape Leeuwin to Esperance (WA); south-west of Kangaroo Island (SA), deep waters of the Tasmanian west and south coasts, areas off southern NSW (e.g., Wollongong) and Stradbroke Island (Qld) (DoE 2023j). Concentrations of Sperm Whales are generally found where seabed rise steeply from a great depth (i.e., submarine canyons at the edge of the continental shelf) associated with concentrations of food such as cephalopods (DoE 2023j).

Females and young males are restricted to warmer waters (i.e., north of 45°S) and are likely to be resident in tropical and sub-tropical waters year-round (DoE 2023j). Adult males are found in colder waters and to the edge of the Antarctic pack ice. In southern Western Australian waters Sperm Whales move westward during the year. In oceanic waters, there is a more generalised movement of Sperm Whales' southwards in summer and northwards in winter (DoE 2023j).

Sperm Whales are prolonged and deep divers often diving for over 60 minutes (Bannister et al. 1996) however studies have observed Sperm Whales do rest at, or just below, surface for extended periods (>1 hr) (Gannier et al. 2002). In addition, female and juvenile Sperm Whales in temperate waters have been observed to spend several hours a day at surface resting or socialising (Hastie et al. 2003).

The Sperm Whale has been observed in the region, however the closest recognised BIA for foraging is further west near Kangaroo Island in South Australia (DCCEEW 2024a). Therefore, it is likely they would be uncommon visitors in the Project Area and Planning Area.

k. Dusky Dolphin

The Dusky Dolphin (*Lagenorhynchus obscurus)* is listed as migratory under the EPBC Act and is rarely sighted in Australian waters, with most records across southern Australia from Western Australia to Tasmania with a handful of confirmed sightings near Kangaroo Island and off Tasmania (DoE 2023k). Only 13 reports of the Dusky Dolphin have been made in Australia since 1828, and key locations are yet to be identified (Bannister et al. 1996). Therefore, it is likely that they would be uncommon visitors in the Project Area and Planning Area. The species is primarily found from approximately 55°S to 26°S, though sometimes further north associated with cold currents. They are considered to be primarily an inshore species but can also be oceanic when cold currents are present (DoE 2023k). No Dusky Dolphins were detected during Beach's Otway drilling campaign.

4.5 **Socio-economic Values**

Potential socio-economic receptors occurring within the Project Area and Planning Area are detailed in the following sections.

4.5.1 Coastal Settlements

There are no coastal settlements or Local Government Areas (LGAs) within the Project Area. The nearest settlement to the Project Area is Port Campbell. The Planning Area and potential shoreline contact are within the following LGAs (Figure 4-63):

- Bass Coast Shire

- Colac Otway Shire
- Corangamite Shire
- Flinders Council
- Glenelg Shire
- Greater Geelong City
- King Island Council
- Mornington Peninsula Shire
- Moyne Shire
- Queenscliffe Borough
- South Gippsland Shire
- Surf Coast Shire

The larger Victorian coastal settlements within the Planning Area are described below based on ABS (2021) census data:

- Anglesea has a population of 3,208 people and a median age of 54. Of those in the labour force, 54.9% work full-time and 39.9% work part-time. Professionals and managers are the most popular occupations, comprising 48.5% of the workforce.
- Apollo Bay has a population of 1,790 people and a median age of 52. Of those in the labour force, 40.05% work full-time and 44.2% work part-time. Labourers and managers are the highest occupation making up 33.9% of the workforce. Accommodation and supermarket and grocery stores are the biggest industries, making up 21.1% of employment.
- Portland has a population of 9,712 people and a median age of 45. Of those in the labour force, 50.3% work full-time and 35% work part-time. Professionals, managers and clerical workers are the most popular occupations, comprising 50.1% of the workforce. Aluminium smelting is the biggest industry, making up 8.1% of employment.
- Warrnambool, which is adjacent to the Planning Area,has a population of 35,406 and a median age of 42. Of those in the labour force, 53.3% work full-time and 36.6% work part-time. Hospitals employ 6.6% of the workforce followed by cheese and other dairy product manufacturing, aged care residential services, other social assistance services and supermarket and grocery stores. Professionals, technicians and trade workers and labourers comprise 47.7% of occupations.

The largest Tasmanian coastal settlement within the Planning Area is described below based on ABS (2021) census data:

- Currie (King Island) has a population of 659 and a median age of 49. Of those in the labour force, 63.0% work fulltime and 33.3% work part-time. Dairy and beef cattle farming comprise 34.6% of occupations.

Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_S04_A.aprx, P100383_S00_03_LGAs, P-UWS-132, 29/09/2024

Figure 4-63 Local Government Areas within the Planning Area

4.5.2 Offshore Petroleum Industry

Petroleum exploration has been undertaken within the Otway Basin since the early 1960s. Gas reserves of approximately 2 trillion cubic feet (tcf) have been discovered in the offshore Otway Basin since 1995, with production from five gas fields using 700 km of offshore and onshore pipeline. Up to 2015, the DEDJTR reports that 23 PJ of liquid hydrocarbons (primarily condensate) has been produced from its onshore and offshore basins, with 65 PJ remaining, while 85 PJ of gas has been produced (Victoria and South Australia), with 1,292 PJ remaining.

There is no non-Beach oil and gas infrastructure within the Project Area. The Cooper Energy Casino gas field and Casino-Henry pipeline and the Minerva gas field and pipeline are within the Planning Area to the north of the Project Area.

4.5.3 Offshore Renewable Energy Industry

In 2021 Australia introduced the Offshore Electricity Infrastructure Bill 2021 (Cth) (OEI Act) and in August 2022 the Federal Government announced 6 proposed areas in Australian Commonwealth waters for offshore renewable energy Projects. The Southern Ocean Region declared offshore wind area is situated off Warrnambool and Port Fairy in western Victoria and was declared by the Australian Government on 6 March 2024, which overlaps the Planning Area (Figure 4-64). The Project Area does not overlap any declared or proposed offshore wind areas. The Southern Ocean declared area is 15.2 km north-west of the Project Area.

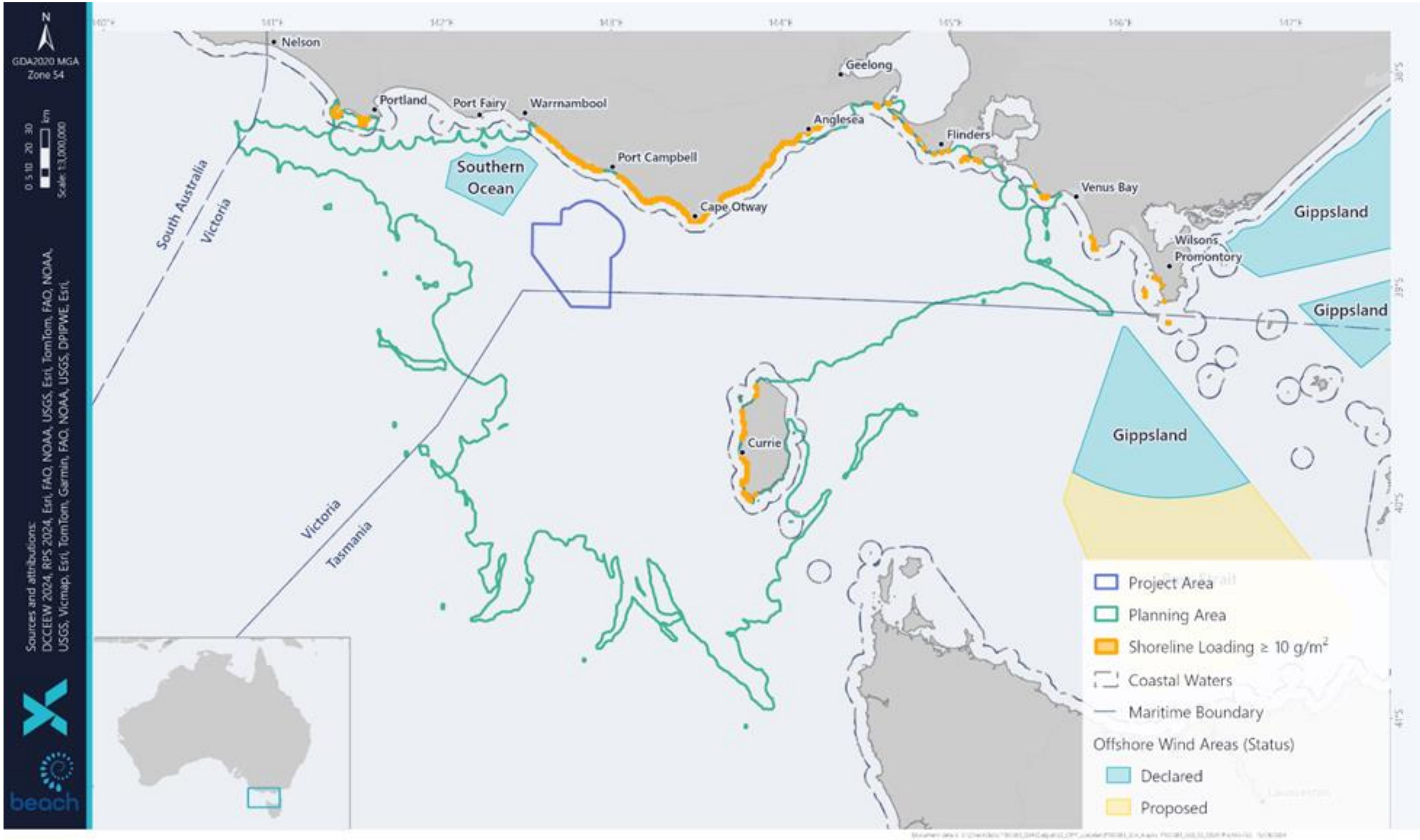


Figure 4-64: Offshore Wind Areas within the Planning Area

4.5.4 Other Infrastructure

The Victorian Desalination Plant is located at Wonthaggi, 5 km north of the Planning Area. Operation of the plant commenced in December 2012. The seawater intake and outlet structures are connected to the onshore plant via a 1.2 km and 1.5 km underground tunnel, respectively. The two intake structures are 8 m high, 13 m in diameter, situated 50 m apart and located in a water depth of 20 m. They draw in water at very low speeds (the suction effect is not strong enough to draw fish in).

The Indigo Central telecommunications cable, which connects Perth and Sydney through southern Australia, intersects the Planning Area north of King Island. There are two Telstra telecommunications cables located in central Bass Strait; Bass Strait-1, and Bass Strait-2, which intersect the east of the Planning Area (Figure 4-65).

Three new cables are planned to be installed in the next 5 years that may be within the Planning Area:

- East Coast Cable System between Melbourne, Sydney and Brisbane is being developed by Vocus.
- Hawaiki Nui – Hawaiki Submarine Cable between Melbourne and Sydney.
- Marinus Link undersea electricity and data cable that will connect Tasmania and Victoria. Construction is likely to commence in early 2025. Based on current spatial data, the cable will be 3.5 km east of the Planning Area (Figure 4-65).

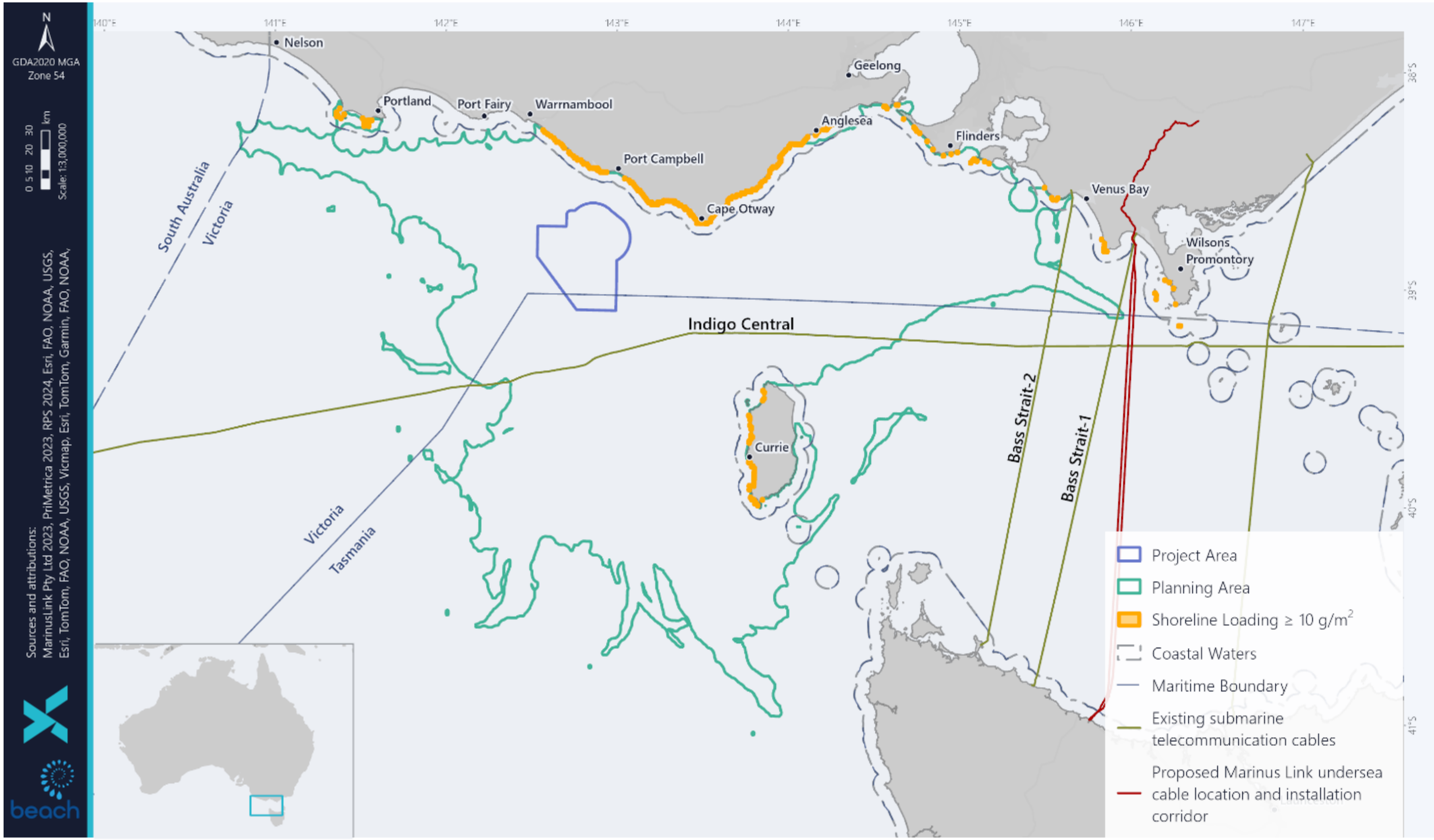


Figure 4-65: Existing Submarine Telecommunication Cables within the Project and Planning Areas

4.5.5 Defence Activities

Ongoing consultation with Department of Defence has identified that the Project Area is located within restricted airspace, but no other defence areas were identified. The Department of Defence also advised that unexploded ordnance (UXO) may be present on and in the sea floor.

UXO is a by-product of past training activities undertaken by the Australian Defence Force or foreign defence forces.

The interactive Department of Defence database (DoD 2023) indicates that the Project Area is located within a UXO Zone 1052 King Island (Figure 4-66), which is within the 'slight potential' category', meaning there is confirmed history of military activities that may have resulted in numerous residual hazardous munitions, components, or constituents, but where confirmed UXO affected areas cannot be defined (DoD 2022). The site was used during 1954 as an Air-to-Air Firing Range (DoD 2022).

Beach will undertake site surveys ahead of any seabed disturbing activities to confirm the absence of UXO within the Project Area.

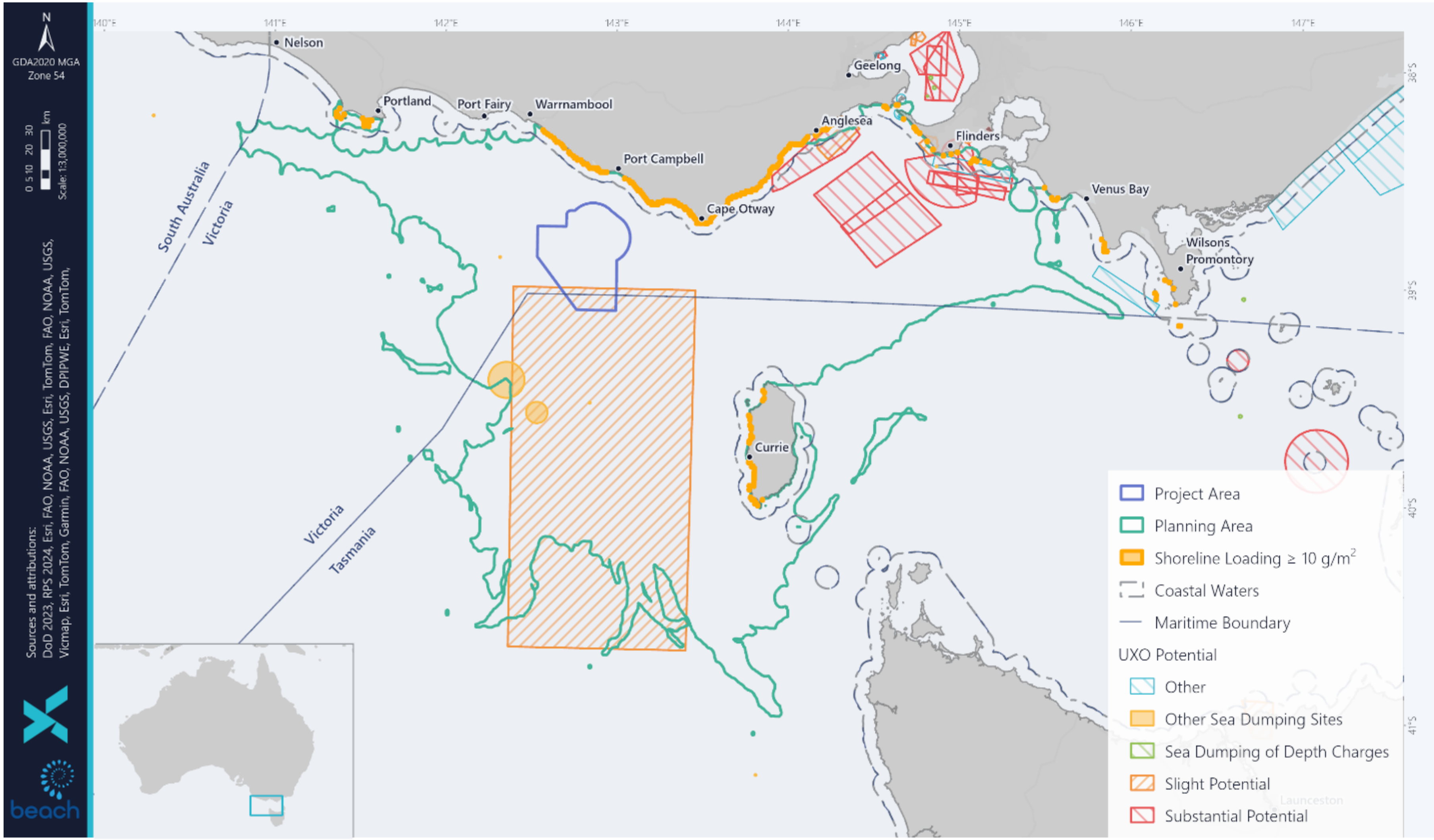


Figure 4-66: UXO within Project and Planning Areas

4.5.6 Shipping

The south-east marine region is one of the busiest shipping regions in Australia and Bass Strait is one of Australia's busiest shipping routes (Figure 4-67). Commercial vessels use the route when transiting between ports on the east, south and west coasts of Australia, and there are regular passenger and cargo services between mainland Australia and Tasmania. Automated Identification System (AIS) data from the Australian Maritime Safety Authority (AMSA 2024) provides a summary of vessels overlapping the Project Area for the period January to December 2022 (Table 4-33).

Ports Australia (2022) provide statistics for port operations throughout Australia's main commercial ports. Based on the latest information (2021) the majority of commercial shipping traffic transiting to and from Victorian ports were container (3,682), general cargo (2,663), bulk liquid carriers (2,019), dry bulk (1,715), car carrier (1,342), bulk gas (220), other cargo (47) and livestock (9).

Table 4-33: Summary of Shipping Traffic within the Project Area (AMSA 2022)

Vessel Type	**Shipping activity within Project Area**	
	Number of Vessels*	**Average Speed (kts)**
Cargo Ship	2,105	11.8
Tanker	453	11.1
Passenger	29	10.5
Other	433	2.6
Tug	196	2.0
Fishing	31	6.7
Sailing	27	4.7
Total	3,274	10
Average vessels per day	9	

*Calculated as individual vessels within Project Area each day

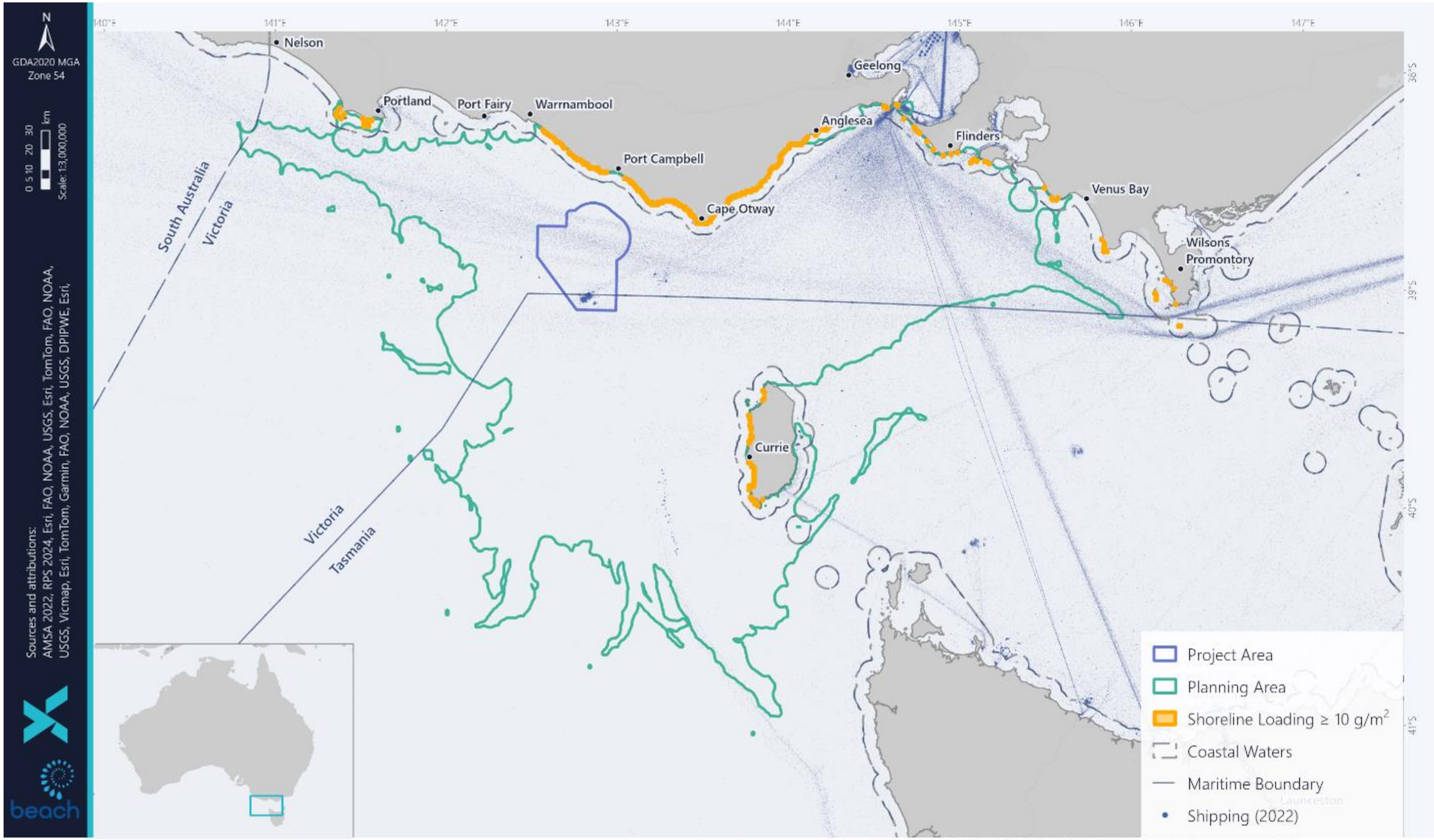


Figure 4-67: Shipping Traffic within the Project and Planning Areas

4.5.7 Tourism

Consultation has identified that the key areas of tourism in the region include land-based sightseeing from the Great Ocean Road and lookouts along that road, helicopter sightseeing, private and chartered vessels touring into the Twelve Apostles Marine Park, diving and fishing. Land-based tourism in the region peaks over holiday periods and in 2011, Tourism Victoria reported a total of approximately 8 million visitors to the Great Ocean Road region.

Local vessels accessing the area generally launch from Boat Bay in the Bay of Islands or from Port Campbell. Given the available boat launching facilities in the area (Peterborough and Port Campbell), and the prevailing sea-state of the area, vessel-based tourism is limited.

4.5.8 Recreational Diving

Recreational diving occurs along the Victorian coastline. Popular diving sites near Peterborough include a number of shipwrecks such as the Newfield, which lies in 6 m of water and the Schomberg in 8 m of water. Peterborough provides a number of good shore dives at Wild Dog Cove, Massacre Bay, Crofts Bay and the Bay of Islands. In addition, there is the wreck of the Falls of Halladale (4 to 11 m of water) which can be accessed from shore or via boat. King Island is also known for several wreck sites and the Waterwitch Reef. A number of operators in the region offer dive charters in the waters of King Island.

Consultation with local vessel charterers and providers of SCUBA tank fills has confirmed that diving activity is generally concentrated around The Arches Marine Sanctuary and the wreck sites of the Loch Ard and sometimes at the Newfield and Schomberg shipwrecks. Diving activity peaks during the Rock Lobster season with the bulk of recreational boats accessing the area launching from Boat Bay at the Bay of Islands or Port Campbell.

4.5.9 Recreational Fishing

Recreational fishing is popular in Victoria and is largely centred within Port Phillip Bay and Western Port, although beach and boat-based fishing occurs along much of the Victorian coastline.

Recreational fishing also occurs in Tasmania in coastal and offshore waters, primarily within 3 nm of the shore.

Recreational fisheries that may occur within the Planning Area are:

- Rock lobster
- Finfish (multiple species are targeted, including sharks)
- Abalone
- Scallops
- Squid
- Pipi

Of these, active recreational fishing for rock lobster, abalone, finfish, and sharks is likely to occur within the Planning Area. Recreational scallop and squid fishing primarily occurs within Port Phillip Bay and Western Port and as such fishing for these species is possible within the Planning Area. Pipi harvesting occurs in Venus Bay, adjacent to the Planning Area, but due to high levels of toxins in pipis at that location the public is currently advised that they are unsafe for human consumption.

There is the potential for low levels of recreational fishing to occur within the areas of the Project Area which are nearest to shore.

Due to the distance offshore (approximately 20 km) and the lack of emergent features, recreational fishing and tourism in the Project Area is unlikely.

4.5.10 Commonwealth Managed Fisheries

Commonwealth fisheries are managed by the Australian Fisheries Management Authority (AFMA) under the Fisheries Management Act 1991 (Cth). AFMA jurisdiction covers the area of ocean from 3 nm from the coast out to the 200 nm limit (the Australian Fishing Zone (AFZ)). Commonwealth commercial fisheries with jurisdictions to fish within the Planning Area are:

- Bass Strait Central Zone Scallop Fishery (BSCZSF)
- Eastern Tuna and Billfish Fishery (ETBF)
- Skipjack Tuna Fishery
- Small Pelagic Fishery (SPF)
- Southern Bluefin Tuna Fishery (SBTF)
- Southern and Eastern Scalefish and Shark Fishery (SESSF)
- Southern Squid Jig Fishery (SSJF)
- Western Tuna and Billfish Fishery (WBTF).

Table 4-34 details fisheries with catch and effort occurring within the Project and Planning Areas using data obtained from Fisheries Status Reports published by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) (Butler et al. 2024; ABARES 2024). The Skipjack Fishery is not currently active and management arrangements for the fishery are under review.

Information relating to the target species, fishing locations, landed catch, value and other relevant aspects of each fishery are taken from current and previous Commonwealth Fishery Status Reports (Butler et al. 2024; Butler et al. 2023; Patterson et al. 2022), unless indicated, is summarised in Table 4-34.

Figures of fishing intensity for 2016 – 2023 are provided where there is an overlap with fishing intensity and the Project Area and/or Planning Area. Relative fishing intensity shows areas where 5 or more fishing vessels operated with the relative effort expended or the catch displayed. Reporting grids show the total area where fishing occurred at a resolution of one degree (approximately 111 x 111 km). Intensity data may not be displayed where less than or equal to 5 vessels operated (policy requirement to protect commercial confidentiality of data). As this data is confidential, due to the limited number of vessels, fishing activity may have occurred anywhere within the reporting grid and not intersect with the Project Area.

Beach also commissioned the South East Trawl Fishing Industry Association (SETFIA) to provide a report on trawl and gillnet fishing activity in Otway Gas Development Phase 4 Project Area (October 2019). The report concluded the following:

- Trawl fishing in the SESSF CTS board trawl sub-sector does not occur in the Otway Gas Development Phase 4 Project area proposed footprint. It does occur to the south-east of the Project Area. The grounds around the Otway Gas Development Phase 4 Project area appear too rough for trawl fishing in its current form. For unknown reasons gillnet fishing in the SESSF GHaT gillnet sub-sector does not seem to occur within the Otway Gas Development Phase 4 Project Area. However, there is some activity from this sub-sector nearby to the east. Gillnet fishing cannot occur deeper than 183 m (100 fathoms).

There is no SESSF CTS Danish seine sub-sector fishing in the Otway Gas Development Phase 4 Project Area.

Table 4-34: Commonwealth Managed Fisheries within the Project Area and Planning Area

Fishery	Target species	Description	Fishing Effort Project Area	Fishing Effort Planning Area
Bass Strait Central Zone Scallop Fishery	Scallop (*Pecten fumatus*)	The Bass Strait Central Zone Scallop Fishery operates in the Bass Strait between Victorian and Tasmanian and starts at 20 nm from their respective coastlines. In 2023, fishing was permitted throughout the management area, except in 4 scallop beds that were closed to fishing under the harvest strategy. Fishing in 2023 was primarily concentrated in the western Bass Strait. Additional information for the 2023 season includes: Active boats – 9 (using towed dredges) (2022 season – 10) Fishing season – 8 July to 31 December. Major landing ports – Apollo Bay and Queenscliff. Actual catch – 2,063 tonnes (2022 season – 495 tonnes; 2021 season – 2,344 tonnes). Total fishery value – A$1.4 million (2022 season – A$1.3 million; 2021 season – A$4.4 million). Sensitivities – Target species can be prone to die-off events (e.g. in 2010 and 2011) and disease (paralytic shellfish toxin in 2014). Target species is not listed under the EPBC Act. Existing pressures – Target species within the Bass Strait (between Victoria and Tasmania) are classified as not overfished and not subject to overfishing. Activity trends – Fishing intensity data between 2016 and 2023 (ABARES 2024) shows no significant shift in the location of either low, medium or high intensity fishing activity within the Bass Strait Central Zone Scallop Fishery. No fishing intensity data between 2016 and 2023 overlaps the Project Area (Figure 4-68). However, the Project Area is overlapped by reporting grids which contain confidential data due to less than 5 vessels operating. The Planning Area overlaps areas of low to high relative fishing intensity which is concentrated to the east of King Island (Figure 4-68).	Yes*	Yes
Eastern Tuna and Billfish Fishery	Albacore Tuna (*Thunnus alulunga*) Bigeye Tuna (*T. obesus*) Yellowfin Tuna (*T. albacares*) Broadbill Swordfish (*Xiphias gladius*)	The Eastern Tuna Billfish Fishery is a longline and minor-line fishery that operates in water depths >200 m from Cape York to Victoria. Fishing effort is typically concentrated along the NSW coast and southern Queensland coast. No Victorian ports are used. Fishing in 2023 was primarily concentrated off the east coast of Australia from Queensland to New South Wales. Additional information for the 2023 season includes: Active boats – 34 longline, 12 minor line (2022 season – 36 longline, 6 minor line) Fishing season – 1 January – 31 December Major landing ports – Bermagui, Cairns, Coffs Harbour, Mooloolaba, Southport, Ulladulla	Yes	Yes

	Striped Marlin (*Tetrapturus audux*)	Actual catch — 4,040 tonnes (2022 season – 4,032 tonnes) Total fishery value — A$40.1 million (2022 season – A$34.7 million). Existing pressures – Striped Marlin overfished. Activity trends – Fishing intensity data between 2016 and 2023 (ABARES 2024) shows no significant shift in the location of either medium or high intensity fishing within the Eastern Tuna and Billfish Fishery. A small increase in low intensity fishing was noted near Flinders outside of the Project Area. No fishing intensity data between 2016 and 2023 overlaps the Project Area. The Planning Area overlaps an area of low relative intensity near Flinders (Figure 4-69). The Project Area and Planning Area overlap reporting grids which contain confidential data due to less than 5 vessels operating (Figure 4-69).		
Skipjack Tuna Fishery (Eastern and Western)	Skipjack Tuna (*Katsuwonus pelamis*)	The Skipjack Tuna Fishery is not currently active and the management arrangements for this fishery are under review. There has been no catch effort in this fishery since the 2008 -2009 season.	No	No
Small Pelagic Fishery (Western sub-area)	Australian Sardine (*Sardinops sagax*) Blue Mackerel (*Scomber australasicus*) Jack Mackerel (*Trachurus declivis*) Redbait (*Emmelichthys nitidus*)	The Small Pelagic Fishery extends from the southern Queensland to southern Western Australia. Fishers use midwater trawls and purse seine nets. Fishing in 2023 was primarily concentrated along the southern coast of New South Wales into Gippsland and the eastern coast of South Australia. Activity trends – Fishing intensity data between 2016 and 2023 is not available. However there is no significant shift in the location of reporting grids showing fishing activity (containing confidential data due to less than 5 vessels operating) within the Small Pelagic Fishery (Western sub-area). There has been no fishing effort reported in the Project Area or Planning Area between 2016 and 2023.	No	No
Southern and Eastern Scalefish and Shark Fishery (SESSF) Commonwealth Trawl Sector (CTS) Danish-seine	Blue-eye trevalla (*Hyperoglyphe antarctica*) Blue grenadier (*Macruronus novaezelandiae*) Blue warehou (*Seriolella brama*) Deepwater sharks (up to 18 spp.) Eastern school whiting (*Sillago flindersi*)	The Commonwealth Trawl Sector (CTS) is part of the SESSF and extends from Barrenjoey Point in northern New South Wales to Kangaroo Island in South Australia. Management of the CTS is separated into demersal otter-board trawl and Danish-seine fishing methods. Danish-seine fishing in 2023 was generally concentrated along the 200 m bathymetric contour from the east coast of Tasmania to the Gippsland coast. Additional information for the 2023 season includes: Active boats – 18 (2022 season – 18) Fishing season – 1 May – 30 April Major landing ports – Eden, Hobart, Lakes Entrance, Portland, Sydney, Ulladulla Actual catch — 10,854 tonnes (combined with otter-board trawl) (2022 season – 11,257 tonnes)	Yes	Yes

	Flathead (*Neoplatycephalus richardsoni*) Orange roughy (*Hoplostethus atlanticus*) Pink ling (*Genypterus blacodes*)	Total fishery value — A$65.9 million (2022 - entire CTS including otter-board trawl and scalefish hook). 2023 financials not published. Existing pressures – Some species overfished or subject to overfishing. Activity trends – Fishing intensity data between 2016 and 2023 (ABARES 2024) shows no significant shift in the location of fishing intensity within the Danish-seine sector of the Commonwealth Trawl Sector (CTS) Fishery. No fishing intensity has been identified within the Project Area during 2016-2023. The Project Area overlaps reporting grids which contain confidential data due to less than 5 vessels operating. The Planning Area overlaps low to medium fishing intensity near Phillip Island (Figure 4-70).		
Southern and Eastern Scalefish and Shark Fishery (SESSF) Commonwealth Trawl Sector (CTS): Otter-board trawl	Blue-eye trevalla (*Hyperoglyphe antarctica*) Blue grenadier (*Macruronus novaezelandiae*) Blue warehou (*Seriolella brama*) Deepwater sharks (up to 18 spp.) Eastern school whiting (*Sillago flindersi*) Flathead (*Neoplatycephalus richardsoni*) Orange roughy (*Hoplostethus atlanticus*) Pink ling (*Genypterus blacodes*)	The Commonwealth Trawl Sector (CTS) is part of the SESSF and extends from Barrenjoey Point in northern New South Wales to Kangaroo Island in South Australia. Management of the CTS is separated into demersal otter-board trawl and Danish-seine fishing methods. Otter-board trawl fishing in 2023 was generally concentrated along the 200 m bathymetric contour from Adelaide to Ulladulla. Additional information for the 2023 season includes: Active boats – 24 (2022 season – 31) Fishing season – 1 May – 30 April Major landing ports – Eden, Hobart, Lakes Entrance, Portland, Sydney, Ulladulla Actual catch — 10,854 tonnes (combined with Danish-seine) (2022 season – 11,257 tonnes) Total fishery value — A$65.9 million (2022 - entire CTS including Danish-seine and scalefish hook). 2023 financials not published. Existing pressures – Some species overfished or subject to overfishing. Activity trends – Fishing intensity data between 2016 and 2023 (ABARES 2024) shows no significant shift in the location of fishing intensity within the otter-board trawl sector of the Commonwealth Trawl Sector (CTS) Fishery. The Project Area and Planning Area overlap a band of relative fishing intensity from 2016-2023 which follows the 200 m bathymetry contour (Figure 4-71). Only low relative intensity overlaps the Project Area.	Yes	Yes
Southern and Eastern Scalefish and Shark Fishery (SESSF)	Blue-eye trevalla (*Hyperoglyphe antarctica*) Blue grenadier (*Macruronus novaezelandiae*)	The Scalefish Hook Sector (SHS) is primarily in the south-east of Australia with most fishing intensity occurring off the coast of Tasmania. The SHS is managed under the Gillnet, Hook and Trap Sector (GHTS) of the SESSF. The broader SESSF stretches south from Fraser Island in southern Queensland, around Tasmania, to Cape Leeuwin in southern Western Australia. The SHS shares target species with the CTS. Scalefish hook fishing in 2023 was generally concentrated along the 200 m bathymetric contour. Additional information for the 2023 season includes:	Yes	Yes

Gillnet, Hook and Trap Sector (GHTS) Scalefish Hook Sector (SHS)	Blue warehou (*Seriolella brama*) Deepwater sharks (up to 18 spp.) Eastern school whiting (*Sillago flindersi*) Flathead (*Neoplatycephalus richardsoni*) Orange roughy (*Hoplostethus atlanticus*) Pink ling (*Genypterus blacodes*)	Active boats – 13 (2022 season – 12) Fishing season – 1 May – 30 April Major landing ports – Eden, Hobart, Lakes Entrance, Portland, Sydney, Ulladulla Actual catch — 719 tonnes (2022 season – 715 tonnes) Total fishery value — A$65.9 million (2022 - entire CTS including otter-board trawl and Danish-seine). 2023 financials not published. Existing pressures – Some species overfished or subject to overfishing. Activity trends – Fishing intensity data between 2016 and 2023 shows no significant shift in the location of reporting grids within the SHS Fishery. Relative fishing intensity data is not published for the SHS fishery and spatial data for the 2023 fishing season is not yet available but is mapped in the fishery status report (ABARES 2024). The Project Area and Planning Area overlap reporting grids for the SHS which contain confidential data due to less than 5 vessels operating (Figure 4-72).		
Southern and Eastern Scalefish and Shark Fishery (SESSF) Gillnet, Hook and Trap Sector (GHTS) Shark Gillnet and Shark Hook Sectors (SGSHS) Shark Gillnet subsector	Elephantfish (*Callorhinchus milii*) Gummy Shark (*Mustelus antarcticus*) Sawsharks (*Pristiophorus cirratus, P. nudipinnis*) School Shark (*Galeaorhinus galeus*)	The Shark Gillnet and Shark Hook Sectors (SGSHS) are part of the Gillnet, Hook and Trap Sector (GHTS) of the Southern and Eastern Scalefish and Shark Fishery (SESSF). Most fishing in the SGSHS using nets occurs in the Bass Strait while most fishing using hooks occurs off South Australia. Shark gillnet fishing in 2023 was concentrated in the waters between Victoria and Tasmania, with the highest intensity occurring off the Gippsland coast and Flinders Island. Additional information for the 2023 season includes: Active boats – 31 (2022 season – 30) Fishing season – 1 May – 30 April Major landing ports – Adelaide, Devonport, Hobart, Lakes Entrance, Port Lincoln, Port Welshpool, Robe, San Remo Actual catch – 1,700 tonnes (combined with Shark Hook sector) (2022 season – 1,661 tonnes) Total fishery value – A$21.6 million (2022 – including Shark Hook sector). 2023 financials not published. Existing pressures – Elephantfish has no reliable indicators of fishing mortality or biomass; Schoolshark overfished Activity trends – Fishing intensity data between 2016 and 2023 (ABARES 2024) shows a slight shift to the east of the Project Area in the location of low, medium and high intensity fishing within the Shark Gillnet Fishery. There has been fishing intensity in the Project Area and Planning Area from 2016-2023 (Figure 4-73Figure 4-73). The northern-most portion of the Project Area overlaps an area of low to medium relative fishing intensity. Areas of low to high fishing intensity occur within the Planning Area throughout the Bass Strait and along the Victorian coast.	Yes	Yes

Southern and Eastern Scalefish and Shark Fishery (SESSF) Gillnet, Hook and Trap Sector (GHTS) Shark Gillnet and Shark Hook Sectors (SGSHS) Shark Hook subsector	Elephantfish (*Callorhinchus milii*) Gummy Shark (*Mustelus antarcticus*) Sawsharks (*Pristiophorus cirratus, P. nudipinnis*) School Shark (*Galeaorhinus galeus*)	The Shark Gillnet and Shark Hook Sectors (SGSHS) are part of the Gillnet, Hook and Trap Sector (GHTS) of the Southern and Eastern Scalefish and Shark Fishery (SESSF). Most fishing in the SGSHS using nets occurs in the Bass Strait while most fishing using hooks occurs off South Australia. Shark hook fishing in 2023 was concentrated along the coast of South Australia, Victoria and Tasmania, with the highest intensity occurring off Cape Jaffa in South Australia. Additional information for the 2023 season includes: Active boats – 68 (2022 season – 57) Fishing season – 1 May – 30 April Major landing ports – Adelaide, Devonport, Hobart, Lakes Entrance, Port Lincoln, Port Welshpool, Robe, San Remo Actual catch – 1,700 tonnes (combined with Shark Gillnet sector) (2021 season – 1,661 tonnes) Total fishery value – A$21.6 million (2022 – including Shark Gillnet sector). 2023 financials not published. Existing pressures – Elephantfish has no reliable indicators of fishing mortality or biomass; School shark overfished Activity trends – Fishing intensity data between 2016 and 2023 (ABARES 2024) shows an increase in activity in South Australian water for 2019 and 2020, decreasing thereafter but with no significant shift in the location of the fishing intensity within the Shark Hook subsector. A small increase in relative intensity also occurred in 2023 near Hunter Island and Three Hummock Island in the north east of Tasmania outside of the Planning Area. The Project Area and Planning Area overlap reporting grids which contain confidential data due to less than 5 vessels operating (Figure 4-74).	Yes	Yes
Southern Bluefin Tuna Fishery	Southern Bluefin Tuna (*Thunnus maccoyii*)	The Southern Bluefin Tuna Fishery covers the entire sea area around Australia, out to 200 nm from the coast. The majority of catch since 1992 has been taken in the Great Australian Bight via purse seine. Longline fishing effort is more common along the east coast. Fishing effort in 2022 was concentrated off the coasts of South Australia and southern New South Wales. Data is not yet published for the 2023 season. Additional information for the 2022 season includes: Active vessels – 24 longline, 6 purse seine (2021 – 22 longline, 8 purse seine) Fishing season – 1 December to 30 November Major landing ports – Port Lincoln Actual catch – 6,034 tonnes (2021 – 5,972 tonnes) Total fishery value – A$32.6 million (2021 – A$35.5 million) Existing pressures – Not overfished or subject to overfishing. Activity trends – Fishing intensity data between 2016 and 2023 (ABARES 2024) shows no significant shift in the location of either low, medium or high intensity fishing within the Southern Bluefin Tuna Fishery. The Project Area and Planning Area overlap reporting grids which contain confidential data due to less than 5 vessels operating (Figure 4-75).	Yes	Yes

Southern Squid Jig Fishery	Gould's Squid (Arrow Squid) (*Nototodarus gouldi*)	The Southern Squid Jig Fishery is a single species fishery that operates year-round. Portland and Queenscliff are the major Victorian landing ports. Jigging typically occurs midwater at depths between 50 and 100 m at night using large lights that illuminate the waters around a boat. Fishing effort for the Southern Squid Jig Fishery in 2023 was concentrated off Victoria and north-eastern Tasmanian coasts, with the highest intensity occurring near Portland and off the east coast of Tasmania. Fishing effort for the CTS squid catch in 2023 followed the 200 m bathymetry contour from New South Wales to the east coast of Tasmania and between Cape Otway and Robe. Additional information for the 2023 season includes: Active vessels – 6 (2021 – 8) Fishing season – 1 January – 31 December Major landing ports – Apollo Bay, Lakes Entrance, Portland, Queenscliff, Triabunna Actual catch – 394 tonnes (2021 – 982 tonnes) Total fishery value – A$1.86 million (2021 – A$3.30 million) Existing pressures – Not overfished or subject to overfishing. Activity trends – Fishing effort in 2023 increased to 4,509 jig-hours from 8 vessels from 1,320 jig-hours from 6 vessels in 2022. Fishing mortality: Not subject to overfishing. Biomass: Not overfished. The Project Area overlaps an area of low relative fishing intensity as well as reporting grids which contain confidential data due to less than 5 vessels operating. The Planning Area overlaps areas of low to high intensity north of King Island and off the coast of Warrnambool (Figure 4-76).	Yes	Yes
Western Tuna and Billfish Fishery	Albacore (*Thunnus alalunga*) Bigeye Tuna (*T. obesus*) Striped Marlin (*Kajikia audax*) Swordfish (*Xiphias gladius*) Yellowfin Tuna (*Thunnus albacares*)	The Western Tuna and Billfish Fishery primarily uses pelagic longline gear with low levels of minor-line fishing. The management area extends west from the eastern border of South Australia to Cape York, including Cocos Keeling Islands and Christmas Island. Fishing effort in 2023 was mostly concentrated in south-west Western Australia. Additional information for the 2023 season includes: Active vessels – 2 longline, 1 minor line (2022 – 2 longline, 3 minor line) Fishing season – 1 July – 30 June Major landing ports – Fremantle, Geraldton Actual catch – 208 tonnes (2022 – 146 tonnes) Total fishery value – confidential	No	Yes

	Existing pressures – Striped marlin overfished; Bigeye Tuna and Yellowfin Tuna subject to overfishing. Activity trends – Fishing intensity data between 2016 and 2023 is not available. However, there is no significant shift in the location of reporting grids showing fishing activity (containing confidential data due to <5 vessels operating) within the Western Tuna and Billfish Fishery. The Planning Area overlaps a reporting grid which contains confidential data due to less than 5 vessels operating (Figure 4-77). There has been no fishing effort identified in the Project Area.

* *Planning Area overlapped by an area designated as a reporting grid at a resolution of one degree (approximately 111 x 111 km).*

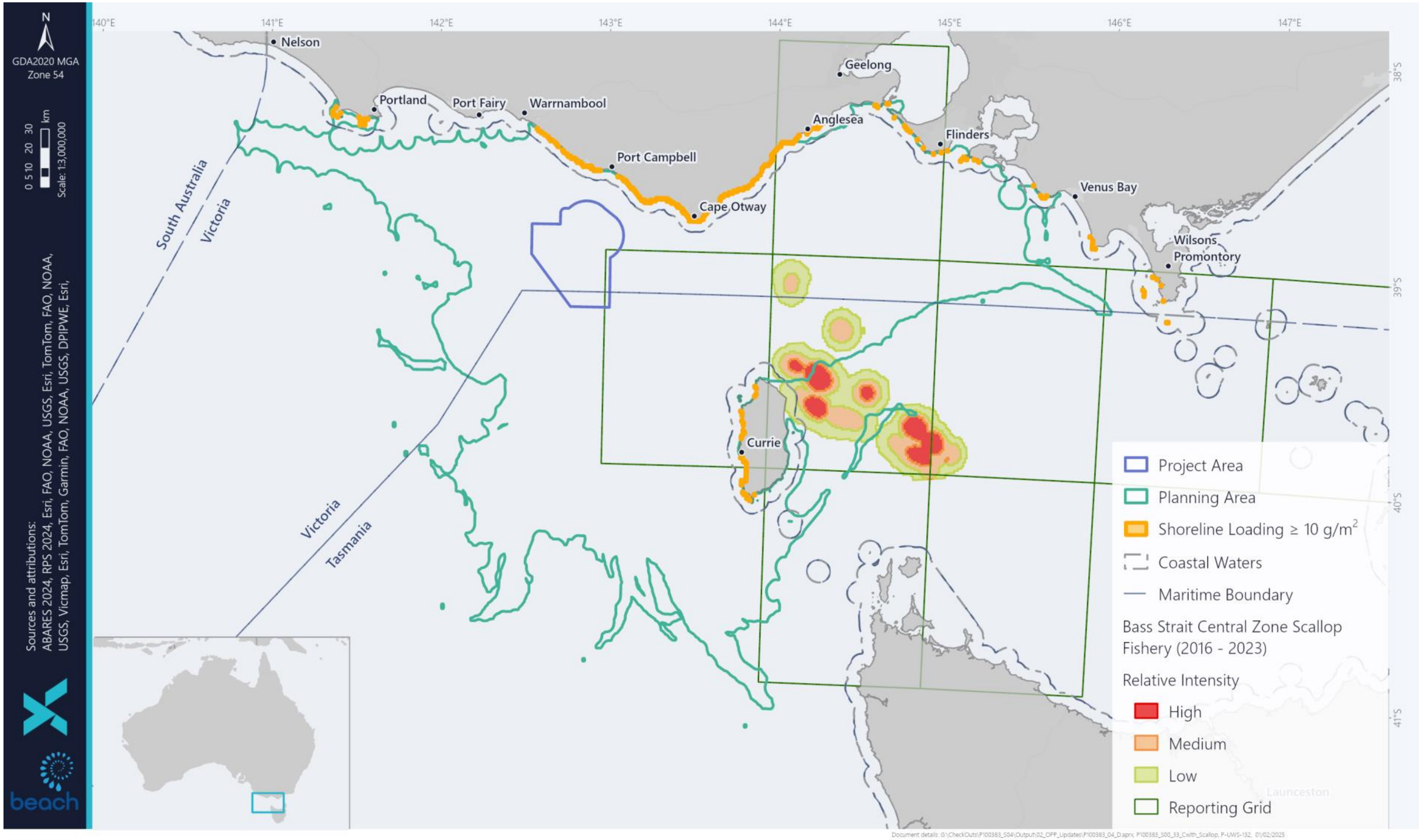


Figure 4-68: Commonwealth Bass Strait Central Zone Scallop Fishery Relative Fishing Intensity (shell weight kg/km^2) and reporting grid

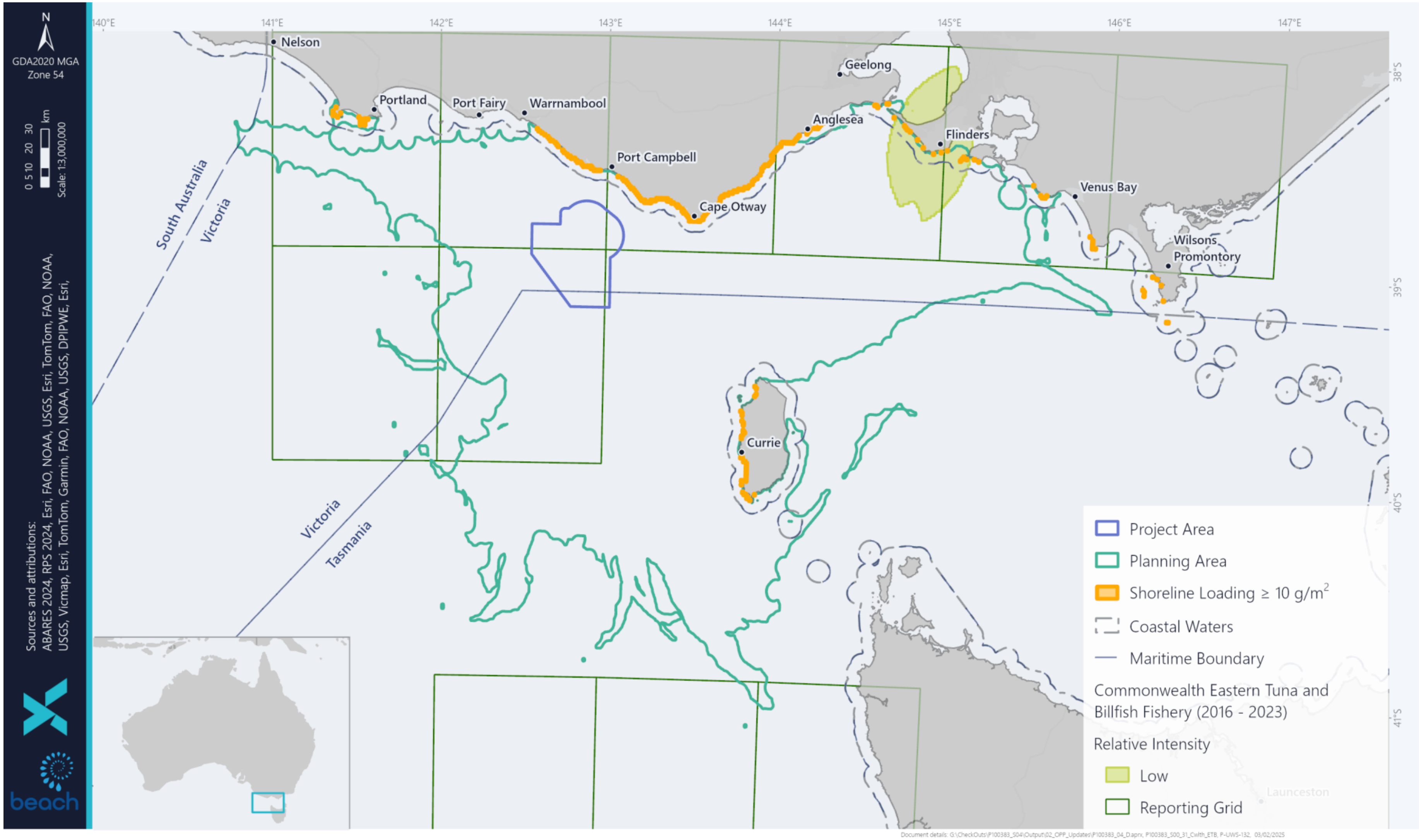
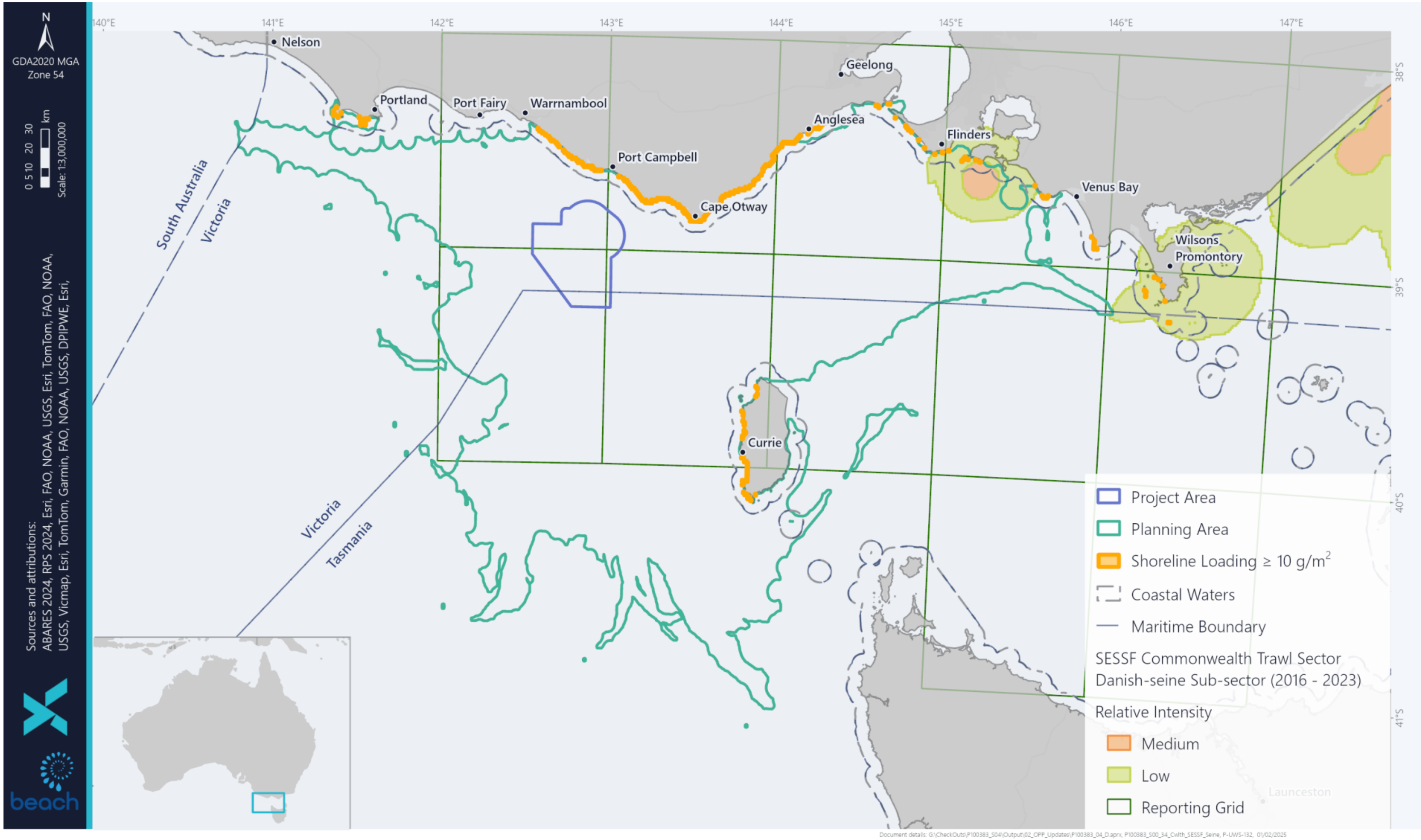


Figure 4-69: Commonwealth Eastern Tuna and Billfish Fishery Relative Fishing Intensity (number of hooks/km^2) and reporting grid



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_04_D.aprx, P100383_S00_34_Cwlth_SESSF_Seine, P-UWS-132, 01/02/2025

Figure 4-70: Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector) Danish-seine Fishery Relative Fishing Intensity (shots/km^2) and reporting grid

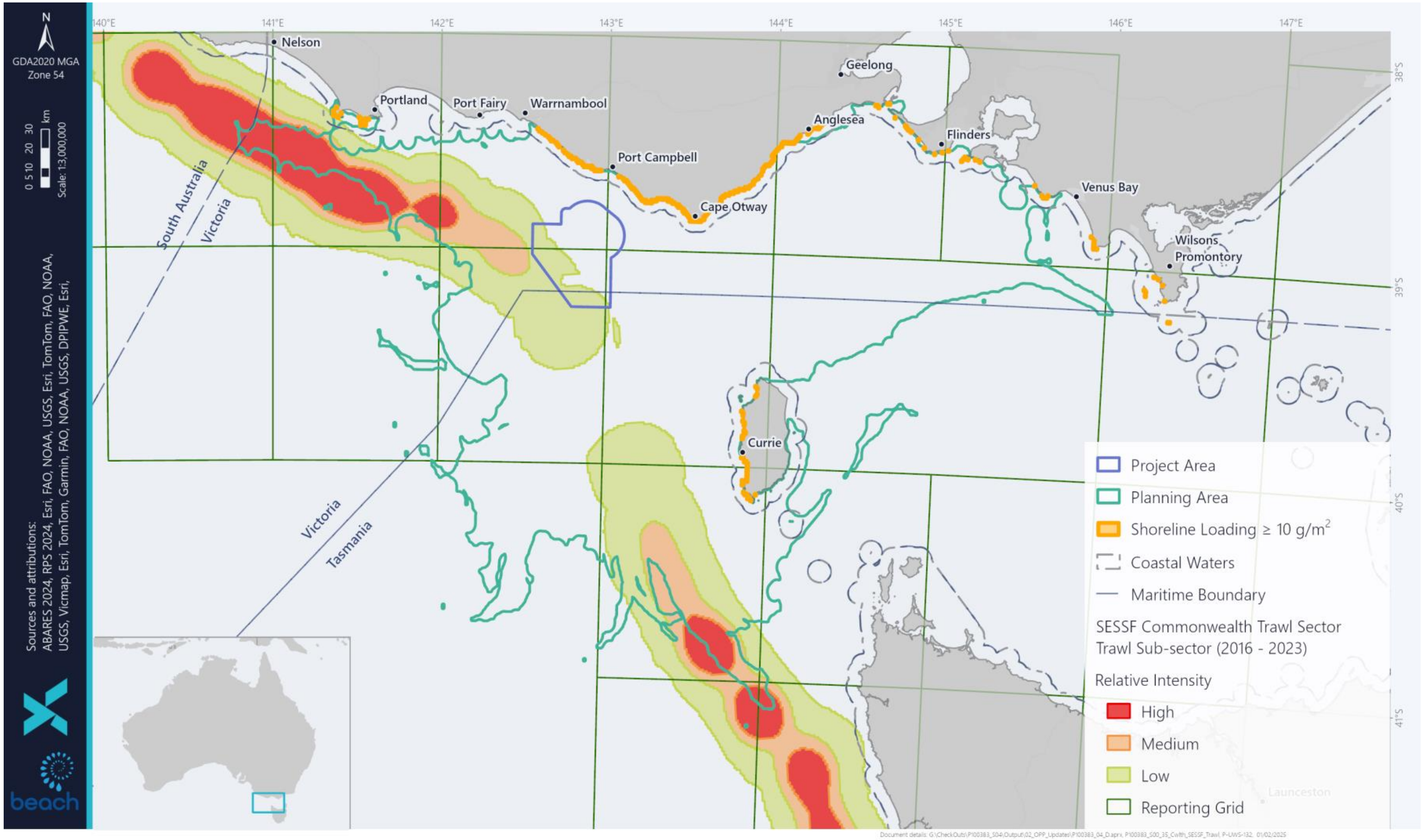
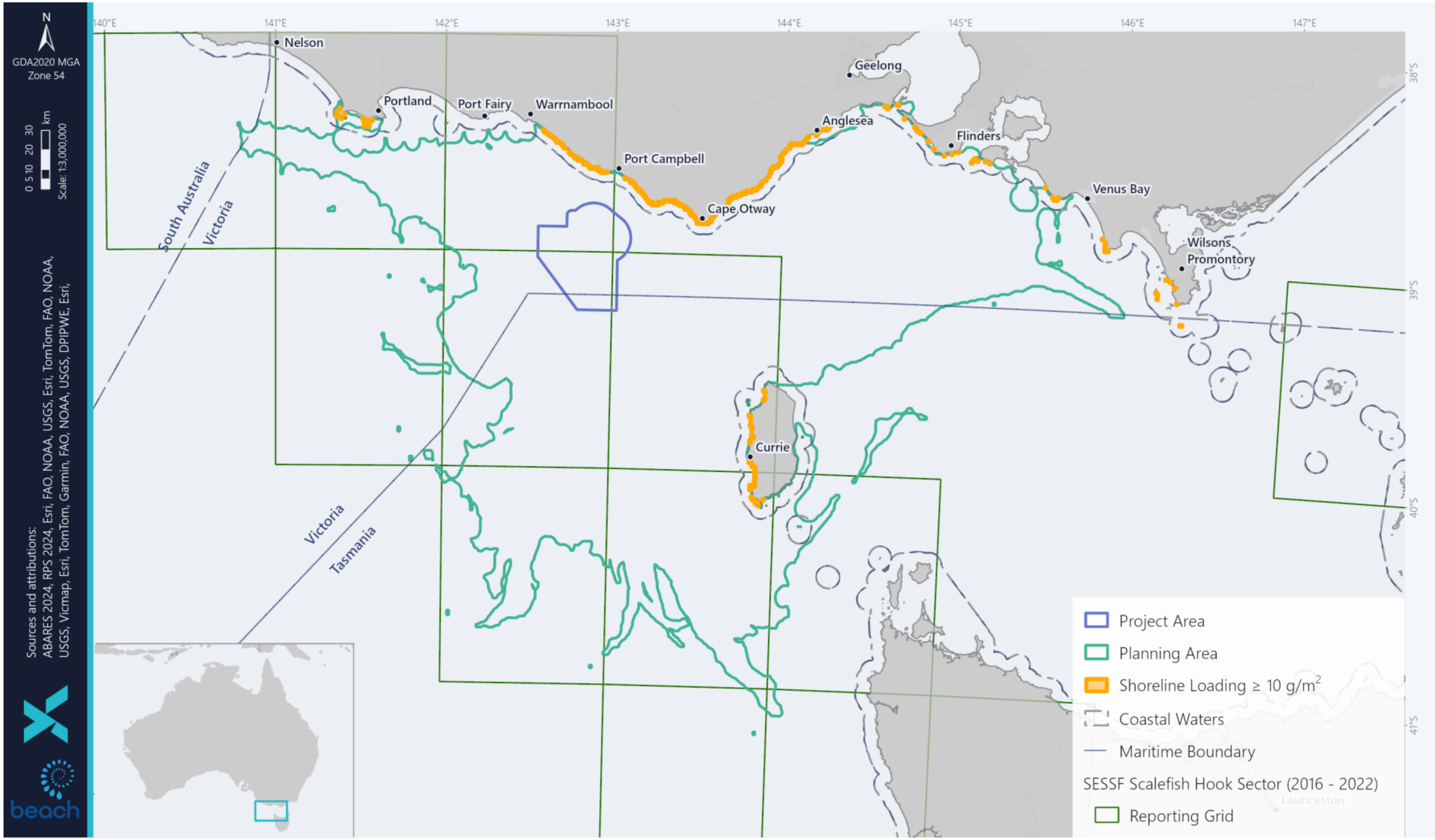
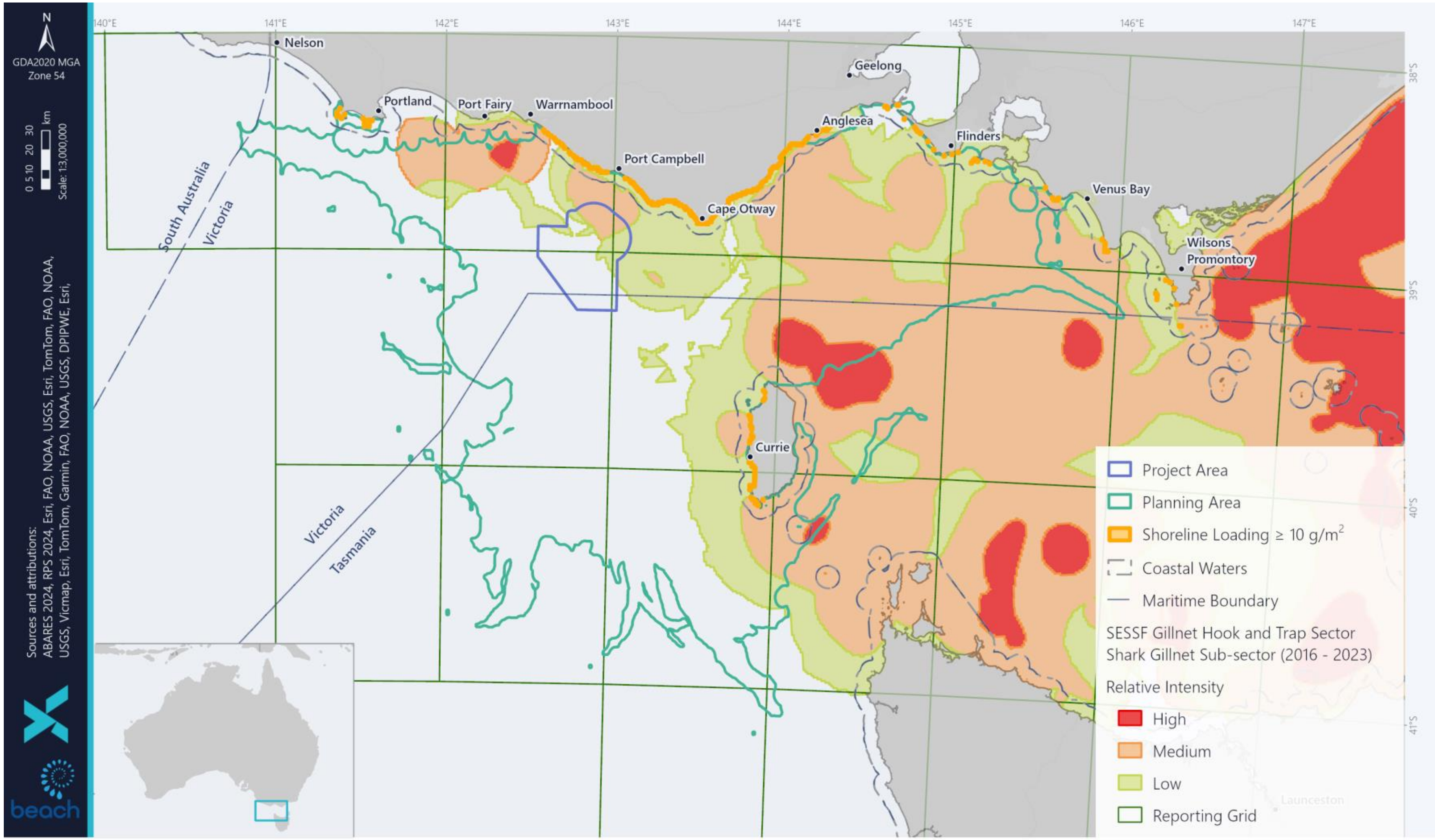


Figure 4-71: Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector) Otter Board Trawl Fishery Relative Fishing Intensity (hours fished/km^2) and reporting grid



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_04_D.aprx, P100383_S00_38_Cwlth_SESSF_ScalefishHook, P-UWS-132, 15/09/2024

Figure 4-72: Southern and Eastern Scalefish and Shark Fishery (Scalefish Hook Sector) Fishery Relative Fishing Intensity (number of hooks/km²) and reporting grid



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_04_D.aprx, P100383_S00_36_Cwlth_SESSF_Gillnet, P-UWS-132, 01/02/2025

Figure 4-73: Southern and Eastern Scalefish and Shark Fishery (Gillnet Hook and Trap Sector) Shark Gillnet Sub-sector Fishery Relative Fishing Intensity (net length, m/km^2) and reporting grid

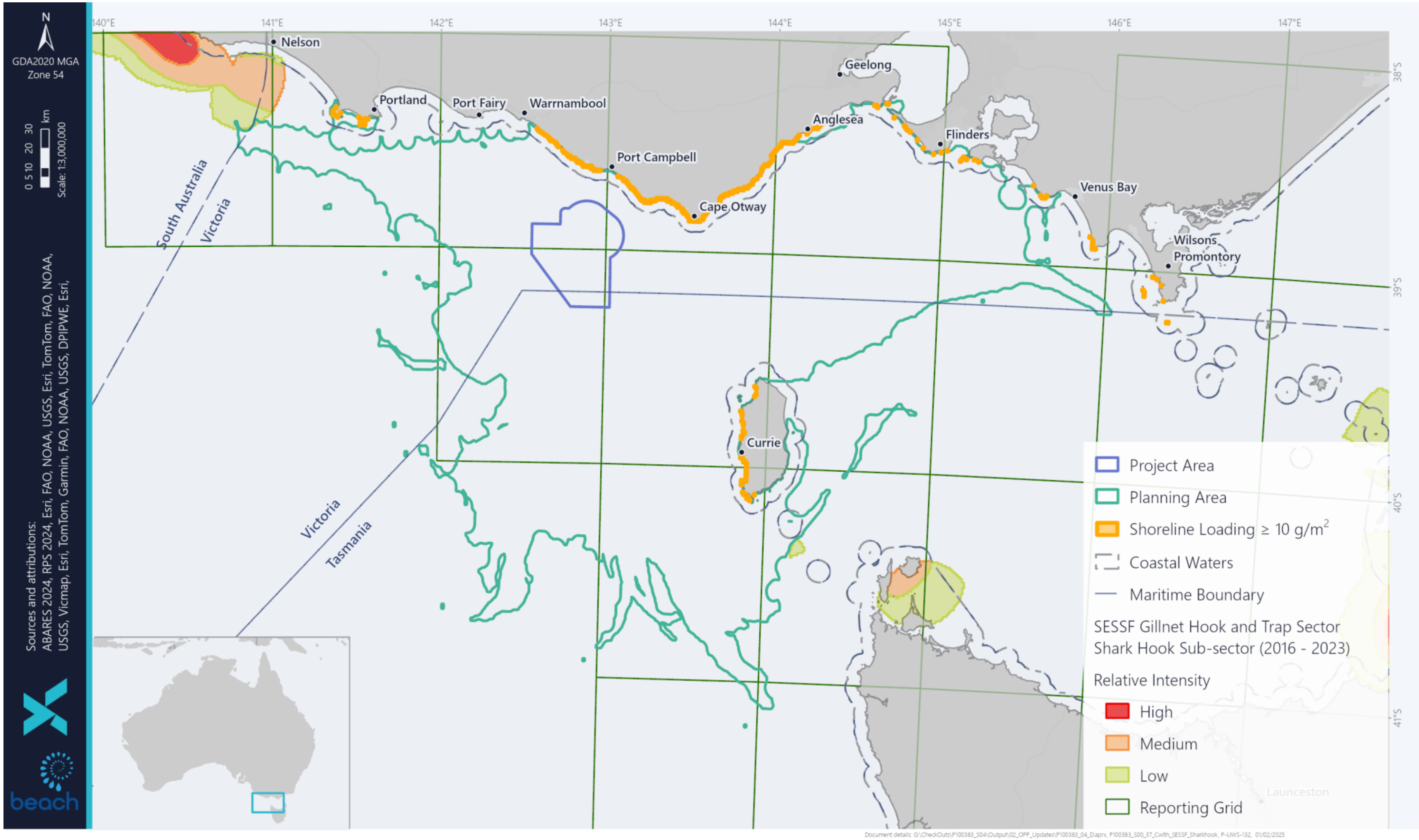
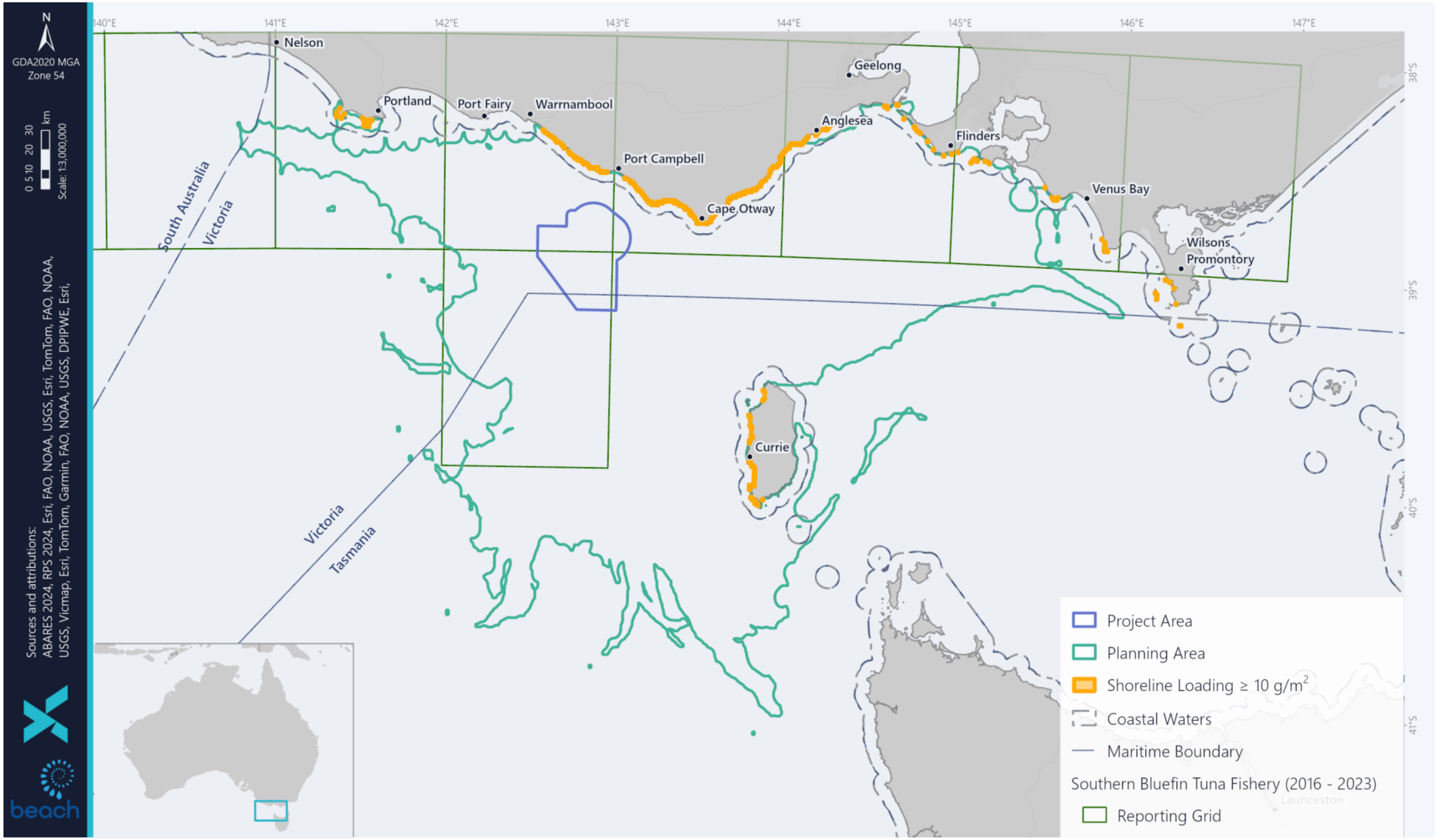
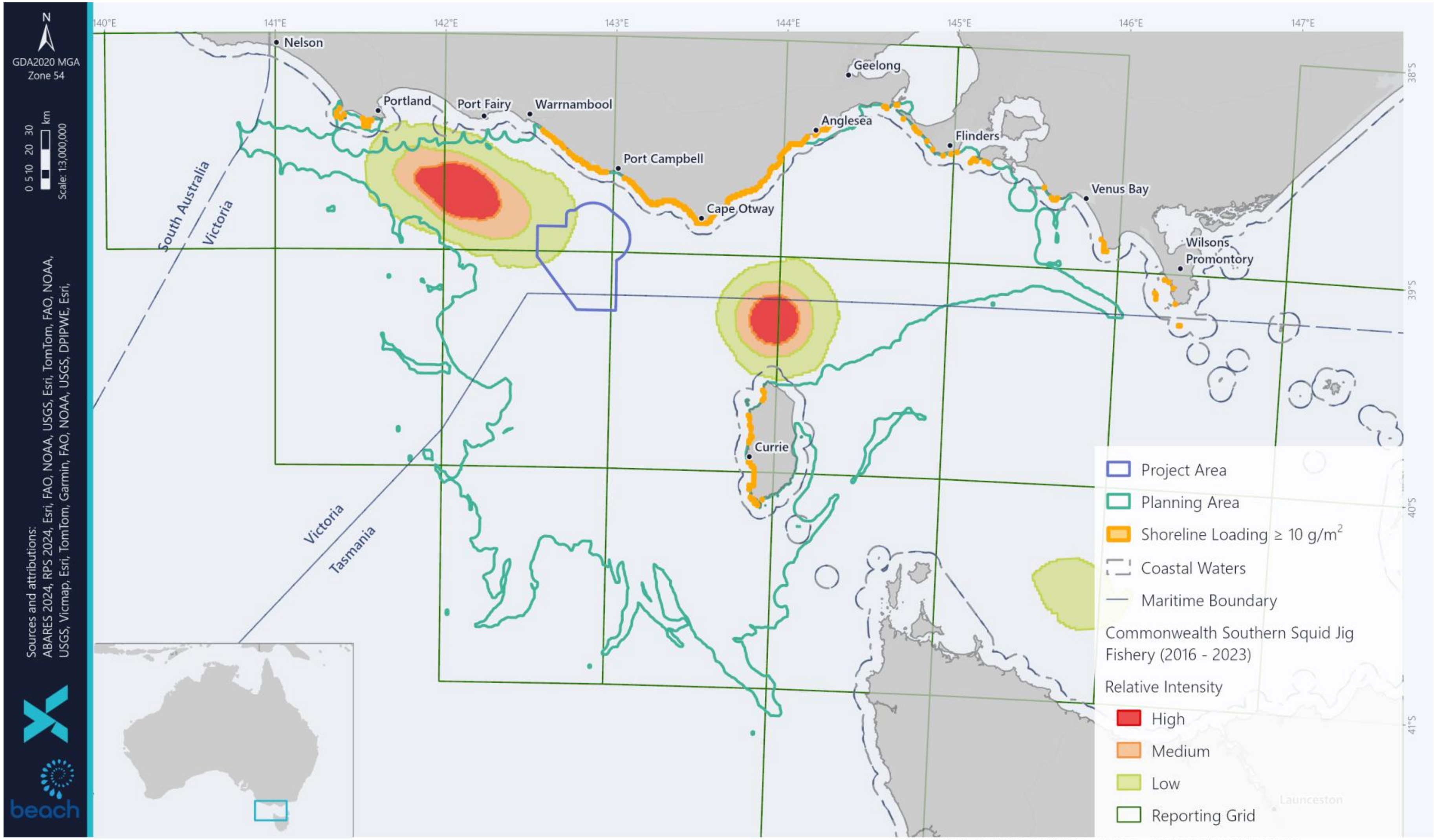


Figure 4-74: Southern and Eastern Scalefish and Shark Fishery (Gillnet Hook and Trap Sector) Shark Hook Fishery Relative Fishing Intensity (number of hooks/km^2) and reporting grid



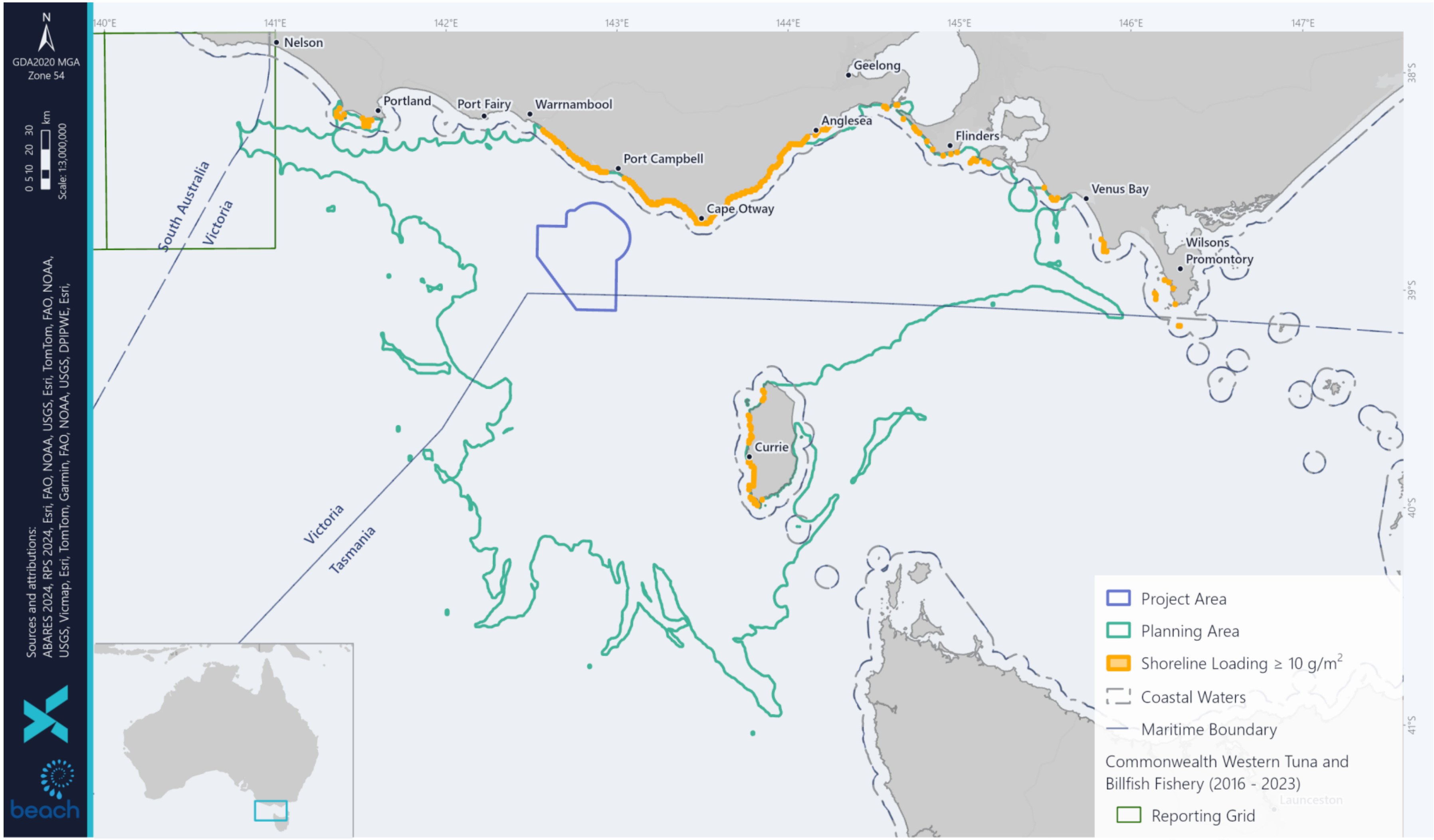
Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_04_D.aprx, P100383_S00_50_Cwlth_SouthernBluefishTuna, P-UWS-132, 03/02/2025

Figure 4-75: Commonwealth Southern Blue Fin Tuna Fishery Relative Fishing Intensity for Purse Seine (ops/km^2) and Longline Fishing (kg retained/km^2) and reporting grid



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_04_D.aprx, P100383_S00_32_Cwlth_Squid, P-UWS-132, 01/02/2025

Figure 4-76: Commonwealth Southern Squid Jig Fishery Relative Fishing Intensity (hours fished/ km^2) and Reporting Grid



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_04_D.aprx, P100383_S00_51_Cwlth_WesternTunaBillfish, P-UWS-132, 01/02/2025

Figure 4-77: Commonwealth Western Tuna and Billfish Fishery Reporting Grid

4.5.11 Victorian Managed Fisheries

There are eight Victorian state-managed commercial fisheries that overlap the Planning Area:

- Abalone Fishery
- Giant Crab Fishery
- Multispecies Ocean Fisheries (Inshore Trawl and Ocean General)
- Octopus Fishery
- Pipi Fishery
- Rock Lobster Fishery
- Scallop (Ocean) Fishery
- Wrasse (Ocean) Fishery

Of these, three Victorian state-managed commercial fisheries were identified to be active within the Project Area in recent years:

- Giant Crab Fishery
- Rock Lobster Fishery
- Wrasse (Ocean) Fishery

Information relating to the target species, fishing locations, landed catch, value and other relevant aspects of each fishery is provided in Table 4-35. Maps are also provided displaying the number of vessels reported in a VFA grid between 2013–2023 in relation to the Project and/or Planning Areas. Fishing effort data is confidential if a grid has less than 5 active vessels. No data on the Abalone Fishery locations was available from VFA due to the confidential nature of the data.

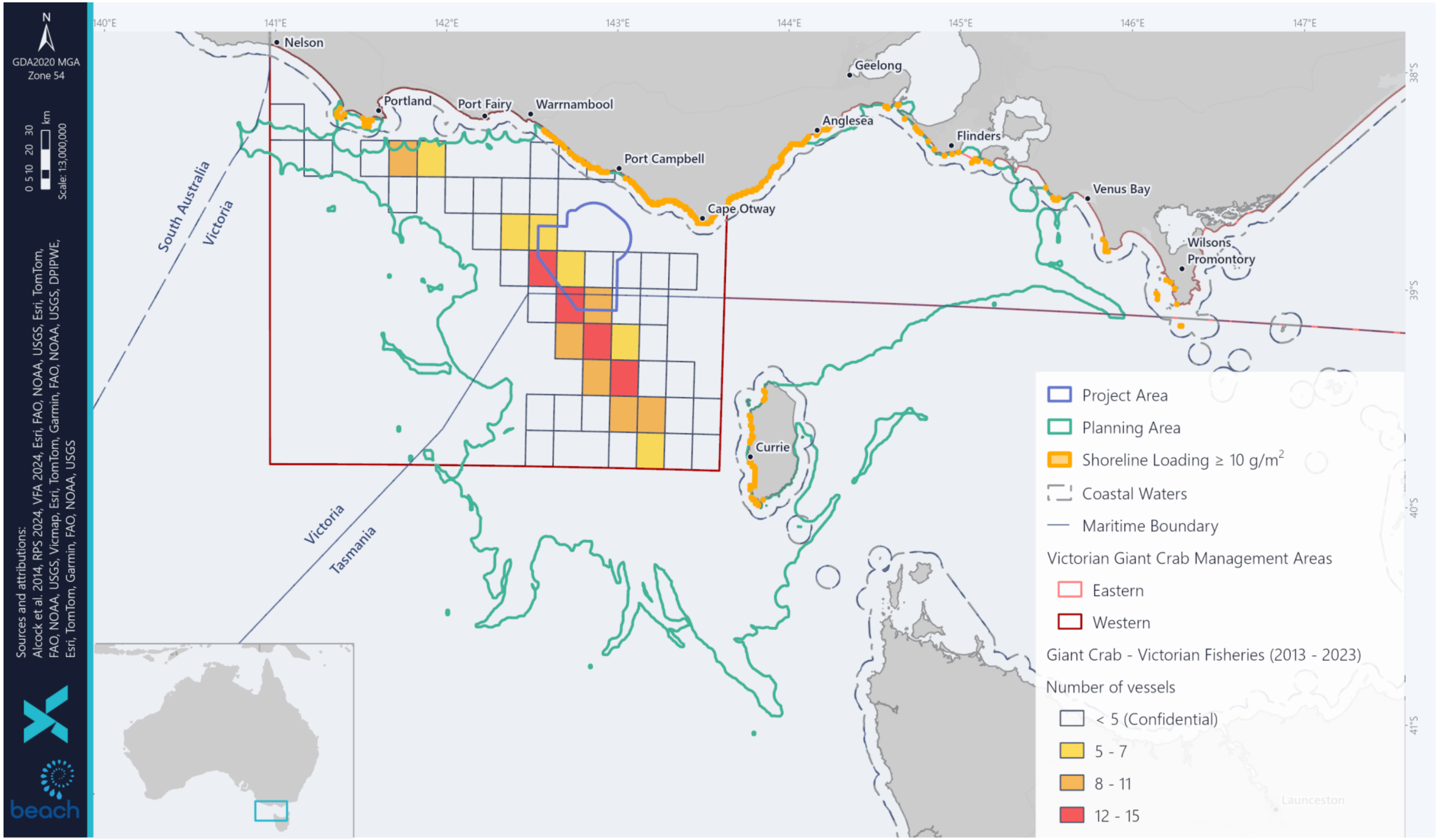
Data sources are from the Victorian Fisheries Authority Commercial Fish Production Information Bulletin July 2020 to June 2021 (VFA 2021) and VFA website (VFA 2024) unless indicated.

Table 4-35: Victorian Managed Fisheries within the Project Area and Planning Area

Fishery	Target species	Description	Fishing Effort Project Area	Fishing Effort Planning Area
Abalone Fishery (central, eastern and western zones)	Blacklip Abalone Greenlip Abalone	The Victorian Abalone Fishery is a highly valuable fishery (A$16.8 million in 2020-21) that operates along most of the Victorian shoreline, generally to 30 m depth. Abalone are harvested by divers. Total allowable commercial catch (TACC) limits of Blacklip Abalone for the western zone are considerably less than the central and eastern zone (for 2019-20 season, 73.2 tonnes compared with 262.5 and 345.5 tonnes, respectively). There are 14 licences in the western zone, 23 in the eastern zone and 34 in the central zone. The water depths where abalone are fished are close to shore and therefore abalone fishing is likely to occur within the Planning Area. No abalone fishing is expected within the Project Area due to minimum water depth being 64 m.	No	Yes
Giant Crab Fishery	Giant Crab	The Giant Crab Fishery is a small fishery operating in western Victoria and closely linked with the Rock Lobster Fishery. Most vessels are used primarily for Rock Lobster fishing with Giant Crab taken as by-product. Fishing effort is concentrated on the continental shelf edge (~200 m). Giant Crabs inhabit the continental slope at approximately 200 m depth and are most abundant along the narrow band of the shelf edge. Closed seasons operate for male (15 Sept to 15 Nov) and female (1 June to 15 Nov) Giant Crabs. Total landed catch in 2015-16 was 10 tonnes. Data for 2020/21 is confidential due to less than 5 vessels reporting fishing effort. The Project Area is within the western management zone of the fishery (Figure 4-78). Figure 4-78 shows overlap of Giant Crab management areas and fishing effort from 2013-2023 with the Project Area and Planning Area (VFA 2024). The Project Area and Planning Area overlap reporting grids with up to 15 active vessels.	Yes	Yes
Multispecies Ocean Fisheries – Inshore Trawl and Ocean General	Australian Salmon Eastern King Prawn Gummy Shark Lobster/Balmain Bug School Shark School Prawn Shovelnose	The Multispecies Ocean Inshore Trawl fishery operates along the entire Victorian coastline, excluding marine reserves, bays and inlets. Most operators are based at Lakes Entrance. The Inshore Trawl fishery uses otter-board trawls with no more than a maximum head- line length of 33 m, or single mesh nets. The Wrasse, Inshore Trawl, Southern Rock Lobster and Giant Crab Fisheries are able to catch Gummy Shark and School Sharks as part of their fishery. The Multispecies Ocean Ocean General fishery uses lines, nets and haul seine to catch snapper. Over 90% of the catch is from Port Phillip Bay, and around 5% from coastal waters. In 2020-21, 45 tonnes were landed but a values could not be provided as there is insufficient data to report because there are less than five licence holders (policy requirement to protect commercial confidentiality of data).	No	Yes

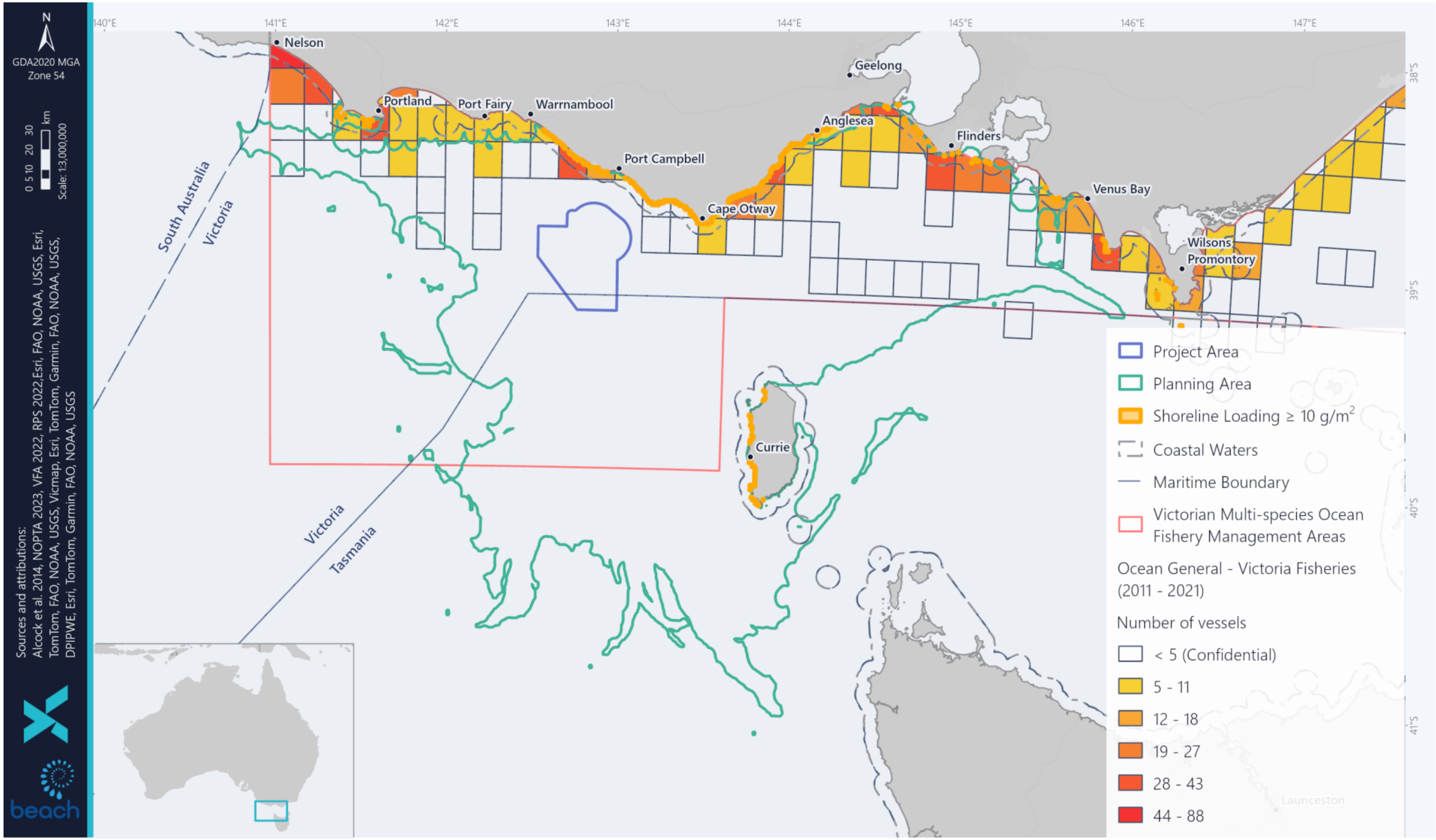
	Snapper Minor bycatch of School Whiting and Flathead	Figure 4-79 shows the Planning Area overlaps areas with up to 78 active vessels for the Multispecies Ocean Fisheries. No fishing effort was identified within the Project Area. Catch effort data is considered confidential if there are less than 5 vessels active.		
Octopus Fishery	Pale Octopus Maori Octopus Gloomy Octopus	The Octopus Fishery (Eastern Zone) is a new fishery harvesting mainly Pale Octopus (*Octopus pallidus*) in East Gippsland. The fishery may also catch Maori Octopus (*Macroctopus maorum*) and Gloomy Octopus (*Octopus tetricus*). Octopus are caught using purpose-built unbaited traps. The fishery commenced on 1st August 2020. Three fishery locations have been established for this new fishery; Eastern, Central and Western octopus zones. The Eastern zone is where the majority of commercial octopus takes place with the Central and Western zones are less established but are being managed by VFA through exploratory, temporary permits. Figure 4-80 shows the Planning Area overlaps reporting grids with up to 14 active vessels between 2013-2023. No fishing effort was identified within the Project Area. Catch effort data is considered confidential if there are less than 5 vessels active.	No	Yes
Pipi Fishery	Pipi	The Pipi Fishery is a newly managed fishery with its first management plan declared in 2018. The fishery is now utilising an ongoing quota management regime with access licences issued for Discovery Bay and Venus Bay management zones, each with their own TACC. Pipi harvested commercially are sold for bait or for human consumption. The main commercial harvesting area for the Victorian Pipi Fishery is Discovery Bay with limited activity in Venus Bay. Pipis are harvested in the high impact beach zone using traditional dip nets. Figure 4-81 shows the Planning Area overlaps a small area fished between 2013-2023. Intensity data for the Pipi Fishery is confidential. the Project Area does not overlap the Victorian Pipi Fishery.	No	Yes
Rock Lobster Fishery (western zone)	Southern Rock Lobster	The Rock Lobster Fishery is Victoria's second most valuable fishery with a production value of A$13.6 million in 2020/21. Since 2009-10, annual quotas have been set at between 230 and 260 tonnes and have been fully caught each year. In the western zone, most catch is landed through Portland, Port Fairy, Warrnambool, Port Campbell and Apollo Bay. Closed seasons operate for male (15 Sept to 15 Nov) and female (1 June to 15 Nov) lobsters. Southern Rock Lobsters are found to depths of up to 150 m, with most of the catch coming from inshore waters less than 100 m. Figure 4-82 shows the Project Area and Planning Area overlap the Southern Rock Lobster Fishery. The Project Area overlaps reporting grids with up to 24 active vessels while the Planning Area overlaps areas with as many as 101 active vessels between 2013-2023.	Yes	Yes

Scallop (Ocean) Fishery	Commercial Scallop	The Scallop Fishery extends the length of the Victorian coastline from high tide mark to 20 nm offshore. Fishers use a scallop dredge. Doughboy Scallops are taken as by-product but are not harvested in commercial quantities. Temporary closures occur when stocks are low to allow scallop beds to recover. TACC for 2015-16 was set at 135 tonnes, with results from the 2017/18 abundance survey indicating that TACC should remain at the same level. Scallops are mostly fished from Lakes Entrance and Welshpool. The Project and Planning Areas do not overlap Victorian Scallop Fishery effort.	No	No
Wrasse (Ocean) Fishery	Bluethroat Wrasse Purple Wrasse Small catches of Rosy Wrasse, Senator Wrasse and Southern Maori Wrasse	The Victorian Wrasse (Ocean) Fishery extends the length of the Victorian coastline from high tide mark to 20 nm offshore. Fishers mostly use hook and line. There is limited entry to the fishery with 22 current licences. Total annual catches in 2019-20 was approximately 21.5 tonnes. Figure 4-83 shows the Project Area overlaps the wrasse fishery management area as well as a small corner of a reporting grid (1.85 km^2) with less than 5 active vessels between 2013-2023 (VFA 2024). The Planning Area overlaps reporting grids along the coast with up to 35 active vessels.	Yes	Yes



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_04_D.aprx, P100383_S00_40_Vic_GC, P-UWS-132, 28/10/2024

Figure 4-78: Giant Crab Fishery Number of Vessels from 2013-2023. Data obtained from VFA 2024



Sources and attributions:
Alcock et al. 2014, NOPTA 2023, VFA 2022, RPS 2022,Esri, FAO, NOAA, USGS, Esri, TomTom, FAO, NOAA, USGS, Vicmap, Esri, TomTom, Garmin, FAO, NOAA, USGS, DPIPWE, Esri, TomTom, Garmin, FAO, NOAA, USGS

Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_04_D.aprx, P100383_S00_44_Vic_OceanGeneral, P-UWS-132, 20/09/2024

Figure 4-79: Multispecies Ocean Fisheries Number of Vessels from 2013-2023. Data obtained from VFA 2024

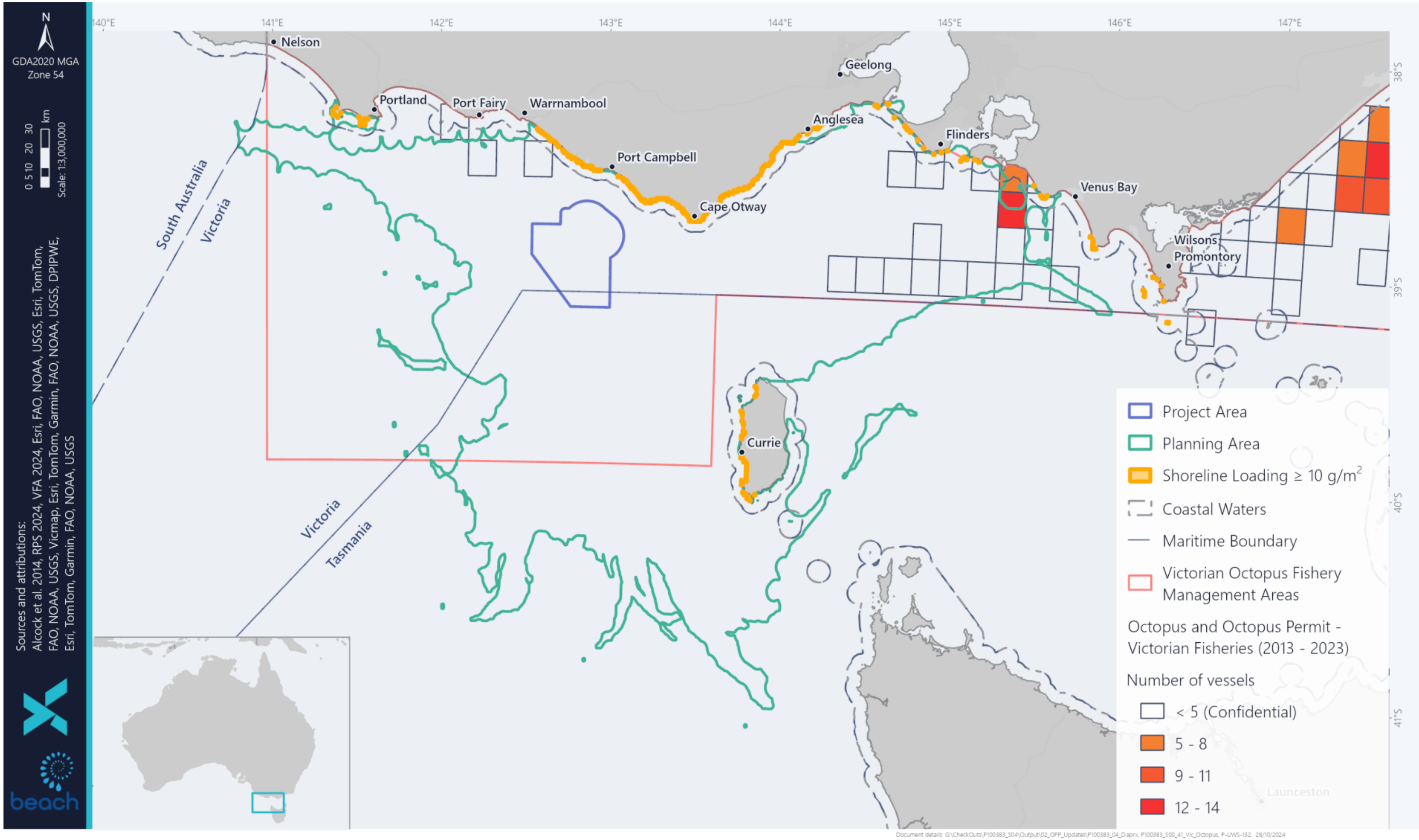
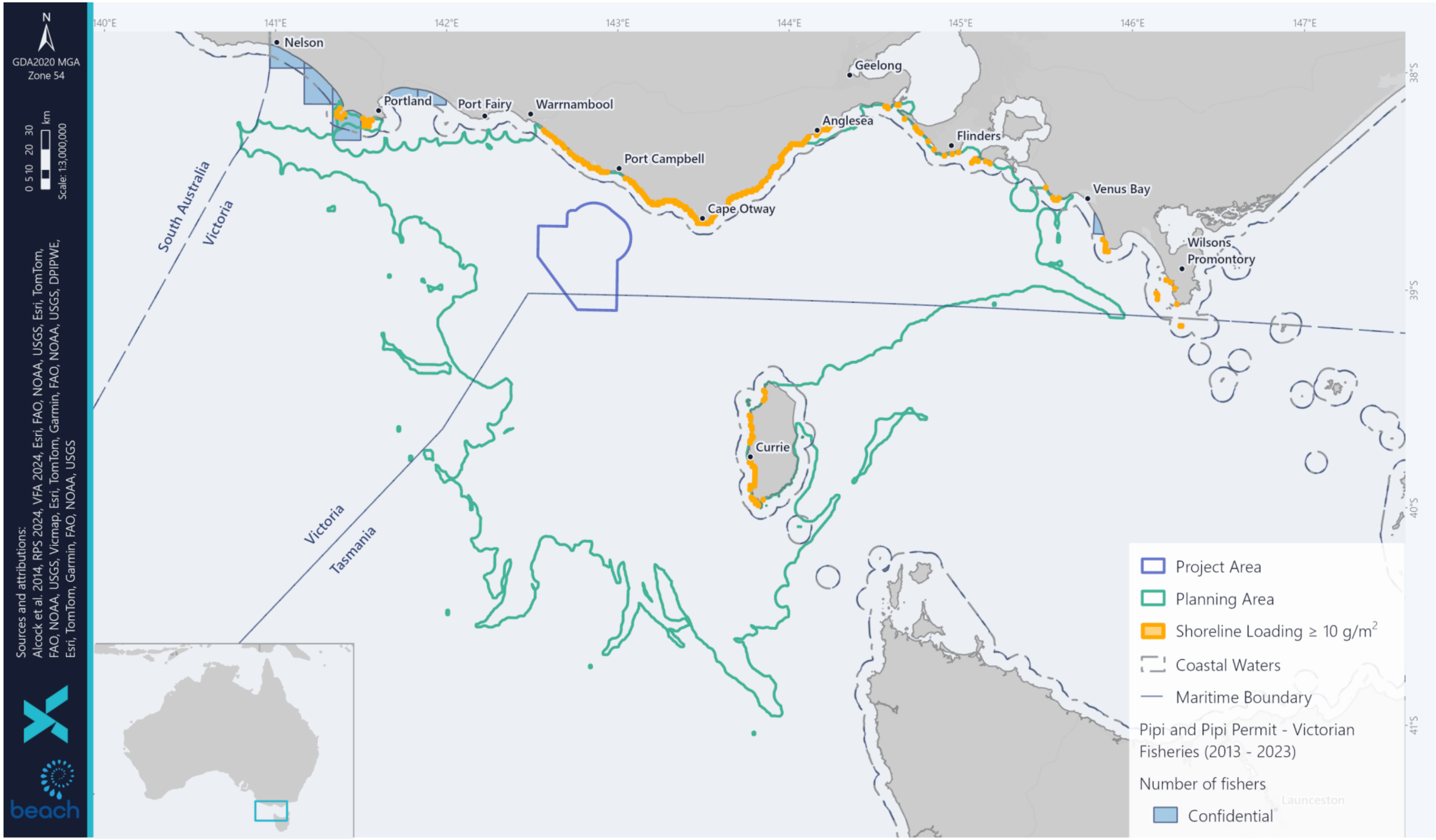
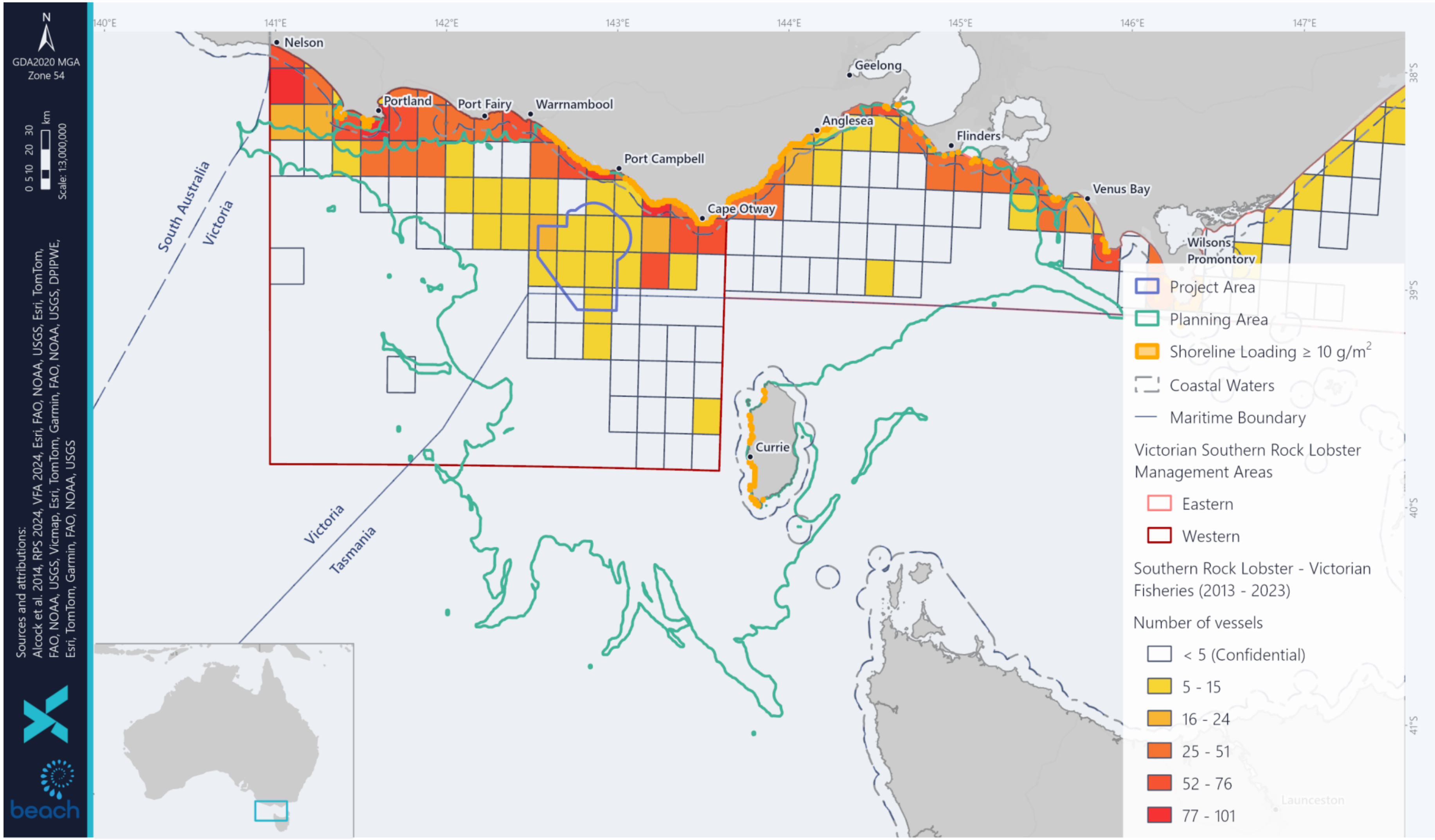


Figure 4-80: Octopus and Octopus Permit Fishery Number of Vessels from 2013-2023. Data obtained from VFA 2024



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_04_D.aprx, P100383_S00_52_Vic_Pipi, P-UWS-132, 28/10/2024

Figure 4-81: Pipi Fishery Number of Vessels from 2013-2023. Data obtained from VFA 2024.



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_04_D.aprx, P100383_S00_42_Vic_SRL, P-UWS-132, 28/10/2024

Figure 4-82: Southern Rock Lobster Fishery Number of Vessels from 2013-2023. Data obtained from VFA 2024.

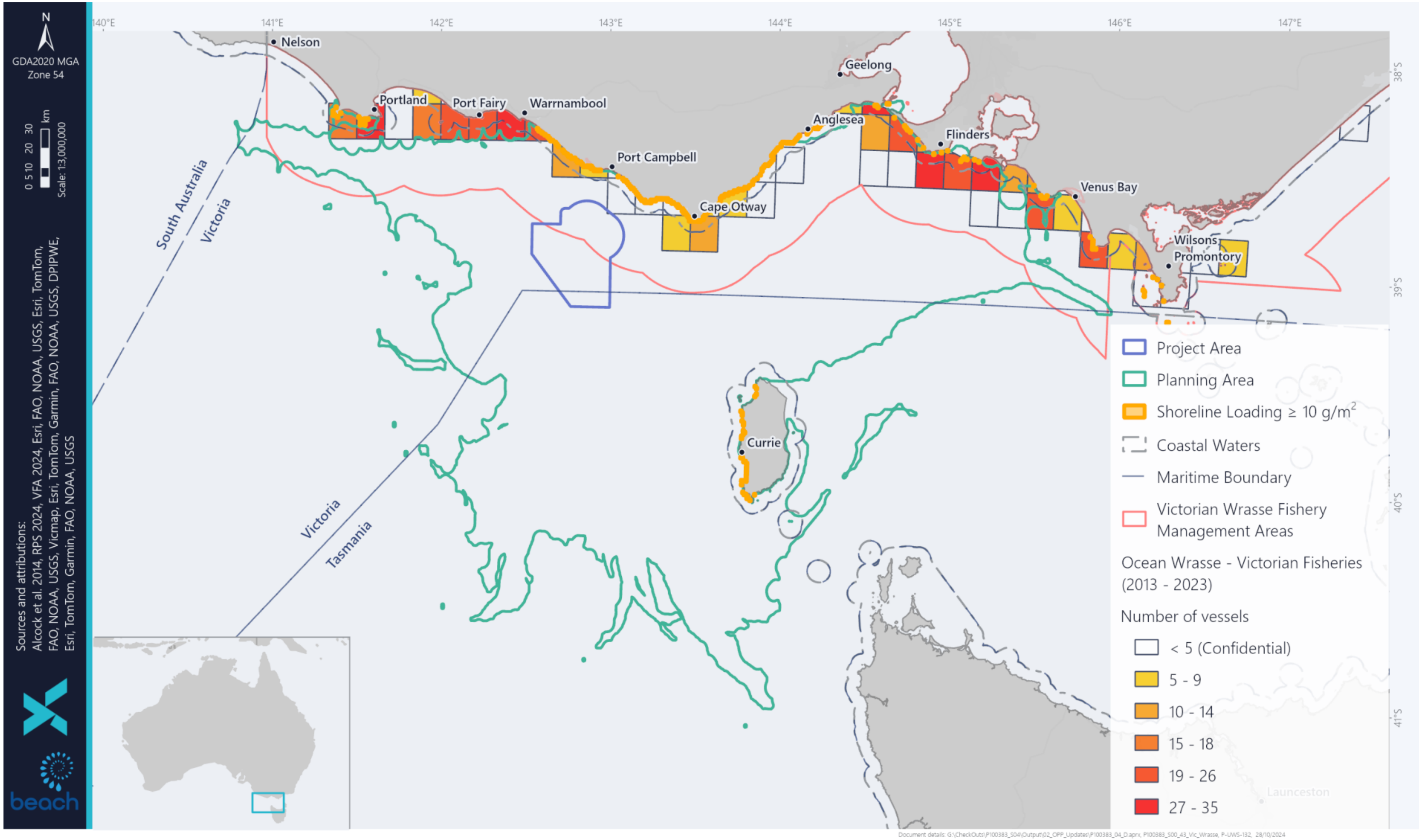


Figure 4-83: Wrasse (Ocean) Fishery Number of Vessels from 2013-2023. Data obtained from VFA 2024

4.5.12 Tasmanian Managed Fisheries

Fishing Tasmania manages Tasmania's commercial fisheries under the *Living Marine Resources Management Act 1995*.

All fisheries except for the Giant Crab Fishery and the Rock Lobster Fishery operate within Tasmanian waters. The Giant Crab Fishery and the Rock Lobster Fishery also operate in Commonwealth waters under an Offshore Constitutional Settlement (OCS) between the Australian Government and the Government of Tasmania.

There are eight Tasmanian state-managed commercial fisheries that may overlap the Planning Area:

- Abalone Fishery
- Commercial Dive Fishery
- Giant Crab Fishery
- Marine Plant Fishery
- Rock Lobster Fishery
- Scalefish Fishery
- Scallop Fishery
- Shellfish Fishery

No fishing effort has been identified within the Project Area. Project information relating to the target species, fishing locations, landed catch, value and other relevant aspects of each fishery is detailed in Table 4-36. Data and information sources are Department of Natural Resources and Environment Tasmania (DNRET 2022) and Australian fisheries and aquaculture statistics 2014-15 (Patterson et al. 2022).

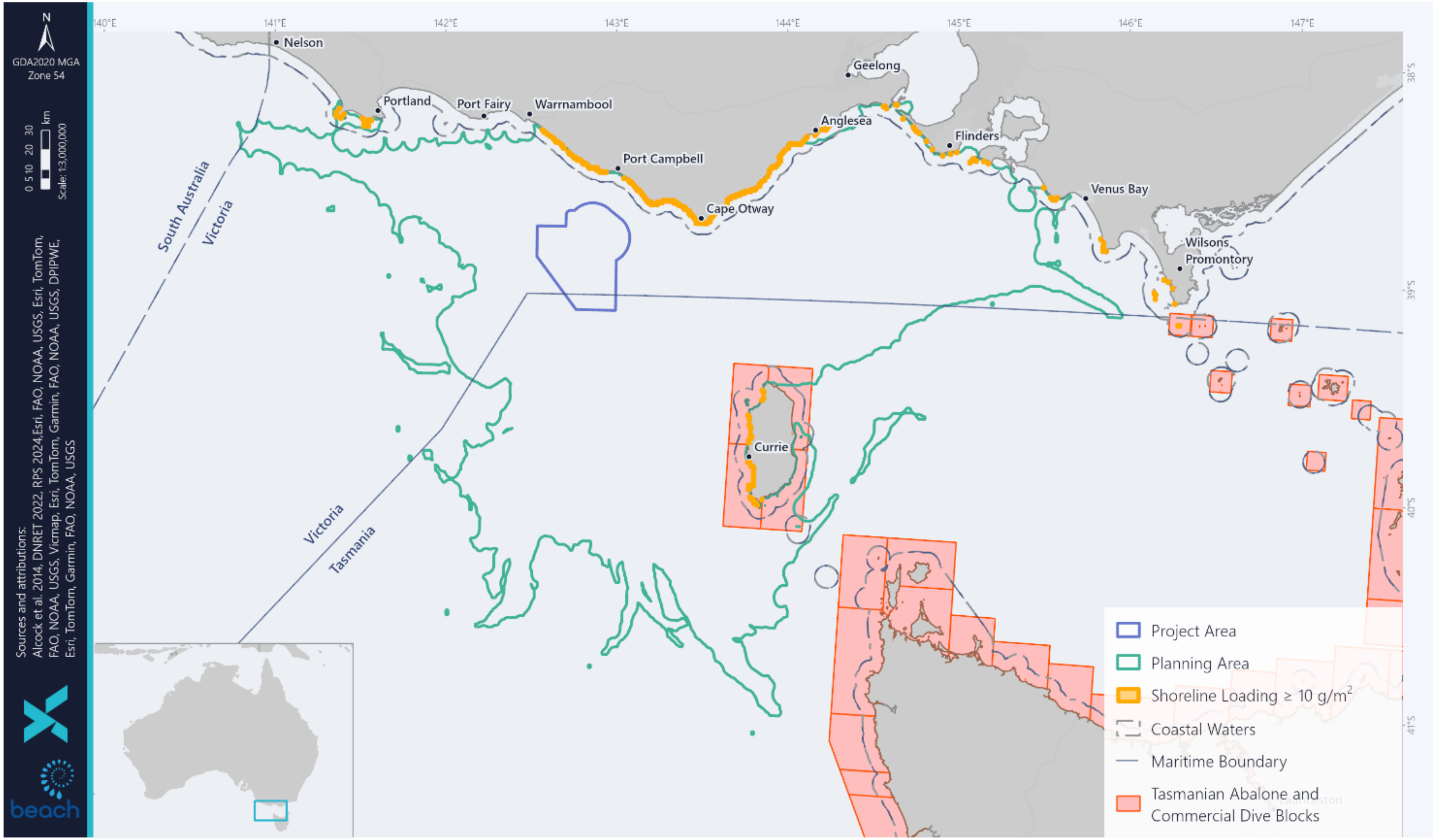
Maps are also provided showing where the number of vessels reported in a Tasmanian Fishery grid between 2011 – 2021 in relation to the Project Area and/or Planning Area and for the Rock Lobster Fishery and Giant Crab Fishery for which data from Fishing Tasmania is available.

Table 4-36: Tasmanian Managed fisheries within the Project Area and Planning Area

Fishery	**Target species**	**Description**	**Fishing Effort Project Area**	**Fishing Effort Planning Area**
Abalone Fishery (Northern, Western and Bass Strait Zones)	Blacklip Abalone Greenlip Abalone	The Tasmanian Abalone Fishery is the largest wild abalone fishery in the world (providing ~25% of global production) and a major contributor to the local economy. Abalone are hand-captured by divers in depths between 5-30 m. Blacklip Abalone are collected around on rocky substrate around the Tasmanian shoreline and are the primary target of the fishery. Greenlip Abalone are distributed along the north coast and around the Bass Strait islands and usually account for around 5% of the total wild harvest. In 2020/21, the gross value of production of the fishery was around A$50 million from a total catch of approximately 1,000 tonnes. The jurisdictional area of the Abalone Fishery is Tasmanian State waters. The Project Area does not overlap the Abalone Fishery. The Planning Area overlaps the Northern Zone (waters around King Island) of the Abalone Fishery (Figure 4-84).	No	Yes
Commercial Dive Fishery (Northern and Western Zones)	Longspined Sea Urchin Shortspined Sea Urchin Wavy Periwinkle	The Tasmanian Commercial Dive Fishery is a capture fishery that targets several different species; the main species collected being sea urchins and periwinkles. In 2020-2021 approximately 180 t of sea urchins and 2.07 t of periwinkles were harvested. Sea urchins and periwinkles accounted for 63% and 37% of the total respectively. Jurisdiction encompasses all Tasmanian State waters (excluding protected and research areas), although licence holders largely operate out of small vessels (<10 m) and effort is concentrated on the south and east costs of Tasmania around ports. The Project Area does not overlap the Commercial Dive Fishery. The Planning Area overlaps the Northern Zone of the Commercial Dive Fishery at King Island (Figure 4-84).	No	Yes
Giant Crab Fishery	Giant crab	The Giant Crab Fishery is a comparatively small fishery with the annual harvest set at 20.7 tonnes but with a high landed value of around A$2 million. The fishery has been commercially targeted since the early 1990s, moving from open access to limited entry. The area of the fishery includes waters surrounding the state of Tasmania generally south of 39º12 out to 200 nm. Within the area of the fishery, most effort takes place on the edge of the continental slope in water depths between 140 m and 270 m. CPUE has declined continually since the inception of the fishery in the early 1990s indicating that it has been overfished. The TAC has been reduced to 20.7 t for 2019/120 and 2021/2022 to address the issue.	No	Yes

		Figure 4-85 shows the Planning Area overlaps areas with up to 11 active vessels. No fishing effort was identified within the Project Area. Catch effort data is considered confidential if there are less than 6 vessels active.		
Marine Plant Fishery	Bull kelp Japanese kelp	Marine plants include kelp, seaweed, seagrasses, and algae which are food and habitat for other marine species. To protect Tasmanian marine ecosystems, no marine plants may be harvested directly from the water, except in the Undaria fishery. The majority of cast bull kelp is collected from King Island. The right to harvest and process kelp on King Island was granted exclusively to Kelp Industries Pty Ltd in the mid-1970s. About 80 to 100 individuals collect cast bull kelp and transport it to the Kelp Industries plant in Currie. An average annual harvest above 3,000 t (dried weight) has been produced in recent years, accounting for about 5% of the world production of alginates (i.e. the end product of dried bull kelp). The cast bull kelp harvesting on King Island generates about A$2 million annually. Comparatively minor cast bull kelp collection also occurs at two centres of operation on Tasmania's West Coast: around Bluff Hill Point and at Granville Harbour. Japanese kelp is harvested by divers only along Tasmania's east coast where it is already well established. The Planning Area overlaps the area where bull kelp is potentially collected from King Island.	No	Yes
Rock Lobster Fishery	Southern rock lobster	The Rock Lobster Fishery is the other major wild-caught Tasmanian fishery. For 2022-23 the Total Allowable Catch remains at 1,050.7 t. Southern rock lobsters are found to depths of 150 m with most of the catch coming from inshore waters less than 100 m throughout state waters. The fishery is a limited entry with 312 licences. Figure 4-86 shows the Planning Area overlaps areas with up to 152 active vessels from 2011-2021. The Project Area does not overlap recent fishing effort for the Tasmanian Rock Lobster Fishery.	No	Yes
Scalefish Fishery (north-west coast)	Multi-species and multi-gear fishery	The Scalefish Fishery is a complex multi-species fishery harvesting a range of scalefish, shark and cephalopod species. Fourteen different fishing methods are used. The highest commercial catches in 2019/20 were reported for southern calamari (85.8 t), wrasse (52.4 t), and eastern school whiting (43.7 t). Due to the fishery being under caught by 26.7% in the previous season 2020/21, the TAC for the 2021/22 season has increased to 30 kg quota unit. The Planning Area overlaps the Scalefish Fishery management area (Figure 4-87).	No	Yes
Scallop Fishery	Commercial Scallop	The Scallop Fishery uses a benthic scallop dredge to target one of three species of scallop naturally occurring in Tasmania, the Commercial Scallop (*Pecten fumatus*). The fishery extends 200 nm from the eastern, western and southern coasts of Tasmania. In the Bass Strait, the fishery extends 3-20 nm offshore along the north coast from King Island to Flinders Island.	No	Yes

		The Planning Area overlaps the Scallop Fishery Management Area.		
Shellfish Fishery	Katelysia Cockles Venerupis Clam Native Oyster Pacific Oyster	The Shellfish Fishery comprises specific shellfish species hand captured by divers in defined locations on the east coast of Tasmania, namely Angasi oysters in Georges Bay, Venerupis clams in Georges Bay and Katelysia cockles in Ansons Bay. The taking of Pacific oysters, an invasive species, is also managed as part of the fishery but no zones apply. Pacific oysters can be collected throughout all State waters (which includes areas within the Planning Area), as the aim of harvesting these animals is to deplete the wild population. The estimated total value of the shellfish fishery based on landings from 2001-2005 was A$345,538. The Planning Area could potentially overlap areas where Pacific oysters are collected.	No	Yes



Sources and attributions:
Alcock et al. 2014, DNRET 2022, RPS 2024,Esri, FAO, NOAA, USGS, Esri, TomTom, FAO, NOAA, USGS, Vicmap, Esri, TomTom, Garmin, FAO, NOAA, USGS, DPIPWE, Esri, TomTom, Garmin, FAO, NOAA, USGS

Figure 4-84: Tasmanian Abalone and Commercial Dive Blocks. Data obtained from DNRET 2022.

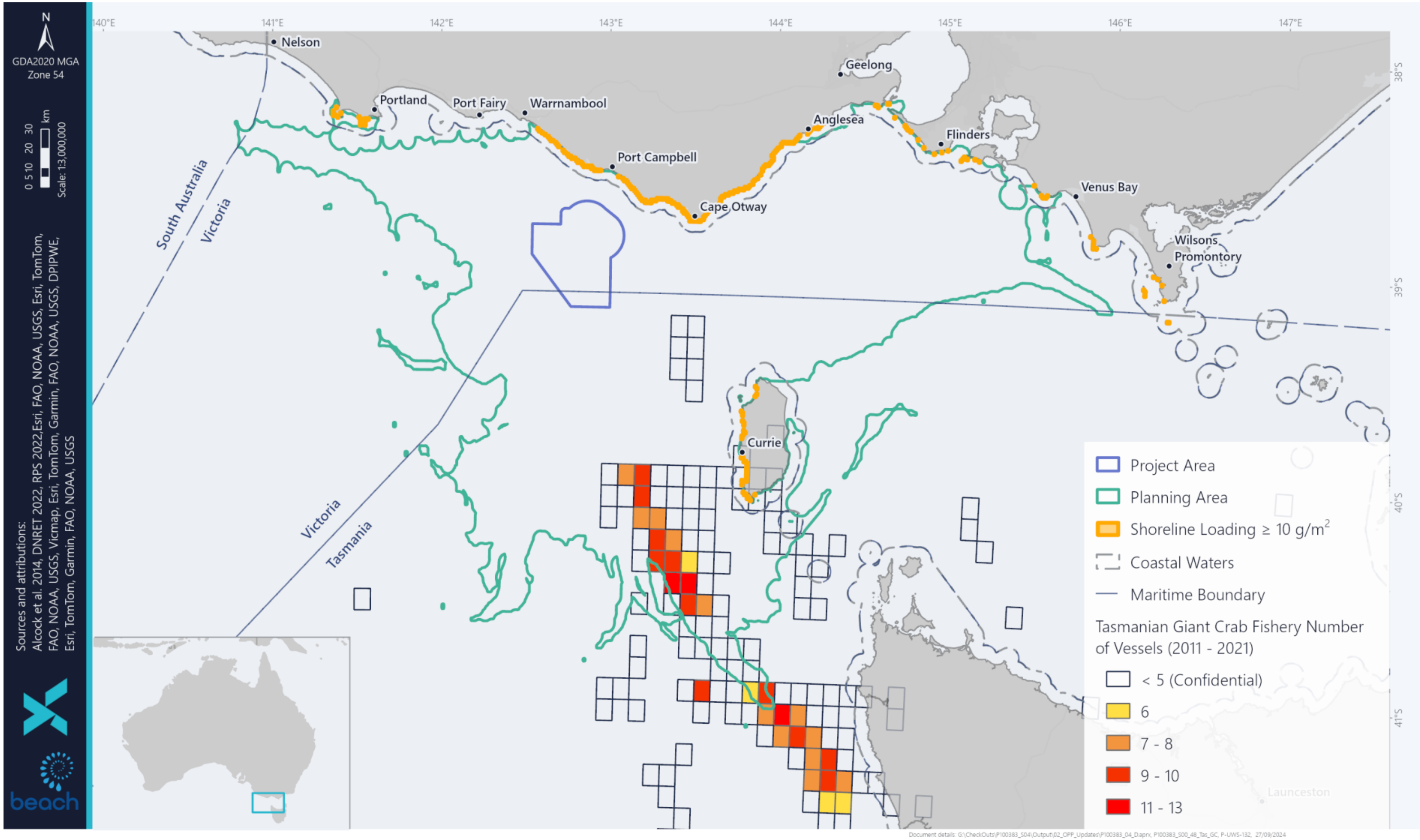


Figure 4-85: Tasmanian Giant Crab Fishery Number of Vessels from 2011 to 2021. Data obtained from DNRET 2022.

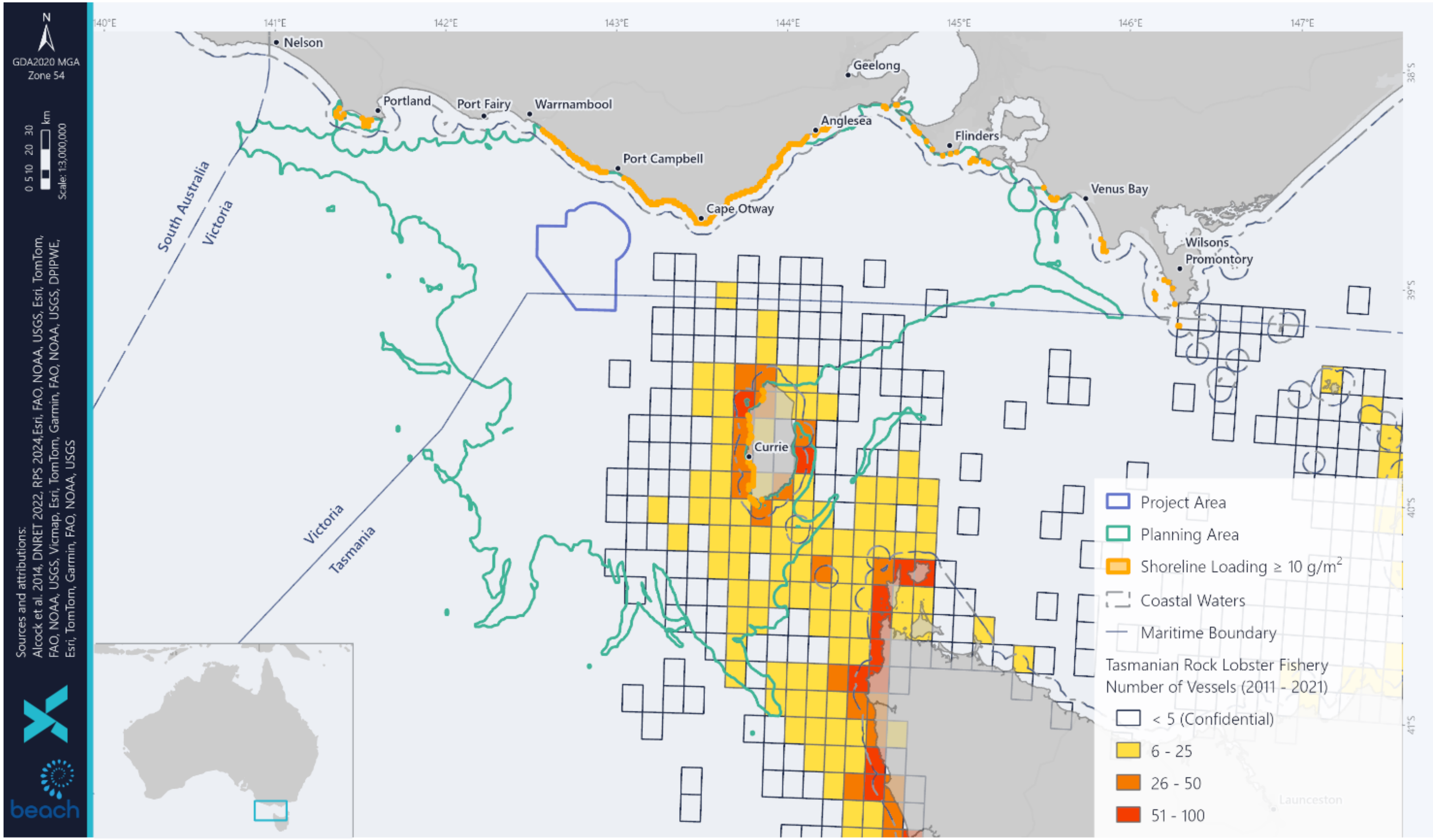


Figure 4-86: Tasmanian Rock Lobster Fishery Number of Vessels from 2011 to 2021. Data obtained from DNRET 2022.

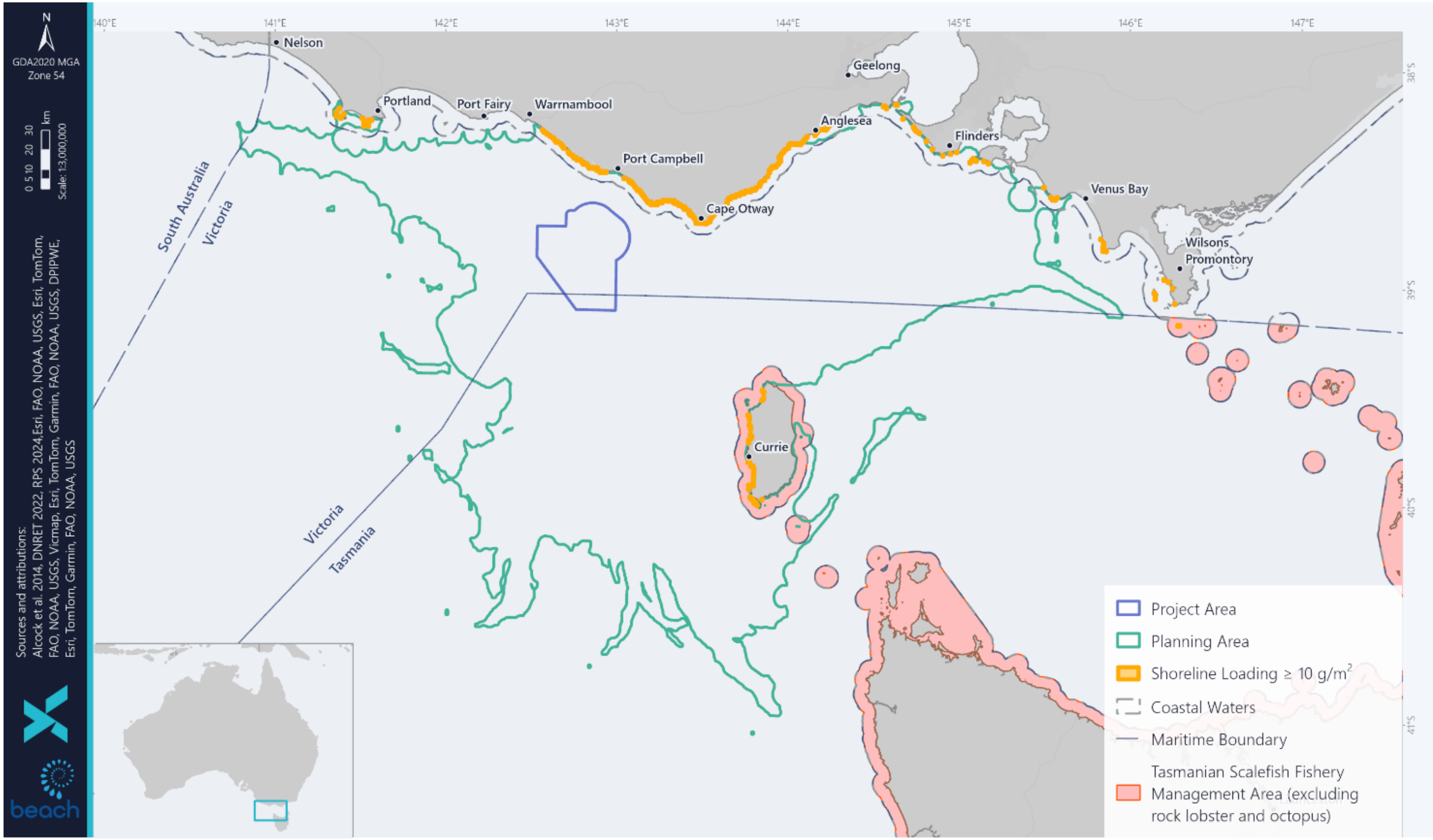


Figure 4-87: Tasmanian Scalefish Fishery Management Area. Data obtained from DNRET 2022.

4.5.13 South Australian Managed Fisheries

The *Fisheries Management Act 2007* and its regulations provide the legislative framework, objectives, and guiding principles for the management of fisheries in South Australia. Management rules for commercial fisheries are provided in fisheries regulations under the Act.

The Department of Primary Industries and Regions (DPIR) is responsible for the ecologically sustainable development of South Australia's aquatic resources and the administration of the *Fisheries Management Act 2007*.

The Project Area does not overlap any South Australian Fisheries.

Data from DPIR identified that the Planning Area overlaps the following fisheries:

- Abalone Fishery
- Charter Boat Fishery
- Giant Crab Fishery
- Marine Scalefish Fishery
- Rock Lobster Fishery

Information relating to the target species, fishing locations, landed catch, value and other relevant aspects of each fishery is included in Table 4-37. Data sources are from DPIR fishing data from 2012 to 2021 for fishing block 58 which the Planning Area overlaps, and PIRSA (2022), unless otherwise noted.

Table 4-37: South Australian Managed Fisheries within the Project Area and/or Planning Area

Fishery	Target species	Description	Fishing Effort Project Area	Fishing Effort Planning Area
Abalone Fishery	Blacklip Abalone Greenlip Abalone	The South Australian commercial abalone fishery takes Greenlip and Blacklip Abalone that inhabit subtidal reefs out to approximately 30 m. Commercial abalone divers mostly operate from large, trailered boats. Divers use surface supplied air from the boat and may use motorised cages to mitigate physical interactions with White Sharks. The Planning Area overlaps the Southern Zone of the fishery however the minimum depth of the Planning Area in South Australian waters is 300 m, so abalone fishing is not expected. The Southern Zone of the Abalone Fishery records six active licences from 2021 to 2022. Hours dived range from 921 to 1,496 per year with annual catch between 101,133 to 153,491 kg.	No	No
Charter Boat Fishery	Various	The Charter Boat Fishery is a limited entry fishery with 82 licence holders of which 47 were active in 2020/2021. Fishing in inshore regions where water depths are <50 m is the most frequent activity. Peak periods are between December and April (summer) and October. Seventy-eight species of fish, shark, mollusc, cephalopods, and crustacean are targeted with King George Whiting, snapper and Bight Redfish are the highest catches. The above information is from Durante et al. (2022). The Planning Area overlaps the fishery reporting grid where there have been 1,104 charter fishing trips from 2012 to 2021 (Figure 4-88).	No	Yes
Giant Crab Fishery	Giant Crab	Information from in this section is from McLeay (2022). Giant Crab (*Pseudocarcinus gigas*), also known as King Crab, is endemic to southern Australian waters and distributed from southern Western Australia to central New South Wales. While they occur at depths ranging from 20 to 600 m, the highest population densities are found at the edge of the continental shelf at depths of approximately 140 to 270 m. Fishers use a maximum of 100 steel-framed pots that must comply with pot dimension specifications. Commercial access to the Giant Crab resource is limited to licence holders in the Miscellaneous Fishery and Rock Lobster Fishery. Total allowable catch in the fishery is 22.1 t per year, consisting of	No	Yes

		13.4 t in the Northern Zone and 8.7 t in the Southern Zone, with total catch ranging from 15.4 t in 202/21 to 18.4 t in 2017/218. The Giant Crab fishing season in between 1 October 31 May, with the fishing season in the Southern Zone between 1 October and 30 April, and in the Northern Zone between 1 November and 31 May. The Planning Area overlaps the southern zone of the fishery. DPIR could not provide data specific to the area that the Environmental Planning Area overlaps as all data for the Giant Crab Fishery is confidential.		
Marine Scalefish Fishery	King George Whiting Southern Garfish Southern Calamari	Information in this section is from Smart et al. (2022). The Marine Scalefish Fishery is a multi-species and multi-gear fishery. Commercial fishing can be undertaken for more than 60 species of scalefish using a range of gear types. The Sardine Fishery is a part of the Marine Scalefish Fishery The Marine Scalefish Fishery operates in all coastal waters of South Australia between the Western Australian and Victorian border. For some species the Offshore Constitutional Settlement extends the fishery area out 200 nm to the Australian Exclusive Economic Zone miles. The fishing area includes gulfs, bays and estuaries, excluding the Coorong. The main species taken are: • King George Whiting • Southern Garfish • Southern Calamari. • Those 4 species comprise: • 60% of the total fishery production weight • 70% of the total fishery value. Not all species taken by this fishery are scalefish. Other species include squid, worms, sharks. In 2020 there were more than 300 licences in the fishery. Total annual catches of primary species decline from 2,089 t in 2001 to 807 tonnes in 2020. The Planning Area overlaps the fishery where there have been 15 active licences in 2012/13 to less than 5 in 2021/22 (Figure 4-86).	No	Yes

Rock Lobster Fishery	Southern Rock Lobster	The information in the section below is from Linnane et al. (2022). The Rock Lobster Fishery is based on the capture of Southern Rock Lobster (*Jasus edwardsii*). Other species are permitted to be landed and sold, including Giant Crabs and octopus. Rock lobsters are commercially harvested with pots that are set overnight. Rock lobster licence holders may also harvest marine scalefish as endorsed on their licence. The Planning Area is within the fishery Southern Zone which is closed from 31 May to 1 October (Figure 4-90). The total reported 2020 logbook catch was 1,275.5 tonnes (99% of TACC). The annual catch within the Planning Area ranged from 331-420 tonnes from 2012 to 2022. During this period the number of licence holders ranged from 43 to 71.	No	Yes

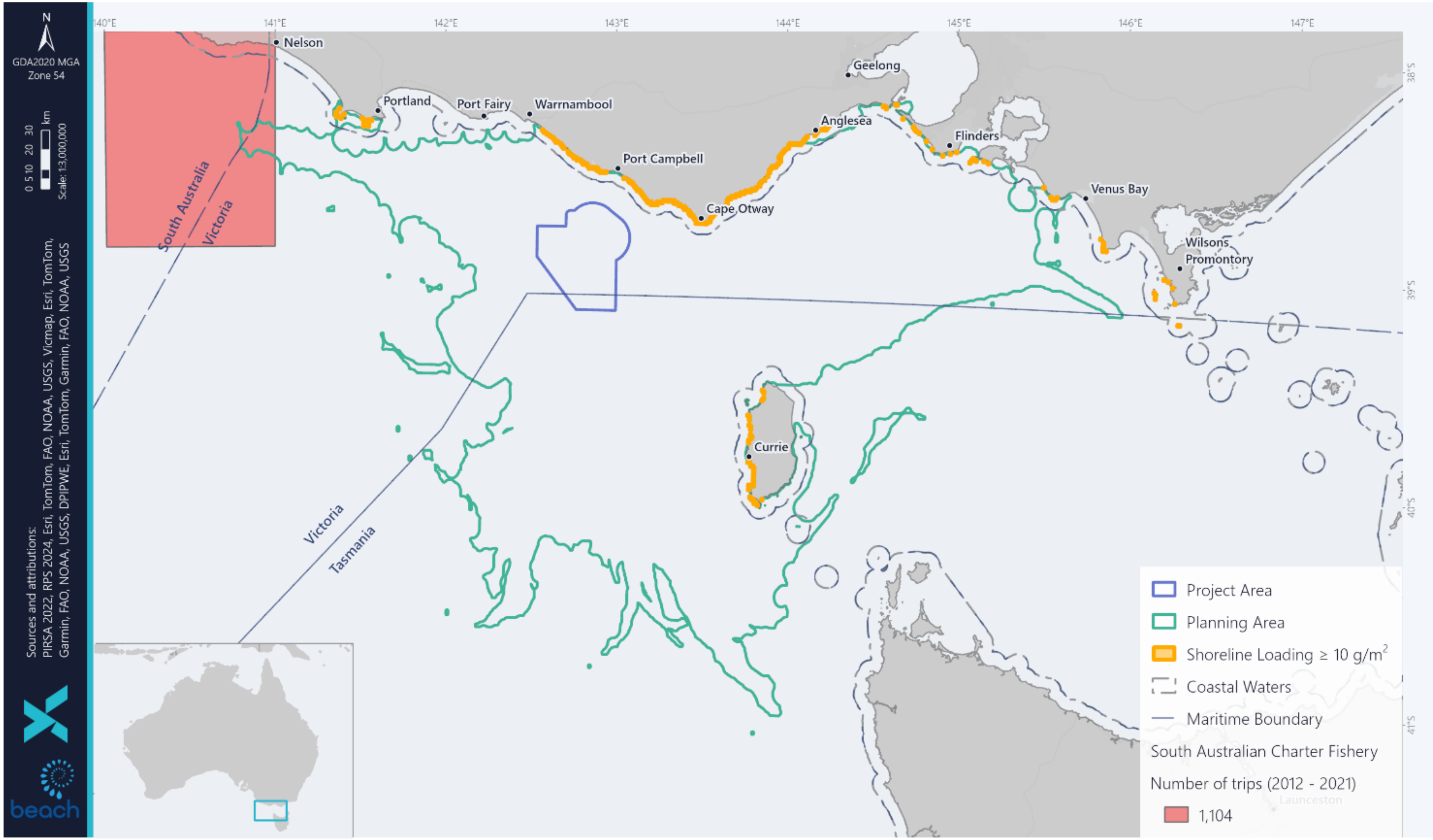


Figure 4-88: South Australian Charter Fishery Number of Trips from 2011-2021. Data obtained from PIRSA 2022.

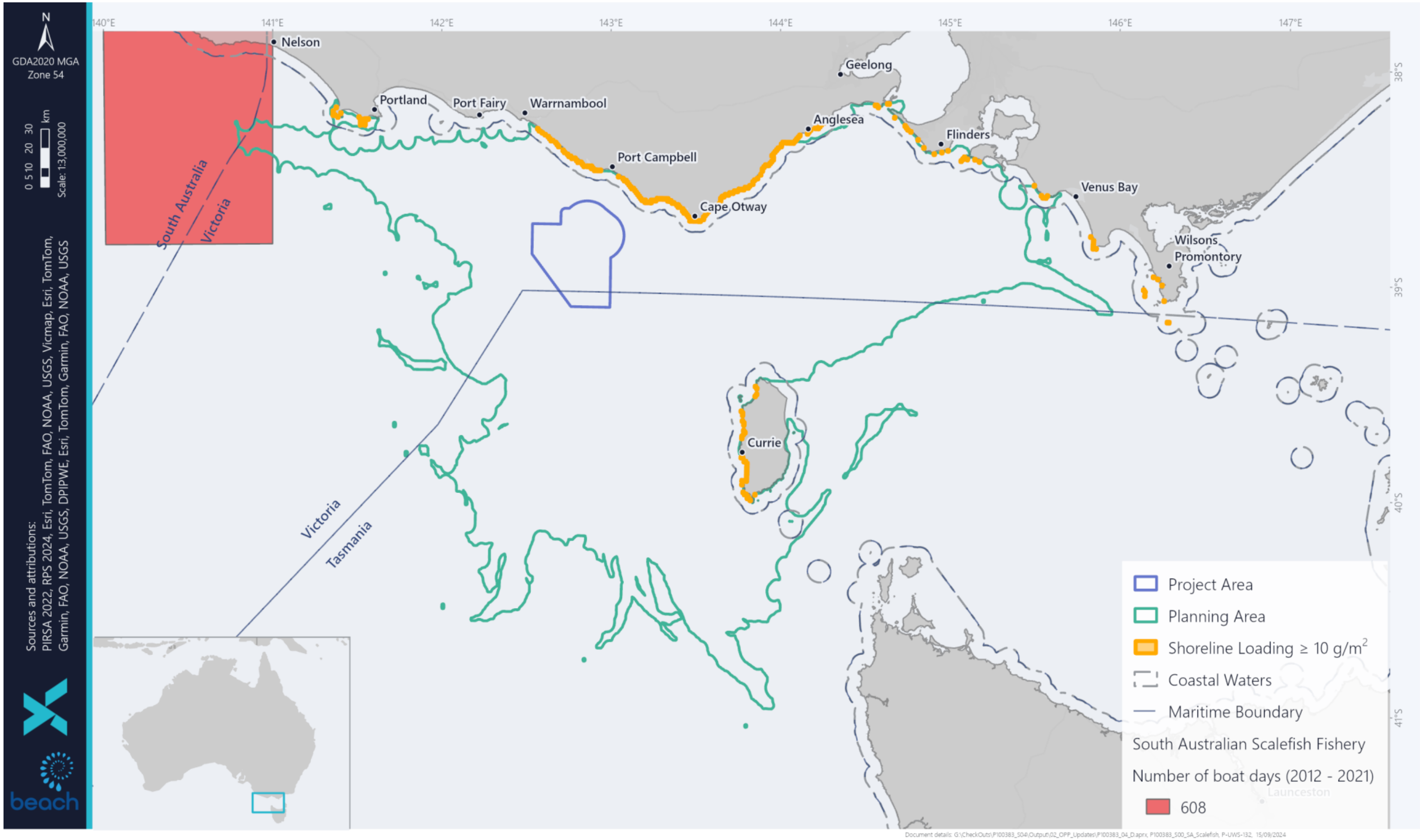


Figure 4-89: South Australian Scalefish Fishery Number of Boat Days from 2012-2021. Data obtained from PIRSA 2022.

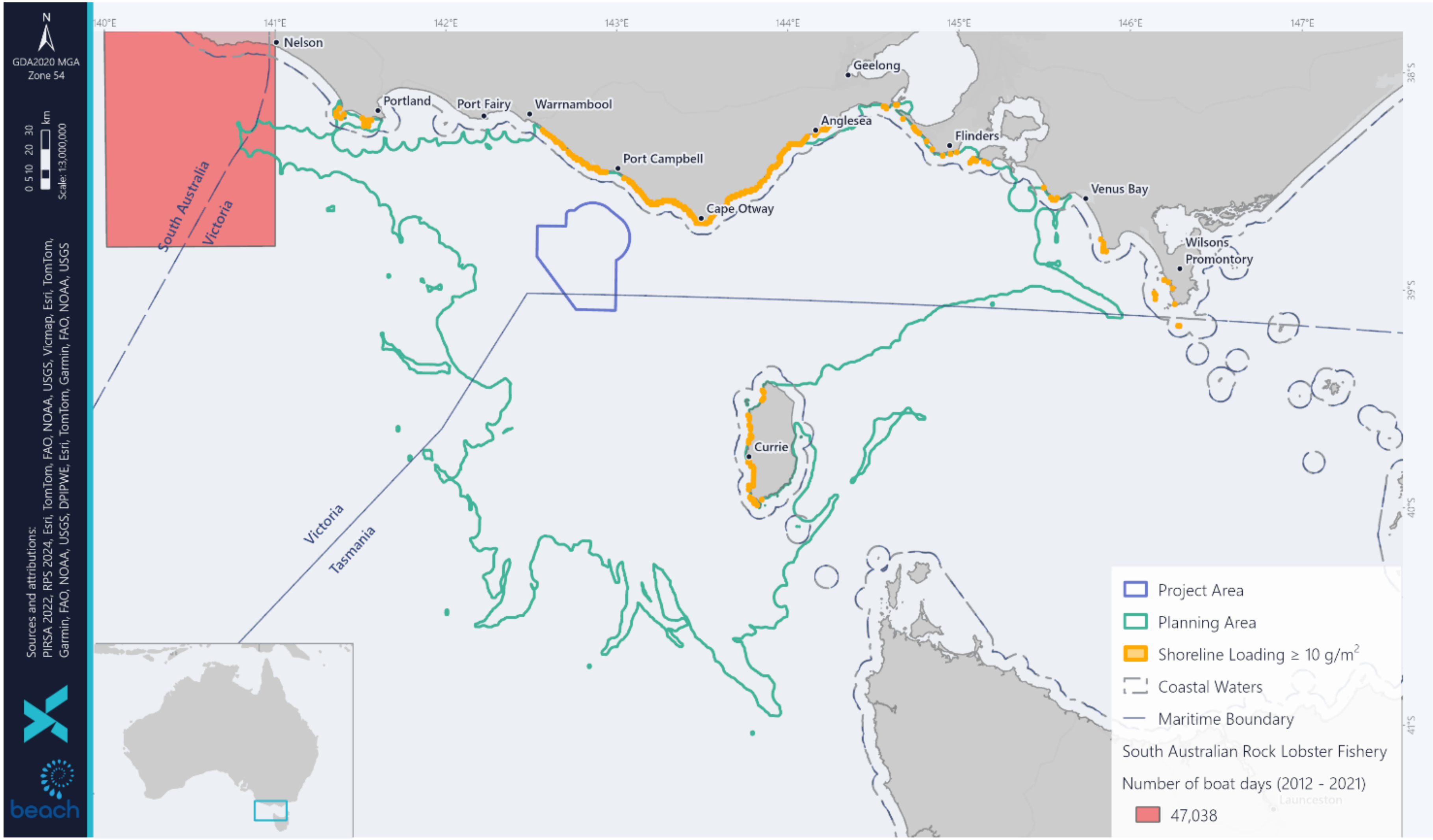


Figure 4-90: South Australian Southern Rock Lobster Fishery Number of Boat Days from 2012-2021. Data obtained from PIRSA 2022.

4.5.14 Seaweed Industry

The Australian seaweed industry is small: currently valued at an estimated GVP of AUD $3 million. Of this, the majority is from one company, Kelp Industries Pty Ltd on King Island in Tasmania, who hand collect plants cast bull kelp (*Durvillea pototorum*) on the beaches from predominantly the west coast of the island, predominantly for export to a large alginate manufacturer and for use in biofertiliser products (Australian Seaweed Institute 2023). Australia Bureau of Statistics (ABS) data shows seaweed exports from Australia are valued at $1.5 million for non-human consumption and it is assumed that this is almost entirely from Kelp Industries exports.

Besides Kelp Industries, other seaweed collectors in Tasmania include Kelpomix and TasKelp. There are also licenses for wild harvest of the invasive species of Undaria in Tasmania (KaiHo Ocean Treasure) and some in Victoria (Australian Seaweed Institute 2023).

The harvesting of native seaweed in Victorian marine waters is prohibited without a permit (s. 112(2) Fisheries Act 1995) and licences enabling seaweed aquaculture are not currently available in Victoria (VFA 2023a).

While there are numerous research projects taking place or being planned, currently there are two projects in Tasmania (Australian Seaweed Institute 2023). The first, is a CRC-P project involving collaboration with Tassal, Spring Bay Seafoods and University of Tasmania (UTAS). This project aims to demonstrate the benefits of Kelps as part of an integrated multitrophic aquaculture approach. The second is a research collaboration between UTAS and Huon Aquaculture in Storm Bay that will also yield its first harvest in late 2020. A Giant Kelp Marine Forest Restoration Plan is sponsored by the Tasmania Smart Seafood Partnership [PC184].

4.6 **First Nations**

4.6.1 Methodology to Identify Cultural Values and Sensitivities

The definition of environment in the OPGGS(E)R includes the people and communities, heritage value of places, and their social, economic, and cultural features. Specifically for First Nations peoples, this includes cultural heritage and sea country values which, in accordance with Indigenous tradition, may be a spiritual and cultural connection that may be affected by the Project.

Beach recognises First Nations Groups and their deep spiritual and cultural connection to the environment. The cultural values and features within the Project and Planning Areas are addressed in this section.

The description of the environment for cultural features and values was developed through:

- Consultation with First Nations Groups with connection to Sea Country in the Project and Planning Areas
- Review of available publications by First Nations Groups relating to Sea Country.
- Engagement of Extent Heritage Pty Ltd (Extent), a specialist archaeological consulting firm, to undertake a literature review and review of Beach's assessment.

Through these processes, and in particular, consultation with First Nations Groups, Beach is confident that the cultural heritage values, and cultural features and sensitivities of First Nations groups within the Project and Planning Areas have been identified.

4.6.2 Recognition of First Nations Groups

First Nation Groups and Traditional Owners and connection to Country is recognised through contemporary laws such as the Commonwealth *Native Title Act (1993)*, as well as various State laws and agreement making (e.g. *Traditional Owner Settlement Act 2010* (Vic) and Aboriginal Heritage Acts).

While connection to Country for some First Nations Groups has been formally recognised through native title, other First Nations Groups and their connection and rights to land and sea is recognised through relevant State legislation.

A review of the statutory laws, rights and recognition conferred to First Nations Peoples within the Planning Area is summarised in the below sections.

4.6.2.1 Native Title

The Commonwealth *Native Title Act 1993* is an Australia-wide native title scheme with the following key objectives:

- Providing for the recognition and protection of native title.
- Establishing a mechanism for determining claims to native title.
- Establishing ways in which future dealings affecting native title (future acts) may proceed.

Native title is the formal recognition that Aboriginal and Torres Strait Islander people have rights and interests to land and waters according to their traditional law and customs.

A key principle for native title determination is for First Nation's people to establish and prove that Indigenous people have an unbroken and current connection to their lands and waters and in practicing their culture from the time of European settlement.

Native title can be granted with non-exclusive or exclusive rights to lands and waters. Non-exclusive native title can include, for example, the right to live and camp on an area, and hunt and fish, and can co-exist with the rights of other land users. In sea areas, only non-exclusive native title can be recognised as exclusive native title is considered inconsistent with other common law rights regarding marine access and navigation (Native title 2010).

The Federal Court of Australia first recognised native title over the sea for the Traditional Owners of Croker Island in Arnhem Land in 1998 (Tribunal File No. DCD 1998/001). Since the Croker Islands Seas native title determination, (non-exclusive) native title in sea country has been recognised along Australia's coastline through numerous claims and determinations under the Native Title Act 1993.

A search of the National Native Title Tribunal (the Tribunal) database identified the following native title claims and consent determinations within the Planning Area.

1. Victoria
    a. Eastern Maar People

The Eastern Maar People made application to the Federal Court of Australia for a native title claim which was accepted and registered on 20 March 2013 (Tribunal File No. VC2012/001). A consent determination by the Federal Court of Australia recognising the native title rights for the Eastern Maar Peoples was registered on 28 March 2023 (Tribunal File No. VCD2023/001). The native title area is located in south-western Victoria near Port Fairy along the Great Ocean Road, up to Ararat in the north, and to Colac in the East and extends seaward 100 m from the mean low-water mark of the coastline (Figure 4-91; NNTT 2016).

The determination recognises Eastern Maar's non-exclusive right to access, use, and protect public land in accordance with their traditional law and custom. The Eastern Maar First Nations Corporation (EMAC) is the registered native title body corporate under the *Corporations (First Nations and Torres Strait Islander) Act 2006* and manages the native title rights for the Eastern Maar Peoples.

    b. Gunditjmara - Part A

A consent determination recognising the native title rights of the Gunditjmara People was registered on 30 March 2007 (Tribunal File No. VCD2007/001) over 140,000 hectares in South-west Victoria (Figure 4-91). The determination recognises Gunditjmara People's native title rights and interests in traditional lands and waters and provides non-exclusive rights to access, use, and protect public land in accordance with their traditional law and custom. The Gunditj Mirring Traditional Owners Aboriginal Corporation (GMTOAC) is the registered native title body corporate under the *Corporations (First Nations and Torres Strait Islander) Act 2006* and manages the native title rights for the Gunditjmara Peoples.

    c. Gunditjmara and Eastern Maar

On 27 July 2011, the Federal Court of Australia determined (Tribunal File No. VCD2011/001) that both the Traditional Owners represented by GMTOAC and the EMAC are the native title holders for the land and waters between the Shaw and Eumeralla Rivers from Deen Maar (including Yambuk) to Lake Linlithgow (Figure 4-91). The native title includes Deen Maar (Lady Julia Percy Island) which holds deep and significant cultural association for Traditional Owners.

    d. Wadawurrung People

A native title claim application was registered for the Wadawurrung People on 24 July 2023 (Tribunal File No. VC2022/002). The claim area covers land and waters covering about 12,510 km^2 on the southern coast of Victoria (Figure 4-91). The application area is located south-east of Ararat and extends towards the coast around Sugarloaf, Geelong, and Port Phillip Bay.

    e. Gunaikurnai People.

A determination by the Federal Court of Australia recognising the native title rights of the Gunaikurnai People over parts of the determination area was registered on 22 October 2010 (Tribunal File No. VCD2010/001). This determination area exists outside but adjacent to the Planning Area.

The area covers the land and waters, including sea country, from Wilsons Promontory to Newmerella, and includes the culturally significant Nooramunga Marine & Coastal Park and Lakes Entrance and connected wetlands (Figure 4-91). The Gunaikurnai Land & Waters Aboriginal Corporation is the registered native title body corporate under the *Corporations (Aboriginal and Torres Strait Islander) Act 2006* and manages the native title rights for the Gunaikurnai People.

2. Tasmania

There are no native title areas in Tasmania.

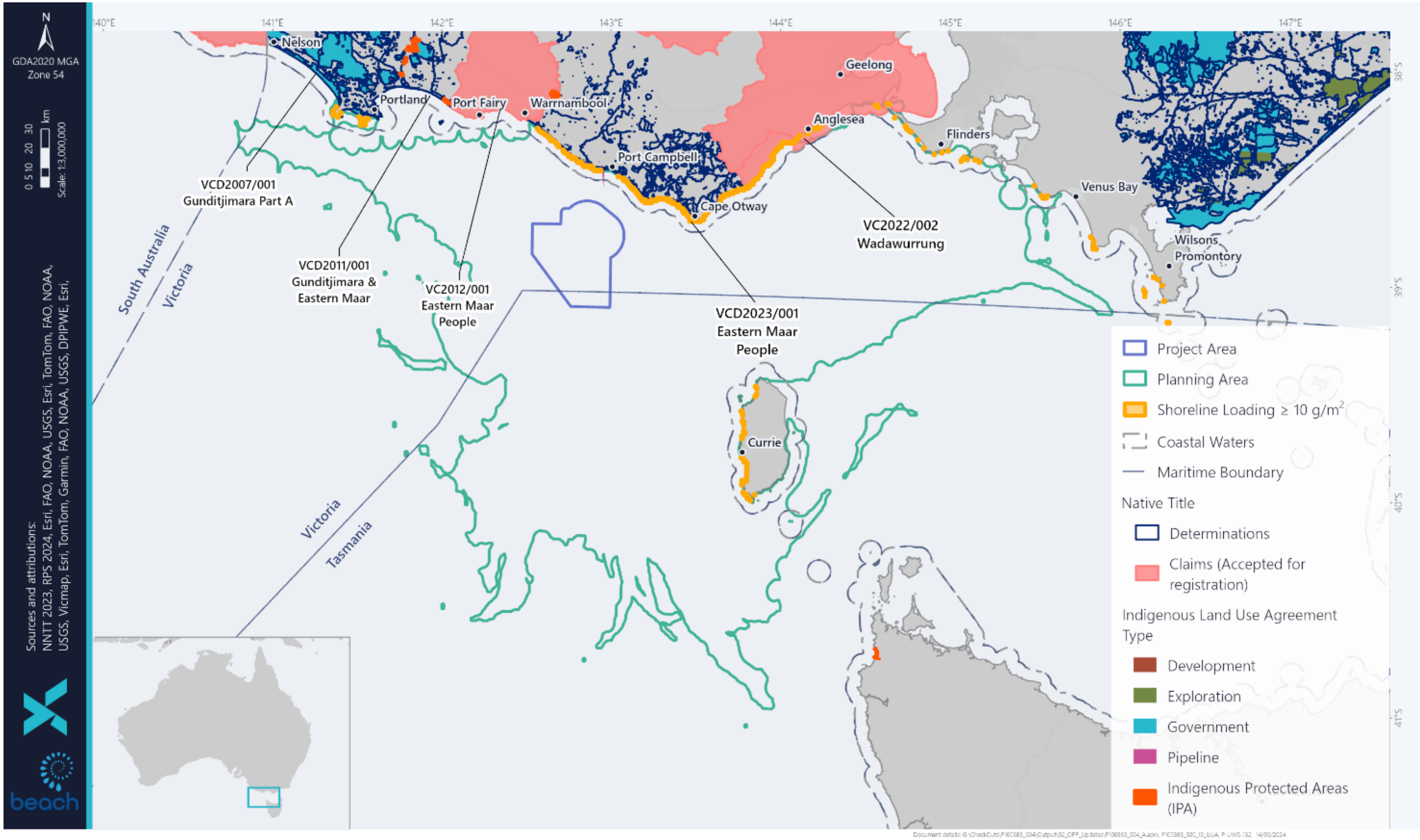


Figure 4-91: Native Title, Indigenous Protected Areas, and Indigenous Land Use Agreements relevant to the Project

4.6.2.2 Registered Aboriginal Parties

As an operator in Victoria, Beach is also cognisant of the *Aboriginal Heritage Act 2006* (Vic) (AHA 2006 VIC) that recognises a Registered Aboriginal Party (RAP) as the Traditional Owner Corporation to manage and protect First Nations cultural heritage over their Country including coastal and onshore waters. The AHA 2006 VIC recognises RAPs as the primary guardians, keepers and knowledge holders of First Nations cultural heritage and the primary source of advice and knowledge on matters relating to First Nations places or objects in the appointed RAP region.

The following groups are recognised RAPs within the Planning Area described in this OPP:

- Bunurong Land Council Aboriginal Corporation
- Eastern Maar Aboriginal Corporation
- Gunaikurnai Land and Waters Aboriginal Corporation
- Gunditj Mirring Traditional Owners Aboriginal Corporation
- Wadawurrung Traditional Owners Aboriginal Corporation

Figure 4-92 details the location of these Registered Aboriginal Parties.

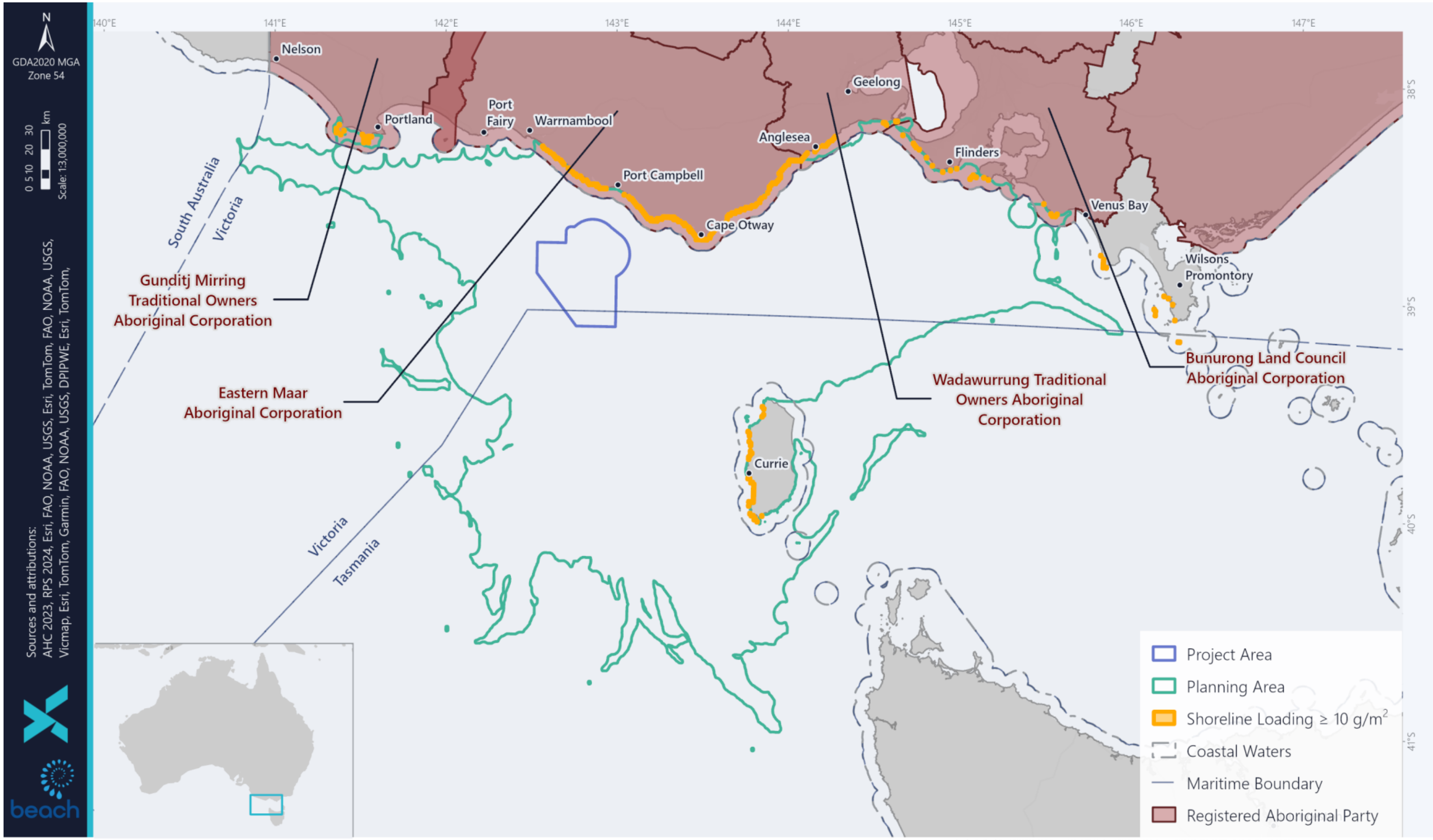


Figure 4-92: Registered Aboriginal Parties relevant to the Project

4.6.2.3 Indigenous Land Use Agreements

An Indigenous land use agreement (ILUAs) is a voluntary agreement between a native title group and other parties on the use and management of land and waters. ILUAs are established by the *Native Title Act 1993*.

No registered ILUAs were identified within the Project Area. The following ILUAs have been identified in the Planning Area:

- VI2006/004: Gunditj Mirring and State of Victoria.
- VI2010/001: Gunditj Mirring Non-Extinguishment Principle ILUA.
- VI2015/002: Gunditjmara – SEAGAS Port Campbell VIC to Torrens Island SA Pipeline ILUA.
- VIA1999/001: BHPP – Minerva.
- VIA2000/004: Blairgowrie.

ILUA locations are shown in Figure 4-91.

4.6.2.4 Land Rights

Most states and territories have legislation which sets out land rights arrangements with First Nations peoples within their jurisdiction. In most cases the statutory land rights legislation does not extend to marine areas. An exception is under the *Traditional Owner Settlement Act 2010* (Vic) which provides the possibility of agreements to extend to marine areas.

1. Victoria

In Victoria, the *Traditional Owner Settlement Act 2010* (Vic) was developed as an alternative approach to the native title process that recognises traditional owners' relationship to land and provides certain rights on Crown land.

The Gunaikurnai People entered into an agreement with the State of Victoria under the *Traditional Owner Settlement Act 2010* (Vic). An agreement to commence negotiate a recognition and settlement agreement between the Eastern Maar and the Victorian Government under the Traditional Owner Settlement Act 2010 was announced in 2017 (Justice and Community Safety (Vic) 2023).

In Victoria, the *Aboriginal Nations Heritage Act 2006* (Vic) recognises a Registered Aboriginal Party as the Traditional Owner to manage and protect First Nations cultural heritage over their Country including coastal and onshore waters.

2. South Australia

In South Australia, the *Aboriginal Land Trust Act 2013* (SA) is land rights legislation that provides for land to be acquired, held, and managed by the Aboriginal Lands Trust. No land rights have been granted or agreed under the relevant SA legislation within the Project or Planning Areas.

3. Tasmania

Tasmania does not have a First Nations land rights legislative regime. Rather, under the *Aboriginal Lands Act 1995* (Tas), grants of land parcels of historic or cultural significance 'to promote reconciliation with the Tasmanian Aboriginal community' may be made and vested in the Aboriginal Land Council of Tasmania. Some islands in the Bass Strait and adjacent to the Planning Area, such as Badger Island and Clarke Island, were returned to the Tasmanian First Nations community under the *Aboriginal Lands Act 1995*.

4.6.2.5 Indigenous Protected Areas

Indigenous Protected Areas (IPAs) are areas of land and sea managed by First Nations groups through their custodianship and stewardship obligations for Country. IPAs deliver biodiversity conservation outcomes for the benefit of all Australians, through voluntary agreements the Traditional Owners of land or sea and the Australian Government. The IPA program has a dual purpose of achieving conservation obligations and providing sustainable uses to deliver social, cultural, and economic benefits for local Indigenous communities. Indigenous People are active participants in the management of IPAs through land and sea ranger programs and other custodian and management activities.

No IPAs were identified in the Project Area or Planning Area (Figure 4-91). One future sea country IPA is likely to overlap with the Planning Area which is described below.

1. Future Sea Country IPAs

The Australian Government, through DCCEEW, is expanding the IPA program. In 2021-22 the Australian Government announced a program to expand the IPA network to include coastal and marine areas (the Sea Country IPA Program). Through the Sea Country IPA Program, the Australian Government is seeking to strengthen the conservation and protection of the marine and coastal environments, while creating employment and economic opportunities for Indigenous People (DCCEEW 2024c).

Of the ten future Sea Country IPA consultation projects announced in 2022, one is located within the Planning Area (DCCEEW 2024c). No spatial data is available for the Sea Country IPAs at the time of writing.

a. Gunditjmara Sea Country IPA, Victoria (Gunditj Mirring Traditional Owners First Nations Corporation with Eastern Maar First Nations Corporation)

The IPA consultation area is located in south-west Victoria from the Convincing Ground north-east of Portland to Yambuk Lakes in the east. The area includes volcanic plains, rivers, coast, estuaries, and coastal wetlands, and is an important breeding place and nursery for fish, eels, and birds, including nationally listed species. The area's waters encompass sites of national geological and geomorphological importance, and habitat for threatened marine animal species. The area also incorporates important cultural sites such as Deen Maar Island, which has a central role in the creation story of Gunditjmara Country. Whilst Budj Bim is located outside of the Project and Planning Areas, the Sea Country IPA Program will allow Traditional Owners to further protect the Budj Bim Cultural Landscape with activities including implementation of on land/sea management activities; community employment and capacity building; sharing and documentation of traditional knowledge; and the development and enhancement of regional partnerships.

4.6.3 Cultural Values and Sensitivities

4.6.3.1 Country and Sea Country Overview

Country is a cultural landscape, it includes the tangible (cultural heritage) and intangible (song, creation stories and cultural practices). First Nations cultural concepts are firmly intertwined with the nature of the environment, of Country. Country describes all aspects of place, environment, spirituality, law, and identity. Part of Country that extends into the oceans is known as Sea Country. Values of Country differ between First Nations groups, and not all First Nations groups and communities in Australia hold the same belief systems as formational pillars of their community or spirituality. Differences can be due to aspects of post-colonialism, such as dispossession, genocide, and cultural practice restrictions.

Due to the varied culture and history of First Nations groups, and in particular owing to various degrees of dispossession and removal from country, loss of connection, and continuation of culture, the responses of First Nations communities to caring for and talking about Country are different throughout Australia. These individualised but community-based beliefs and values contribute to the need for a varied and responsive approach to managing cultural (tangible and intangible) values.

A cultural landscape is about both pre-colonial and contemporary interactions between humans and the physical environment including non-human animals, plants, physical structures, ancestors, song lines, trade routes and other significant cultural connections to Country. Cultural landscapes are reflections of how First Nations people engaged with Country, as they see that landscape features are not just physical features, their understanding is that the landscape intrinsically connects the past and the present to people, stories, and history.

Smyth and Isherwood (2016) describe Sea Country as all estuaries, beaches, bays, and marine areas collectively, within a traditional estate. Sea Country contains evidence of the ancient mystical events by which all geographic features, animals, plants, and people were created. Sea Country contains sacred sites and contains tracks (or song lines) along which mythological beings travelled during the creation period (Smyth and Isherwood 2016). The sea, like the land, is integral to the identity of First Nations groups. Connection to Sea Country is accompanied by a complexity of cultural rights and responsibilities. Formal recognition of Sea Country rights lags considerably compared to land rights; this could be for a range of reasons including conflicting perspectives and opinions on traditional custodianship of land and how far it extends (Smyth and Isherwood 2016).

Coastal areas were amongst the most densely populated areas, due to abundance of resources. Sea Country, as it does on land, has been found to contain evidence of the ancient Dreamtime events by which all geographic features, animals, plants, and people were created. Sea Country may contain sacred sites, which may be related to these creation events, and it contains tracks (or Songlines) along which ancestral beings travelled during the creation period. Sea Country has a continuing cultural value because of the connection to creation and dreaming stories, ceremonial sites, and places of occupation.

Country is the term often used by First Nations people to describe the lands, waterways, and seas to which they are connected. The term contains complex ideas about law, place, custom, language, spiritual belief, cultural practice, material sustenance, family, and identity (AIATSIS 2022). Sea Country also known as Saltwater Country extends into the Project and Planning Areas.

4.6.3.2 Sea Country within the Project and Planning Areas

There are First Nations groups with Native Title recognition in areas adjacent the Project and Planning Areas. However, it is important to also acknowledge and respect the intangible cultural values and sensitivities that exist for other First Nations groups described in this section that are not directly adjacent to the Project Area, due to the interconnectedness of marine ecosystems and existences of various marine fauna and flora and intangible cultural values.

The land adjacent the Project and Planning Areas is the traditional land of the Eastern Maar Peoples legally represented by the EMAC. EMAC is both a Registered Aboriginal Party and a Recognised Native Title Prescribed Body Corporate. Eastern Maar land extends north to Ararat and encompasses Port Fairy, Warrnambool, Port Campbell, and other areas along the Great Ocean Road. It also extends 100 m out to sea from low tide and therefore includes the iconic Twelve Apostles (EMAC 2024). Based on consultation, Eastern Maar have always had a close connection with Sea Country which has nourished and supported their ancestors for thousands of years. Sea Country for Eastern Maar holds significant Dreaming stories, telling the story of their ancestors movement across Country. Harvesting of eel, or “Kooyang”, is incredibly important to the Eastern Maar today and remains a cultural practice handed down from their ancestors.

The land adjacent the Planning Area includes the traditional lands of the Wadawurrung people. Sea Country, or “Warre” for Wadawurrung extends from Painkalac Creek at Aireys Inlet, east into Port Phillip Bay and to the Werribee River and to the north as far as Mt Emu and Fiery Creeks (Clark 1990). Based on consultation, for the Wadawurrung peoples, Warre, holds the stories and footprints of their ancestors, with Warre being a place to meet, trade, share meals and practice ceremony. Eel, or Beniyak, have cultural significance to the Wadawurrung peoples.

The Wadawurrung native title claim and registration decision (Tribunal File No. VC2022/002) state that the claimants see Wadawurrung country and its waters as an anatomical being, with its head to the south, spine to the east, feet to the north and the arms lying along the Otway coast. This posture and orientation is replicated in traditional burial practices. Names of places in Wadawurrung language also follow the same theme and are named after body parts, like spine, head, tongue, or elbow. The Wadawurrung ‘see our Dja land and Warre sea Country as all one’ (WTOAC 2020).

Also adjacent to the Planning Area is the lands and Sea Country of the Gunditjmara. Gunditjmara recognise four types of landscape across their Country Sea Country, as one of the four, “Koonang Mirring” is defined by the meeting of salt and fresh water. Abundant in shellfish, fish, and birds, it also has a history of conflict and violence between the Gunditjmara and colonial settlers. Koonang Mirring includes the submerged landscape and the place where the spirits of Gunditjmara ancestors cross the sea to Deen Maar (CoA 2017b). The Gunditjmara published their Sea Country Plan, Gunditjmara Nyamat Mirring Plan 2023-2033, on 13 March 2024 (GMTOAC 2023). This plan details Gunditjmara’s values and species of cultural significance in the Sea Country [PC196, etc].

The Bunurong First Nations peoples are the Traditional Owners of the Victorian land adjacent to the Planning Area. They are represented by the Bunurong Land Council Aboriginal Corporation (BLCAC). Bunurong Country extends from the Werribee river to Wilsons Promontory includes some of the submerged land bridge to Tasmania. Through consultation with Beach, BLCAC advised that Sea Country is very significant for cultural practices and ceremony. Eels hold special cultural significance for the Bunurong people.

The Project and Planning Areas are also adjacent to lutruwita (Tasmania) The palawa (Tasmanian First Nations) are the Traditional Owners of lutruwita (Tasmania). Palawa people have inhabited Tasmania for at least 35,000 years. At the end of the last ice age the sea level rose, and Tasmania became isolated from the mainland of Australia. They survived in the changing landscape partly due to their ability to harvest aquatic resources, such as seals and shellfish. Following conflict between the European colonists and the Tasmanian First Nation peoples, many were relocated to missions on Bruny Island, Flinders Island, and other sites, and finally to Oyster Cove. Through consultation with Department of Premier and Cabinet and Department of Aboriginal Affairs Tasmania, Beach understands that kelp, whales, and mutton birds hold special cultural significance for First Nations peoples on mainland Tasmania, King Island and Flinders Island.

4.6.3.3 Sea Country Values

The Planning Area overlaps the South-east Marine Region. Indigenous uses and values within the South-east Marine Region are described in Sea Country - an Indigenous Perspective (NOO 2002). Specifically, Indigenous activities described in the South-east Marine Region Profile (CoA 2015) state:

Most parts of coastal Australia are of continuing cultural and spiritual significance to Indigenous people, many of whom engage in subsistence hunting, fishing and gathering and depend directly on marine resources for food. Through their involvement in commercial activities, many Indigenous people also depend on marine resources for their income.

Fishing is an important part of Indigenous culture, and a variety of methods and equipment are used, including hand gathering, lines, rods and reels, nets, traps and spears. Indigenous fishing targets a range of species of fish, shellfish, crabs and worms that are used for food, medicine or bait. Abalone, crab and lobster harvesting are important Indigenous fisheries. Indigenous people in south-eastern Australia engage in fishing and shellfish collecting on a regular basis and are involved in commercial fishing activities.

Indigenous people in the South-east Marine Region have articulated particular aspirations in terms of access rights and traditional use of marine resources, participation in management processes, and participation in the fishing sector.

First Nations people’s interests in the South-east Marine Region, are diverse and complex. Indigenous people live around the region in major cities, regional centres, small towns and on First Nations land. Coastal areas of south-east Australia were amongst the most densely populated regions of pre-colonial Australia. These highly populated areas provided an abundance of marine and other resources. However, we know that many have been displaced from the coastal areas (NOO 2002).

It is recognised that spiritual corridors extend from terrestrial areas into nearshore and offshore waters, that a number of marine animals are totems for Indigenous people, and that songlines pass through marine parks.

4.6.3.4 Sea Country Values - Resources

1. Adornment and Function

Frequently, tangible resources, such as food items, animal and plant species, and other resources, such as stone, bone and wood, are also tied strongly to intangible elements of First Nations culture. First Nations people of Tasmania, the palawa, were noted for creating durable and waterproof containers of sea-kelp threaded and dried to shape on wooden handles. In addition, shells were collected and worn as adornment. Throughout south-eastern Australia, reports of seaweed use include for cultural and ceremonial activity, medicine, clothing, food, fishing, and domestic/shelter uses (Thurstan et. al 2017). The Wadawurrung, for example, used "pink seaweed" as a poultice for jellyfish stings (Lane 1980).

Other fish and shellfish species have been noted by community during consultation, including abalone, cockles, and rock lobster (crayfish). The Eastern Maar have noted the migration routes of crustaceans as of notable significance. The Wadawurrung mention that crayfish, mussels, oysters, pipis, and fish provided important bush tucker, medicines, and other resources. Fish were caught using hooks, nets, and traps (WTOAC 2020). Other species were specifically not eaten or associated with other custom, for example, the Stingray (Baalangurk) was not eaten by the Kurnai (Howitt n.d.). Swans were hunted with boomerangs and spears, whilst other birds were caught in nets woven from plant fibres (WTOAC 2020).

2. Eels

It has been well documented that the Gunditjmara employed complex systems of aquaculture, comprising channels, weirs, and dams, to harvest kooyang (eels) on their Country (CoA 2017b). The migration of juvenile eels from freshwater to the ocean to mature and breed is integral to the survival of the species, and their physical health is inherently tied to the spiritually of the Gunditjmara. The aquaculture system is an economic and social base for Gunditjmara society (CoA 2017b). Eels and their migration are also held in social and cultural significance by the Eastern Maar, as neighbours to the Gunditjmara sharing many similar beliefs of their significance. Other coastal and river groups, including the Wadawurrung (buniya) and Bunurung, also utilised eels as an important resource and seek to protect their migration along rivers, creeks, and into the oceans. Section 4.4.9.3 provides more details on eels.

The Kulin and Kurnai Dreaming Story of Lo-an includes Lo-an and his wife Lo-an-tuka surviving mostly on eels cooked in a marin-a-thung (earth oven) on the Yarra flats. After finding a feather on his chest, Lo-an with Lo-an-tuka proceeded to follow the breeze to find the swans that the feather had come from and walked to the shores of Western Port. They camped for a long time feeding on swans and continued following the coastline to Corner Inlet. The Kulin believe they became the stars Sirius and Canopis. The Kurnai believe Lo-an is upon his mountain and looks out towards to sea, watching over the people (Massola 1968).

3. Whales

Through consultation, whales and whale migration have been noted as of significance by coastal groups in Victoria. Eastern Maar have noted the migration routes of the southern right and blue whale as of social and cultural importance. The same whale species are similarly noted by the Gunditjmara and Wadawurrung.

First Nations communities in the south-east of Australia often saw whales as spirits that transformed when they entered the water, creating a respectful relationship between whales and First Nations communities.

Kartnubul (whales) have featured in dreaming stories, ceremony, song and dance of Gunditjmara people for millennia. Gunditjmara maintain a strong spiritual connection to all species of whales that travel through Gunditjmara country (GMTOAC RNTBC 2023). Karntabul yarkeen (whale dreaming) stories connect Aboriginal groups all along the coasts of Australia, neighbouring groups in Victoria, including Gunditjmara, still gather today to strengthen the connection of groups to whales and their stories. The arrival of Karntabul in Gunditjmara waters also signifies the beginning of the 'big wet' season (May-Oct), 1 of 6 Gunditjmara seasons. Whales are also a food source, in traditional times, tribes would send up smoke signals and gather when whales got beached. Protection of whales is paramount to Gunditjmara spiritual, physical wellbeing (GMTOAC RNTBC 2023). [PC230]

Whale hunts took place from small, shore-based vessels, and targeted smaller animals (Eldridge 2015). First Nations methods of hunting may have included using fire and smoke to lure the whales to the coast and bays (Eldridge 2015), and the opportunistic utilisation of beached whales also occurred, which may have prompted periods of intense gathering of people and ceremony like those observed by early settlers such as Henty (Eldridge 2015). In Howitt's notes on the Kurnai, whales are called Ganda - 'Dead whales thrown up by the sea were supposed to have been killed by the Mrarts [ghost or spirit] and birds called Yauruk [or Yara-wuk] and sent ashore. The Mrarts then communicated to the Biraaks who told the Kurnai where to go and find the Ganda. (Howitt n.d.).

The Gunaikurnai have noted bottlenose dolphin at Lakes Entrance, and the significance of dolphins is echoed by the Wadawurrung. Wesson (2001) notes that 'the souls of prominent community leaders [were] reincarnated as dolphins and orcas'.

4.6.3.5 Sea Country Intangible Values

Landforms and landscape features in and surrounding watery places are known to hold particular significance for First Nations coastal communities. Islands off the Southern Ocean coastline have cultural importance to First Nations people as Islands of the Dead and are frequently connected to the shore by journey-after-death stories (Draper 2015).

For example, the Gunditjmara of Western Victoria seasonally occupied the caves and escarpments in the coastal limestone karst formation. These caves at Cape Bridgewater are associated with Bunjil who descended from the caves where he resided to walk along the shoreline (Bonwick 1858). The Gunditjmara believe that 'Bunjil, their creator and eagle and his brother Pallian ascended to the sky from Deen Maar in a sheet of flame after creating the land and sea and all living things' (Draper 2015). Mathews (1904) noted that the Gunditjmara buried their dead on the mainland with their heads pointed to Deen Maar island where their souls would be transported to await reincarnation. Dawson (1881) records that a haunted cave, Tarn wirring 'road of the spirits', is believed to form a passage between the mainland and the island, and the good spirit 'Put put cheptech' conveys the spirit from the island to the clouds. Other Islands in south-eastern Australia, such as Kangaroo Island (Karta), hold similar stories.

Contact and post-contact places are also noted to be in or adjacent to Sea Country, and these include sites of massacre and dispossession. The site of the Convincing Ground massacre (1833/34), where a group of whalers murdered Gunditjmara over ownership of a stranded whale, is located north of Allestree on the Portland coast. This place continues to be a place of great sorrow for the community. Other coastal massacre sites include on the Aire River Estuary at Cape Otway (1846), Eurmerella (1842), Freshwater Creek (1843) Twofold Bay (1806), and Cape Grimm (1828) (Newcastle University 2024). Missionary activity and forced removal of First Nations people in Tasmania resulted in detainment of First Nations people on Flinders Island (at Wybalenna). Other First Nations groups were taken to Swan Island and Gun Carriage Island. This detainment resulted in significant loss of life, and a loss of culture, language, and connection.

1. Law, Spirituality and Songlines

Intangible heritage refers to the cultural assets, cultural knowledge and intellectual property collectively held by First Nations and may involve practices, oral traditions, ancestral narratives, performing arts, local knowledges and practices concerning nature, the environment, and the universe. Intangible cultural heritage performs an important function of safeguarding to recognise and protect knowledge and skills that are transmitted through it from one generation to the next.

Songlines are described as short songs pertaining to the travels and exploits of ancestral beings during the Dreamtime. These songs are usually sung in association with a ritual activity, particularly dancing (Tonkinson 1972). Songlines are stories ancestral beings which includes creation stories, they are multipurpose the stories educate and uphold traditional lore, they are also communication and trade routes. (Fuller & Busill 2021).

Understanding First Nations songlines and stories also means understanding the Dreaming. Often described as the 'Dreamtime', or 'deep time', recognising the existence of Dreamtime beyond the Western concept of past, present, and future.

First Nation's people around Australia have long had a strong connection to whales, which has significance as totemic ancestors to some groups. The arrival of whales along Australia's coastline marked the arrival of the "elders of the sea", which follows a songline or ancient memory code, that traces the journeys of ancestral spirits as they created the land, animals, and lore.

In Victoria, Koontapool (southern right whales) occur along the coastlines of south-west Victoria in Gunditjmara Sea Country to feed and birth. These Koontapool Woorrkngan Yakeen (Whale Birthing Dreaming Sites), are in coastal bay areas from Port Campbell to Portland, including Warrnambool. These places on Gunditjmara Country are known resting and feeding sites for mothers and calves and are directly related to Gunditjmara Neeyn (midwives), explaining why Gunditjmara is a Matrilineal Nation. (DCCEEW 2024o).

A Kulin Dreaming story includes Angel Cave (between Port Philip and Western Port) where "One Day Bunjil, the All Father, was walking upon the sea, when suddenly there rose a great storm. Bunjil walked to the rocky shore and spoke to it, and immediately the shore rose up into a cliff and the cave was made before his eyes. Bunjil stepped into it and sheltered there till the storm was over' (Massola 1968).

A Kurnai Dreaming story of Port Albert includes the sick frog, Tide-lek, who drank all the water from the land. He didn't feel sick anymore, but he felt bad for leaving the people with nothing to drink. He walked across Port Albert one day and everyone tried to make him laugh to regurgitate the water, but they all failed until No-yang (the eel) danced on his tail and Tide-lek laughed and the land flooded. Many people died or were marooned, forming the islands. The pelican saved people with a large canoe. As part of this Dreaming Story, the pelican also formed the white pipe-clay used for ceremony at White Rock, the southernmost Island of the Seal Group east of Wilsons Promontory (Massola 1968).

As part of the Kurnai creation stories the first man and woman were Borun the pelican, and Tuk the musk duck (VACL 2014). Totemic Species are spiritually important and can be bestowed in a number of ways – through family relations or through ceremony. Randall Mumbler, from the Eurobodalla region, for example, discusses that '… Fish are more likely to be ceremonial totems; it is not common to have a fish as a totem… I have certain species that I can't fish for or eat. These rules have been placed upon me through ceremony and so I stay away from them. There are certain fish that my brother and I never eat. That is also like a conservation thing…it keeps that species alive…" Randal Mumbler (in Donaldson 2012).

The Eastern Maar discuss their connection to Sea Country noting that the sea was 'central to our culture, economy, and survival. The coastline is home to sites that are important for our Dreaming - Three Sisters Rocks and Deen Maar (Lady Julia Percy Island) where our Ancestors leave the earth. Our connection with our Sea Country extends well beyond the current shoreline to the edge of the continental shelf. While this area is under the sea today, we occupied it for thousands of years and rising sea levels have not washed away the history, physical evidence or our connection (EMAC 2015).

4.6.3.6 Submerged Cultural Heritage and Landscapes

First Nations peoples in Victoria have occupied, used, and managed sea country for thousands of years, including areas now submerged by sea level rise since time immemorial. An understanding of submerged landscapes and sea level changes may be evident from stories from First Nations groups, "Indigenous peoples still relate to land that was inundated by sea during the last ice age and regard it as their own" (NOO 2002b).

The lava flows of the World Heritage listed Budj Bim Cultural Landscape (which is outside of the Project and Planning Areas) have recently, through ocean scanning methods, been revealed to extend into the sea. The mapping of this geological formation allows the Gunditjmara to connect to Sea Country in new ways assisted by modern technology, as a supplement to their traditional knowledge and ancient connection to the sea. There is potential that early cultural deposits relating to aquaculture systems have been preserved in association with this formation, and as stated above evidence of this kind is highly significant to Gunditjmara.

4.6.3.7 Conservation and Contemporary Cultural Values

It is frequently raised by First Nations communities that ecological protection and sustainability is integral to First Nations cultural and contemporary values. Sea Country Plans, such as those completed by the Gunaikurnai (GLAWAC 2015), Wadawurrung (WTOAC. 2020), and Eastern Maar (EMAC 2015), highlight the importance of approaches that protect and enhance the environment, including biodiversity, coastal erosion, management of sea level rise and addressing climate change impacts. Goals include managing impacts to whale migration, bird and bat nesting and migration (such as the microbat, bent-wing bat, and orange-bellied parrot), protection of environmentally fragile resources such as seagrass and kelp fields, as well as securing habitat for threatened species such as the leafy seadragon.

'Increased pollution from coastal communities, agricultural and industrial run off is changing the sea hydrology and choking our sea life with plastics. Our Warre is being overused and heating up with climate changes. We are seeing the loss of our kelp forests and dramatic changes in sea life which we all depend upon' (WTOAC 2020).

'Our coastal dunes are layered with living places and hearths from the many generations of our ancestors living, harvesting, sharing meals, trading in these living places, and practicing ceremony here. We have the largest stretch of registered cultural sites in Australia along our coastline. Our fish traps, which were used to catch the abundant fish, have survived the storms and sea level changes. Ochre pits of different colours are dotted along our sandstone and limestone cliffs and headlands. Our sandy beaches, rock pools, rocky platforms and reefs were and continue to be places of abundance for harvesting food and resources like crustaceans, shellfish, and kelp' (WTOAC 2020).

Seals, or Bithaui or Gurnun in Kurnai (Howitt n.d.), are noted by the Gunaikurnai as a significant species, and habitat for fur seals at Wilsons Promontory Marine National Park is identified as an important resource to be protected, particularly due to the reliance of species on both the land and sea for different life cycle stages. It is therefore considered important that programs for environmental management consider both land and marine environments, as they are interconnected and must be managed as a whole to ensure success (GLAWAC 2015).

Through the processes identified above, and in particular, consultation with First Nations Groups, Beach is confident we have identified the cultural heritage values, and cultural features and sensitivities of First Nations groups identified within the Project and Planning Areas.

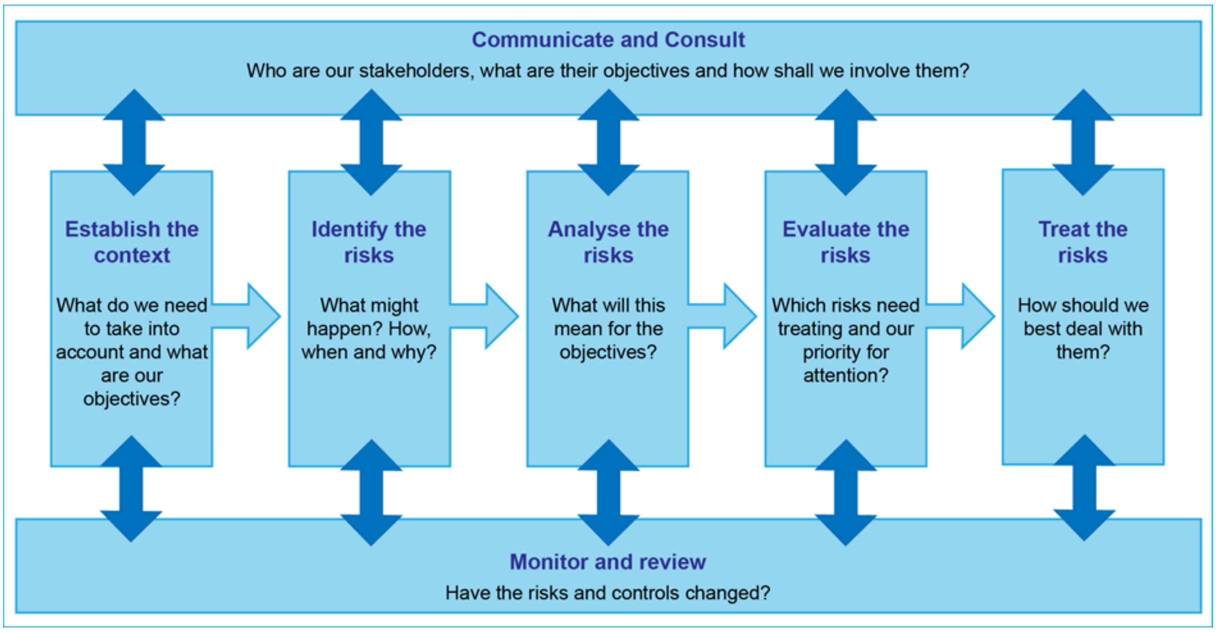
4.6.4 Assessment of Potential Impacts and Risks to Cultural Values and Sensitivities

Sections 6 and 7 evaluate the environmental impacts and risks of the Project and identifies where First Nations cultural values and sensitivities may be potentially affected. Where a potential impact to First Nations cultural values and sensitivities has been identified, details of the control measures, if required, to reduce impacts and risks from the Project are of an acceptable level and as low as reasonably practicable are provided.

5 Environmental Impact and Risk Assessment Methodology

5.1 Overview

This section outlines the environmental impact and risk assessment methodology used for the assessment of Project activities in this OPP. The methodology is consistent with the Australian and New Zealand Standard for Risk Management (AS/NZS ISO 31000:2018, Risk Management – Principles and Guidelines). Figure 5-1 outlines this risk assessment process.



Communicate and Consult

Who are our stakeholders, what are their objectives and how shall we involve them?

Establish the context

What do we need to take into account and what are our objectives?

Identify the risks

What might happen? How, when and why?

Analyse the risks

What will this mean for the objectives?

Evaluate the risks

Which risks need treating and our priority for attention?

Treat the risks

How should we best deal with them?

Monitor and review

Have the risks and controls changed?

Figure 5-1: Risk Assessment Process

5.2 Definitions

Definitions of the term used in the risk assessment process are detailed in Table 5-1.

Table 5-1: Definition of Terms for Risk Assessment

Term	Definition
Activity	Refers to a 'petroleum activity' as defined under the OPGGS(E)R as: petroleum activity means operations or works in an offshore area undertaken for the purpose of: • exercising a right conferred on a petroleum titleholder under the Act by a petroleum title; or, • discharging an obligation imposed on a petroleum titleholder by the Act or a legislative instrument under the Act.
Consequence	The consequence of an environmental impact is the potential outcome of the event on affected receptors (particular values and sensitivities). Consequence can be positive or negative
Control measure	Defined under the OPGGS(E)R as a system, an item of equipment, a person or a procedure, that is used as a basis for managing environmental impacts and risks
Emergency condition	An unplanned event that has the potential to cause significant environmental damage or harm to MNES. An environmental emergency condition may, or may not, correspond with a safety incident considered to be a Major Accident Event
Environmental aspect	An element or characteristic of an operation, product, or service that interacts or can interact with the environment. Environmental aspects can cause environmental impacts
Environmental impact	Defined under the OPGGS(E)R as any change to the environment, whether adverse or beneficial, that wholly or partially results from an activity
Environmental performance outcome	Defined under the OPGGS(E)R as a measurable level of performance required for the management of environmental aspects of an activity to ensure that environmental impacts and risks will be of an acceptable level.
Environmental performance standard	Defined under the OPGGS(E)R as a statement of the performance required of a control measure
Environmental risk	An unplanned environmental impact has the potential to occur, due either directly or indirectly from undertaking the activity
Likelihood	The chance of an environmental risk occurring
Measurement criteria	A verifiable mechanism for determining control measures are performing as required
Residual risk	The risk remaining after control measures have been applied (i.e. after risk treatment).

5.3 **Communicate and Consult**

Beach has been operating in the Otway Basin for numerous years and has undertaken extensive consultation with relevant person(s) (stakeholders) to obtain information about their functions, activities and interests and to assess how the Project and associated activities may impact on these. This information has been used to inform the impact and risk assessment in the OPP.

The stakeholder consultation process is described in detail in Section 10.

5.4 **Establish the Context**

The first step in the risk assessment process (outlined in Figure 5-1) is to establish the context. This involves:

- Understanding the regulatory framework in which the activity takes place (described in the in Section 2 – Environmental Legislation and Other Requirements)
- Defining the activities that will cause impacts and create risks (outlined in Section 3 – Description of the Project)
- Understanding concerns of stakeholders and incorporating those concerns into the design of the activity where appropriate (outlined in Section 10 - Stakeholder Consultation)
- Describing the environment in which the activity takes place (described in Section 4 – Description of the Environment)

Once the context has been established, the hazards of the activity can be identified, along with the impacts and risks of these hazards. This process is described in the following sections.

5.5 **Identify the Impacts and Risks**

This step seeks to identify the impacts and risks to be managed. It involves considering the objectives and the uncertainties of the internal and external context and identifying what might happen, when and where it might happen and why and how it can happen. In general, the process for identifying risks involves identifying the following:

- Sources of impact or risk
- Areas of impact
- Events and other uncertainties and their causes
- Potential consequences

Impacts and risks are differentiated as follows:

Impacts result from planned events – there will be consequences (known or unknown) associated with the event occurring and there is little or no uncertainty. Impacts are an inherent part of the activity. For example, sound and light will be generated during the activity and this will have consequences for marine life.

For impacts, only a consequence is assigned (likelihood is irrelevant given that the event does occur).

Risks result from unplanned events – there may be consequences if an unplanned event occurs. Risks are not an inherent part of the activity. For example, a hydrocarbon spill may occur if the activity vessel collides with another vessel, but this is not a certainty. The risk of this event is determined by considering the consequence of the impact (using factors such as the type and volume of hydrocarbons and the nature of the receiving environment) and the likelihood of this event happening (which may be determined objectively or subjectively, qualitatively or quantitatively).

5.6 **Analyse the Impacts and Risks**

Risk analysis involves developing an understanding of the impacts or risks. Risk analysis provides an input to risk evaluation and to decisions on whether risks need to be treated, and on the most appropriate risk treatment strategies and methods. Risk analysis can also provide an input into making decisions where choices must be made, and the options involve different types and levels of risk.

Beach's risk analysis process is described below:

- Establish criteria for an acceptable level of impact or risk
- Determine the maximum credible consequence arising from the impact or risk without introducing additional controls. This determination is provided in the risk assessment tables throughout Section 6 and 7
- Adopt controls for each impact or risk
- Undertake an assessment of the consequence of the impact or risk, corresponding to the maximum credible impact across the consequence categories (Figure 5-2) considering the controls identified and their effectiveness
- Identify the likelihood of occurrence of those consequences ('remote' through to 'almost certain'), considering the controls identified and their effectiveness, as outlined in Figure 5-2.
- For risks, use the consequence and likelihood to determine the overall risk level using the Beach Risk Matrix.

5.7 **Evaluate and Treat the Potential Impacts and Risks**

The following steps are undertaken using the Beach Risk Matrix (Figure 5-2) to evaluate the potential impacts and risks:

- Identify the consequences of each potential environmental impact, corresponding to the maximum credible impact.
- For unplanned events, identify the likelihood (probability) of unplanned environmental impacts occurring.
- For unplanned events, assign a level of risk to each potential environmental impact using the risk matrix.
- Identify control measures to manage potential impacts and risks to an acceptable level
- Establish environmental performance standards for each of the identified control measures.
- Environmental performance outcomes (EPO) (or objectives) are developed to provide a measurable level of performance for each environmental hazard

CDN 14740489 Beach Risk Matrix

Risk Matrix

CONSEQUENCE	CONSEQUENCE CATEGORY					LIKELIHOOD						
	PEOPLE	**ENVIRONMENT**	**REPUTATION**	**FINANCIAL[1]**	**LEGAL**	**A. Remote**	**B. Highly Unlikely**	**C. Unlikely**	**D. Possible**	**E. Likely**	**F. Almost Certain**	
	Impact to Beach or contracting personnel	Natural environment	Community safety, reputation/social licence. media, items of cultural significance.	Financial impact (e.g. due to loss of revenue, business interruption, asset loss etc.)	Breach of law, prosecution, civil action	<1% chance of occurring within the next year. Requires exceptional circumstances, unlikely event in the long-term future. Only occur as a 100-year event.	>1% chance of occurring within the next year. May occur but not anticipated. Could occur years to decades.	>5% chance of occurring within the next year. May occur but not for a while. Could occur within a few years.	>10% chance of occurring within the next year. May occur shortly but a distinct probability it won't. Could occur within months to years.	>50% chance of occurring within the next year. Balance of probability will occur. Could occur within weeks to months.	99% chance of occurring within the next year. Impact is occurring now. Could occur within days to weeks.	
6 Catastrophic	Multiple fatalities >4 or severe irreversible disability to large group of people (>10)	Catastrophic offsite or onsite release or spill; long-term destruction of highly significant ecosystems; significant effects on endangered species or habitats; irreversible or very long-term impact	Multiple community fatalities; complete loss of social licence; prolonged negative national media; complete loss of items of cultural significance	>$500m	Prolonged and complex civil and/or regulatory litigation; potential jail terms and/or very high fines and/or damages claim	HIGH	HIGH	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH	6 Catastrophic
5 Critical	1-3 fatalities or serious irreversible disability (>30%) to multiple persons (<10)	Significant offsite or onsite release or spill; eradication or impairment of the ecosystem; significant impact on highly valued species or habitats; widespread long-term impact	Community fatality; significant loss of social licence; negative national media for 2 or more days; significant damage to items of cultural significance	$100m-$500m	Civil and/or regulatory litigation; potential significant fines and/or damages claim	MEDIUM	MEDIUM	HIGH	HIGH	VERY HIGH	VERY HIGH	5 Critical
4 Major	Serious permanent injury/ illness or moderate irreversible disability (<30%) to one or more persons	Major offsite or onsite release or spill; very serious environmental effects, such as displacement of species and partial impairment of ecosystem; major impact on highly valued species or habitats; widespread medium and some long-term impact	Serious permanent injury to community member; major damage to social licence; negative national media; major damage to items of cultural significance	$10m-$100m	Civil and/or regulatory litigation; potential major fine and damages claim	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH	VERY HIGH	4 Major
3 Serious	Serious reversible/ temporary injury/illness; Lost Time Injury >5 days or Alternate/Restricted Duties >1 month	Minor offsite or onsite release or spill; serious short-term effect to ecosystem functions; serious impact on valued species or habitats; moderate effects on biological or physical environment	Serious reversible injury to community member; serious damage to social licence; negative state media; serious damage to items of cultural significance	$1m-$10m	Serious potential breach of law; report and investigation by regulator; possible prosecution or regulatory notice (e.g. improvement notice or equivalent), or possible civil litigation and serious damages claim	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH	3 Serious
2 Moderate	Reversible temporary injury/ illness requiring Medical Treatment; Lost Time Injury ≤5 days or Alternate/Restricted Duties for ≤1 month	Event contained within site; short-term effects but not affecting ecosystem functions; some impact on valued species or habitats; minor short-term damage to biological and/or physical environment	Moderate injury to community member; moderate impact to social licence; negative local media; moderate damage to items of cultural significance	$100k-$1m	Potential breach of law or non-compliance; inquiry by a regulator leading to Low-level legal issues; possible civil litigation and moderate damages claim	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	2 Moderate
1 Minor	First Aid Injury/illness	Spill limited to release location; minor effects but not affecting ecosystem functions; no impact on valued species or habitats; low-level impacts on biological and physical environment	Minor injury to community member, public concern restricted to local complaints, minor damage to items of cultural significance	≤$100k	Minor potential breach of law; not reportable to a regulator; on the spot fine or technical non-compliance	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	1 Minor

Figure 5-2: Beach Risk Matrix

5.7.1 Impact and Risk Level

The Beach Risk Matrix (Figure 5-2) provides a six-level scale for assessing both consequence and likelihood which leads to an overall risk level which can be Low, Medium, High or Very High. Consequence and likelihood levels are defined in Figure 5-2, whereas the risk levels can be understood as follows:

- Low: risks can be considered broadly acceptable and are required to be reviewed annually by the risk owner. Compliance with 'good industry practice' is generally sufficient for these risks to be considered acceptable by the Site Activity Manager. No further controls are required for risks at this level.

- Medium: risks can be considered broadly acceptable and are required to be reviewed annually by the risk owner. In addition to ‘good industry practice’, further controls may be considered for risks at this level to be reduced to a level deemed acceptable by the Asset/Project/Site Manager.

- High: Beach considers High risks to be material risks which require regular quarterly reviews to ensure they are being managed effectively. Further controls will be considered for risks at this level to be reduced to a level deemed acceptable

- Very High: Beach considers Very High risks to bematerial risks which require regular monthly reviews to ensure they are being managed effectively. Further controls and high level oversight is maintained for risks at this level

5.7.1.1 Low Order Environmental Impacts and Risks

NOPSEMA defines lower-order environmental impacts and risks as those where the environment or receptor is not formally managed, less vulnerable, widely distributed, not protected and/or threatened and there is confidence in the effectiveness of adopted control measures.

Impacts and risks are considered lower-order and are generally acceptable when, using the Beach risk matrix (Figure 5-2), the impact consequence is rated as ‘minor’ or ‘moderate’ or risks are rated as ‘low’ or ‘medium’. In these cases, applying ‘good industry practice’ is sufficient to manage the impact or risk to an acceptable level as defined in Table 5-4. To ensure lower-order impacts and risks are acceptable, an evaluation of lower-order risks are undertaken against a range of factors to demonstrate the acceptability of these impacts and risks (refer to Section 5.8).

5.7.1.2 Higher Order Environmental Impacts and Risks

NOPSEMA defines higher-order environmental impacts and risks as those that are not lower order risks or impacts (i.e., where the environment or receptor is formally managed, vulnerable, restricted in distribution, protected or threatened and there is little confidence in the effectiveness of adopted control measures).

Impacts and risks are considered higher-order when, using the Beach risk matrix (Figure 5-2) the impact consequence is rated as ‘serious’, ‘major’, ‘critical’ or ‘catastrophic’, or when the risk is rated as ’ high’ or ‘very high’. In these cases, further controls and control plans must be considered to reduce impacts and risks to levels deemed acceptable by the Risk, Corporate Governance and Sustainability Committee. To ensure higher-order impacts and risks are acceptable, an evaluation of higher-order risks are undertaken against a range of factors to demonstrate the acceptability of these impacts and risks (refer to Section 5.8).

5.8 **Demonstration of Acceptability**

A key outcome of the OPP process is to inform a conclusion as to whether the impacts and risks will be of an 'acceptable' or 'unacceptable' level. Beach considers a range of factors to demonstrate the acceptability of the environmental impacts and risks, including:

- The principles of ecologically sustainable development (ESD)
- Other requirements (e.g. laws, policies, standards, conventions etc.), including significant impacts to MNES
- Internal context
- External context
- Comparison of predicted impact or risk against the defined acceptable level.

5.8.1 Principles of Ecologically Sustainable Development

Based on Australia's National Strategy for Ecologically Sustainable Development (Council of Australian Governments, 1992), Section 3A of the EPBC Act defines ecologically sustainable development as:

Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased.

The principles of ecologically sustainable development as defined under the EPBC Act and in alignment with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024) are provided in Table 5-2. Table 5-2 describes how this OPP aligns with these principles and the relevance of each principle in the development of acceptable levels of impact.

Table 5-2: Assessment of Ecologically Sustainable Development Principles

Principle	Definition	OPP Demonstration
A 'Integration principle'	Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.	Assessment confirming identification and evaluation of environmental impacts and risks and defining acceptable levels (against conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities described in Section 4.6), incorporates consultation feedback, and demonstrates that the potential impacts and risks are manageable to an acceptable level. Consideration of the integration principle of ESD is provided against each defined acceptable level in Table 5-4 and all impact and risk acceptability demonstration evaluations in Sections 6 and 7.
B 'Precautionary principle'	If there are threats of serious or irreversible environmental damage, lack of full scientific certainty	Serious or irreversible environmental damage equates to higher-order environmental impacts and risks. Impacts and risks are considered higher-order when, using the Beach risk matrix (Figure 5-2) the impact consequence is rated as 'serious', 'major', 'critical' or 'catastrophic', or when the risk is rated as 'severe' or 'extreme'.

	should not be used as a reason for postponing measures to prevent environmental degradation.	Review of potential impacts and risks identified threats of serious or irreversible environmental damage to be limited to the unplanned events of • introduction of IMS • loss of containment of hydrocarbons and chemicals. However, as a conservative approach, an evaluation of scientific uncertainty is conducted for all impacts and risks. This includes assessing how uncertainty is addressed in adopted controls for managing residual uncertainty throughout the project. Consideration of the precautionary principle of ESD is provided for all impact and risk acceptability demonstration and environmental performance evaluations in Sections 6 and 7.
C 'Intergenerational principle'	The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Evaluation that the predicted impacts and risks will be managed to an acceptable level that will ensure the health, diversity, or productivity of the environment for current and future generations. Consideration of the intergenerational principle of ESD is provided against each defined acceptable level in Table 5-4 and all impact and risk acceptability demonstration evaluations in Sections 6 and 7.
D 'Biodiversity principle'	The conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making.	Evaluation that the predicted impacts and risks (including impacts and risks to MNES identified within regulation 7(3) of the Environment Regulations) will be managed to an acceptable level that will not affect the conservation of biological diversity and ecological integrity. Consideration of the biodiversity principle of ESD is provided against each defined acceptable level in Table 5-4 and all impact and risk acceptability demonstration evaluations in Sections 6 and 7.
E 'Valuation principle'	Improved valuation, pricing and incentive mechanisms should be promoted.	Consideration of the valuation principle of ESD is factored into the maintenance of project financial assurances to prove Beach's capacity to meet costs, expenses and liabilities associated with the Project. As part Project financial assurances, Beach will bear the cost of environmental management for the whole of project life to ensure that the environmental impacts and risks are managed to an acceptable level. Financial assurance obligations includes consideration of costs associated with: • The polluter pays principle: eliminating or controlling the escape of petroleum, cleaning up the escaped petroleum and remediating any resulting damage to the environment and carrying out environmental monitoring of the impact of the escape on the environment. • Maintenance and removal of property: Section 572 of the OPGGS Act places requirements on titleholders in relation to the maintenance and removal of structures, equipment and other property brought into a title area. • Safeguard mechanism: Scope 1 emissions associated with gas production from the Project would be reported at the individual facility (NGER) level and are forecast to be below the Safeguard Mechanism threshold. Beach have engaged with the Clean Energy Regulator to discuss the Safeguard Mechanism boundary. Beach

	will continue these discussions with the Clean Energy Regulator as the Project progresses. In accordance with the OPGGS Act, Beach will demonstrate compliance with the financial assurance obligations under the OPGGS Act to NOPSEMA prior to acceptance of an EP under this OPP. No further consideration of the valuation principle of ESD has been provided in this OPP.

5.8.2 Other Requirements

Other requirements includes compliance with relevant legislation, government policies and guidelines, international agreements and industry best practice.

Given this OPP forms the basis for NOPSEMA’s assessment of matters protected under Part 3 of the EPBC Act in Commonwealth waters, particular attention is paid to MNES (Section 2.3) with acceptability demonstrated if:

- Significant impact criteria (Table 5-3) are not exceeded; and
- Impacts and risk are not inconsistent with published guidance material from DAWE, including species management plans, recovery plans and conservation advice (Section 2.3.1).

Table 5-3: MNES Significant Impact Criteria Defined in the Significant Impact Guidelines Published by the DoEE (DoE 2013a)

Category	**Significant Impact Criteria**
Listed Critically Endangered and Endangered species	An action is likely to have a significant impact on critically endangered or endangered species if there is likelihood that it will: • Lead to a long-term decrease in the size of a population • Reduce the area of occupancy of the species • Fragment an existing population • Adversely affect habitat critical to the survival of a species • Disrupt the breeding cycle of a population • Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat • Introduce disease that may cause the species to decline, or • Interfere with the recovery of the species.
Listed Vulnerable Species	An action is likely to have a significant impact on vulnerable species if there is a likelihood that it will: • Lead to a long-term decrease in the size of an important population • Reduce the area of occupancy of an important population • Fragment an existing important population into two or more populations • Adversely affect habitat critical to the survival of a species • Disrupt the breeding cycle of a population • Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Category	Significant Impact Criteria
	• Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat • Introduce disease that may cause the species to decline, or • Interfere substantially with the recovery of the species.
Listed Migratory Species	An action is likely to have a significant impact on migratory species if there is likelihood that it will: • Substantially modify, destroy or isolate an area of important habitat for a migratory species • Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or • Seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.
Wetlands of International Importance	An action is likely to have a significant impact on a wetland of international importance if there is likelihood that it will result in: • Areas of wetland being destroyed or substantially modified • A substantial and measurable change in the hydrological regime of the wetland • The habitat or lifecycle of native species dependent upon the wetland being seriously affected • A substantial and measurable change in the water quality of the wetland which may adversely impact on the biodiversity, ecological integrity, social amenity or human health, or • An invasive species that is harmful to the ecological character of the wetland being established in the wetland.
Commonwealth Marine Area	An action is likely to have a significant impact on the environment in a Commonwealth Marine Area if there is likelihood that it will: • Result in a known or potential pest species becoming established in the Commonwealth marine area • Modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity on a Commonwealth marine area results • Have a substantial adverse effect on a population of a marine species or cetacean including its life cycle and spatial distribution • Result in a substantial change in air quality or water quality which may adversely impact on biodiversity, ecological integrity, social amenity or human health

Category	Significant Impact Criteria
	• Result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity[3], social amenity or human health may be adversely affected, or • Have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck.

5.8.3 Internal Context

The internal context relates to alignment with Beach's policies, objectives, environmental risk management framework, internal standards, procedures, technical guidance and opinions of internal stakeholders.

5.8.4 External Context

The external context relates to consultation undertaken with Relevant Persons (Section 10) both during historic activities and in the process of preparing this OPP. Impacts and risks will be acceptable if merits of claims or objections raised by Relevant Persons are adequately assessed and where relevant additional controls are adopted to manage concerns.

5.8.5 Acceptable Levels of Impact and Risk

The acceptable levels of impacts and risks to environmental receptors that are applied in the impact and risk assessments to determine and demonstrate acceptability are summarised in Table 5-4 and are based on the following:

- **Principles of ESD**, specifically:
    - Integration principle (decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations)
    - Precautionary principle (if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation)

---

[3] In the context of the activities covered by this OPP, a change to ecological integrity is considered to take into account broadscale, long term impacts to the ecosystem. With regards to the Commonwealth marine environment, the Project Area is located in open offshore waters and the seabed is generally characterised by soft sediments. These characteristics are typical of the offshore Otway Basin."

  - Intergenerational principle (environment is maintained or enhanced for the benefit of future generations)
  - Biodiversity principle (conservation of biodiversity and ecological integrity should be a fundamental consideration in decision making)
- **Other requirements**: including legislative requirements (relevant requirements of the EPBC Act and the endorsed NOPSEMA Program), policy frameworks, scientific literature, standards, guidelines, plans of management (for protected matters under the EPBC Act), MNES Significant impact criteria (defined in Matters of National Environmental Significance -Significant impact guidelines 1.1. EPBC Act (Department of the Environment 2013))
- **Internal context:** Beach processes and procedures
- **External context:** stakeholder advice.

In alignment with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the predicted level of impact and risk (Sections 5.9) will be compared against the acceptable level(s) to determine if they can be met, or if additional adopted controls are required to further reduce the impact or risk so that they do not exceed the acceptable level(s).

Table 5-4 outlines acceptable levels of impact and risk for receptors potentially affected by Project activities, as assessed in Sections 6 and 7. Receptors not credibly impacted by the Project will not have defined acceptable levels of impact and risk.

Table 5-4: Summary of Acceptable Levels of Impact for Environmental Receptors that may be Affected by the Activities Considered in this OPP

Receptor sub-category	Project aspect interactions	Acceptable level of impact and risk to the receptor sub-category	Sources used to define acceptable level	How the sources define the acceptable level
Conservation values and sensitivities				
Key ecological features	**Emissions light (Section 6.3)** **Invasive marine species (Section 7.1)** **Loss of containment – hydrocarbons and chemicals (Section 7.4)**	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline.	EPBC Act	The objects of the EPBC Act are to provide for the protection of the environment and to promote the conservation of biodiversity. KEFs are elements of the Commonwealth marine environment that are of regional importance for either a region's biodiversity or its ecosystem function and integrity. Project aspects (light, IMS and loss of containment – hydrocarbons and chemicals) may interact with values of the Bonney Coast Upwelling and West Tasmanian Canyon KEFs. These KEFs seasonally support high productivity and aggregations of marine life due to increased food availability. Light emissions may impact aggregations of seabirds supported by the Bonney Coast Upwelling KEF and fish aggregations supported by the West Tasmanian Canyon KEF. To address potential impacts to these marine fauna, acceptable levels 1, 2 and 3 have been defined to incorporate the protection of listed EPBC Act marine fauna species. The unplanned establishment of IMS may change the ecosystem dynamics of the Bonney Coast Upwelling and West Tasmanian Canyon KEFs. Also, unplanned loss of containment – hydrocarbons and chemicals events have the potential to impact on marine fauna aggregations of both Bonney Coast Upwelling and West Tasmanian Canyon KEFs. Acceptable levels 4 and 5 were defined on the premise that the absence of these unplanned events would result in no impact to the KEFs, and therefore, Project activities are acceptable if these unplanned events do not occur.
		Acceptable level 3: Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species.	Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to KEFs including acceptability demonstration for aspects with the potential to impact KEFs. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable levels 1, 2, 3, 4 and 5 have been defined based on the updated impact and risk evaluations and acceptability demonstrations which included consideration of external context. The inclusion of external context to define these acceptable levels ensures consistency with the integration principle of ESD.
		Acceptable level 4: Unplanned establishment of invasive marine species is unacceptable**.**	Principles of ESD (intergenerational principle)	Acceptable levels 1, 2, 3, 4 and 5 are consistent with the intergenerational principle of ESD by aligning with the EPBC Act, to provide for the protection of KEF values that have the potential to be impacted by the Project. Potential impacts equivalent to or better than this acceptable level will ensure Project activities will not significantly impact aggregations of listed EPBC Act marine fauna species that may forego the health, diversity and productivity of the environment for current and future generations.
		Acceptable level 5: Unplanned loss of containment – hydrocarbons and chemicals is unacceptable	Principles of ESD (biodiversity principle)	Acceptable levels 1, 2, 3, 4 and 5 are consistent with the biodiversity principle of ESD given that in meeting these levels the objects of the EPBC Act, which considers protection, and promotion of biological diversity, are also met. Potential impacts equivalent to or better than these acceptable levels will prevent significant impacts on aggregating marine fauna in KEFs, which in turn ensures the conservation of biodiversity and ecological integrity of KEF values unique to the south-east marine region.
Threatened ecological communities	**Invasive marine species (Section 7.1)** **Loss of containment – hydrocarbons and chemicals (Section 7.4)**	**Acceptable level 4:** Unplanned establishment of invasive marine species is unacceptable**.** **Acceptable level 5:** Unplanned loss of containment – hydrocarbons and chemicals is unacceptable	EPBC Act	The objects of the EPBC Act are to provide for the protection of the environment and to promote the conservation of biodiversity. Listed threatened ecological communities are matters of national environmental significance (protected matters) under the EPBC Act. TECs provide wildlife corridors or refugia for many plant and animal species (including threatened species). Unplanned project aspects (IMS and loss of containment – hydrocarbons and chemicals) have the potential to impact listed threatened species within TECs. The unplanned establishment of IMS may change the ecosystem dynamics of TECs. Also, unplanned loss of containment – hydrocarbons and chemicals events have the potential to impact on listed threatened species within TECs. Acceptable levels 4 and 5 were defined on the premise that the absence of these unplanned events would result in no impact to the TECs, and therefore, Project activities are acceptable if these unplanned events do not occur.
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to TECs including acceptability demonstration for aspects with the potential to impact TECs. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable levels 4 and 5 have been defined based on the updated impact and risk evaluations and acceptability demonstrations which included consideration of external context. The inclusion of external context to define these acceptable levels ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable levels 4 and 5 are consistent with the intergenerational principle of ESD by aligning with the EPBC Act, to provide for the protection of TECs from unplanned events of IMS establishment and loss of containment scenarios. Potential impacts equivalent to or better than this acceptable level will ensure Project activities will not impact TECs and therefore will protect the health, diversity and productivity of the environment for current and future generations.
			Principles of ESD (biodiversity principle).	Acceptable levels 4 and 5 are consistent with the biodiversity principle of ESD given that in meeting these levels the objects of the EPBC Act, which considers protection, and promotion of biological diversity, are also met. Potential impacts equivalent to or better than these acceptable levels will prevent impacts on TECs, which in turn ensures the conservation of biodiversity and ecological integrity of TECs.

Receptor sub-category	Project aspect interactions	Acceptable level of impact and risk to the receptor sub-category	Sources used to define acceptable level	How the sources define the acceptable level
AMPs	**Emissions light (Section 6.3)** **Invasive marine species (Section 7.1)** **Loss of containment – hydrocarbons and chemicals (Section 7.4)**	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetaceans species. **Acceptable level 4:** Unplanned establishment of invasive marine species is unacceptable**.** **Acceptable level 5:** Unplanned loss of containment – hydrocarbons and chemicals is unacceptable	EPBC Act	The objects of the EPBC Act are to provide for the protection of the environment and to promote the conservation of biodiversity. AMPs are established by proclamation under the EPBC Act for the purpose of protecting and maintaining biological diversity in the parks. Project aspects (light, IMS and loss of containment – hydrocarbons and chemicals) may interact with values for the Apollo and Zeehan AMPs i.e., habitat for EPBC Act listed bird and mammal species. Light emissions have the potential to impact on EPBC Act listed bird and mammal species and their habitats within the Apollo and Zeehan AMPs. To address potential impacts to both EPBC Act listed species and their habitats in AMPs, acceptable levels 1, 2 and 3 have been defined to incorporate the protection of listed EPBC Act marine fauna species. Acceptable level 2 specifically refers to the protection of habitats for EPBC Act listed species. The unplanned establishment of IMS may change the ecosystem dynamics of Apollo and Zeehan AMPs. Also, unplanned loss of containment – hydrocarbons and chemicals events have the potential to expose bird and mammal species and their habitats within the Apollo and Zeehan AMPs to hydrocarbons and chemicals. Acceptable levels 4 and 5 were defined on the premise that the absence of these unplanned events would result in no impact to the AMPs, and therefore, Project activities are acceptable if these unplanned events do not occur.
			South-east Marine Parks Network Management Plan (DNP, 2025)	The objectives of the South-east Network are to provide for: • the protection and conservation of biodiversity and other natural, cultural and heritage values of marine parks in the south-east network • ecologically sustainable use and enjoyment of the natural resources within marine parks in the south-east network, where this is consistent with the objective above. These objectives are broadly applied across all Australian Marine Parks. Potential impacts that meet or are better than acceptable levels 1, 2, 3, 4 and 5 will ensure the protection of the values of the Apollo and Zeehan AMPs and therefore objectives of the South-east Marine Parks Network Management Plan South-east Marine Park Network draft management plan (DNP, 2025) are inherently met.
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to AMPs including acceptability demonstration for aspects with the potential to impact AMPs. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable levels 1, 2, 3, 4 and 5 have been defined based on the updated impact and risk evaluations and acceptability demonstrations which included consideration of external context. The inclusion of external context to define these acceptable levels ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable levels 1, 2, 3, 4 and 5 are consistent with the intergenerational principle of ESD by aligning with the EPBC Act, to provide for the protection of AMP values that have the potential to be impacted by the Project. Potential impacts equivalent to or better than this acceptable level will ensure the protection of listed EPBC Act marine fauna species and habitats to conserve the health, diversity and productivity of the environment for current and future generations.
			Principles of ESD (biodiversity principle).	Acceptable levels 1, 2, 3, 4 and 5 are consistent with the biodiversity principle of ESD given that in meeting these levels the objects of the EPBC Act, which considers protection, and promotion of biological diversity, are also met. Potential impacts equivalent to or better than these acceptable levels will prevent significant impacts on EPBC Act listed marine fauna in AMPs and their habitats, which in turn ensures the conservation of biodiversity and ecological integrity of AMP values unique to the south-east marine region.
National Heritage Places	**Loss of containment – hydrocarbons and chemicals (Section 7.4)**	**Acceptable level 5:** Unplanned loss of containment – hydrocarbons and chemicals is unacceptable	EPBC Act	The objects of the EPBC Act are to provide for the protection of the environment and to promote the conservation of biodiversity. The EPBC Act is Australia's primary legislation to protect and manage national heritage places located in Australia's near and offshore environment (DCCEEW 2024). Unplanned events of loss of containment – hydrocarbons and chemicals have the potential to impact National Heritage Places through hydrocarbon and chemical exposure. National heritage places with the potential to be impacted from these unplanned events include Great Ocean Road and Scenic Environs and Point Nepean which contain natural values associated with rocky cliffs and dunes. Acceptable level 5 was defined on the premise that the absence of these unplanned events would result in no impact to the National Heritage Places, and therefore, Project activities are acceptable if these unplanned events do not occur.
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to National Heritage Places including the acceptability demonstration for loss of containment – hydrocarbons and chemicals. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable level 5 was defined based on the updated impact and risk evaluations and acceptability demonstration which included consideration of external context. The inclusion of external context to define this acceptable level ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable level 5 is consistent with the intergenerational principle of ESD by aligning with the EPBC Act, to provide for the protection of National Heritage Places from unplanned events loss of containment – hydrocarbons and chemicals. For the acceptable level to be met, unplanned events of loss of containment – hydrocarbons and chemicals will be prevented to ensure Project activities will not impact National Heritage Places and therefore will protect the natural values of the environment for current and future generations.

Receptor sub-category	Project aspect interactions	Acceptable level of impact and risk to the receptor sub-category	Sources used to define acceptable level	How the sources define the acceptable level
			Principles of ESD (biodiversity principle).	Acceptable level 5 is consistent with the biodiversity principle of ESD given that in preventing unplanned events of loss of containment – hydrocarbons and chemicals the objects of the EPBC Act, which considers protection, and promotion of ecological integrity, are also met. Great Ocean Road and Scenic Environs and Point Nepean National Heritage Places contain natural values associated with rocky cliffs, and dunes. Potential impacts equivalent to or better than acceptable level 5 will prevent impacts on the natural values of these National Heritage Places, which in turn ensures the ecological integrity of these places.
Nationally Important Wetlands	**Loss of containment – hydrocarbons and chemicals (Section 7.4)**	**Acceptable level 5:** Unplanned loss of containment – hydrocarbons and chemicals is unacceptable	EPBC Act	The objects of the EPBC Act are to provide for the protection of the environment and to promote the conservation of biodiversity. The EPBC Act is Australia's primary legislation to protect and manage Ramsar wetlands and migratory species that may be dependent on Nationally Important Wetlands (DCCEEW 2024). Unplanned events of loss of containment – hydrocarbons and chemicals have the potential to impact Nationally Important Wetlands through hydrocarbon and chemical exposure. Acceptable level 5 was defined on the premise that the absence of these unplanned events would result in no impact to the Nationally Important Wetlands, and therefore, Project activities are acceptable if these unplanned events do not occur.
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to Nationally Important Wetlands including the acceptability demonstration for loss of containment – hydrocarbons and chemicals. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable level 5 was defined based on the updated impact and risk evaluations and acceptability demonstration which included consideration of external context. The inclusion of external context to define this acceptable level ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable level 5 is consistent with the intergenerational principle of ESD by aligning with the EPBC Act, to provide for the protection of Nationally Important Wetlands from unplanned events loss of containment – hydrocarbons and chemicals. For the acceptable level to be met, unplanned events of loss of containment – hydrocarbons and chemicals will be prevented to ensure Project activities will not impact Nationally Important Wetlands and therefore will protect the natural values of the environment for current and future generations.
			Principles of ESD (biodiversity principle).	Acceptable level 5 is consistent with the biodiversity principle of ESD given that in preventing unplanned events of loss of containment – hydrocarbons and chemicals the objects of the EPBC Act, which considers protection, and promotion of ecological integrity, are also met. Potential impacts equivalent to or better than acceptable level 5 will prevent impacts on the Nationally Important Wetlands, which in turn ensures the ecological integrity of these places.
State Protected Areas (Terrestrial and Marin)	**Loss of containment – hydrocarbons and chemicals (Section 7.4)**	**Acceptable level 5:** Unplanned loss of containment – hydrocarbons and chemicals is unacceptable	*National Parks Act 1975* (Vic)	The objects of the *National Parks Act 1975* are for the preservation and protection of the natural environment in national parks, state parks, marine national parks, and marine sanctuaries. These areas aim to ensure conservation and enable recreation in areas of environmental and cultural significance. Unplanned events of loss of containment – hydrocarbons and chemicals have the potential to impact State Protected Areas through hydrocarbon and chemical exposure. Acceptable level 5 was defined on the premise that the absence of these unplanned events would result in no impact to the State Protected Areas, and therefore, Project activities are acceptable if these unplanned events do not occur.
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to State Protected Areas including the acceptability demonstration for loss of containment – hydrocarbons and chemicals. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable level 5 was defined based on the updated impact and risk evaluations and acceptability demonstration which included consideration of external context. The inclusion of external context to define this acceptable level ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable level 5 is consistent with the intergenerational principle of ESD by aligning with the EPBC Act, to provide for the protection of State Protected Areas from unplanned events loss of containment – hydrocarbons and chemicals. For the acceptable level to be met, unplanned events of loss of containment – hydrocarbons and chemicals will be prevented to ensure Project activities will not impact State Protected Areas and therefore will protect the natural values of the environment for current and future generations.
			Principles of ESD (biodiversity principle).	Acceptable level 5 is consistent with the biodiversity principle of ESD given that in preventing unplanned events of loss of containment – hydrocarbons and chemicals the objects of the EPBC Act, which considers protection, and promotion of ecological integrity, are also met. Potential impacts equivalent to or better than acceptable level 5 will prevent impacts on the State Protected Areas, which in turn ensures the ecological integrity of these places.

Receptor sub-category	Project aspect interactions	Acceptable level of impact and risk to the receptor sub-category	Sources used to define acceptable level	How the sources define the acceptable level
Physical environment				
Water quality	**Planned discharge – drill cuttings and fluids (Section 6.7)** **Planned discharge – cement (Section 6.8)** **Planned discharge – commissioning and operational fluids (Section 6.9)** **Planned discharge – routine operational wastes from vessels (Section 6.10)**	**Acceptable level 6:** Localised change in water quality (<2 km from discharge point located in the Project Area[1]) which will return to baseline conditions following completion of planned discharges (as defined in the OPP) is acceptable. These discharges will contain chemical additives subject to Beach's chemical selection process.	EPBC Act	The objects of the EPBC Act are to provide for the protection of the environment and to promote the conservation of biodiversity. It is an offence under the EPBC Act if an action results or will result in a significant impact on the environment. The significant impact guidelines for MNES defines an action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that the action will result in a substantial change in water quality which may adversely impact on biodiversity, ecological integrity, social amenity, or human health. Acceptable level 6 defines a localised extent (2 km from the discharge point localised in the Project Area) of impact to water quality which will return to baseline conditions following completion of planned discharges (as defined in the OPP) to ensure there is no real chance Project activities will result in a substantial change in water quality.
			Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018)	The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) establishes standards for marine water quality protection (ANZG, 2018). The key objective of these guidelines is maintenance of biological diversity and advise a precautionary approach for assessment (ANZG, 2018). Acceptable level 6 is consistent with the ANZG given it prevents substantial change in water quality which will ensure biological diversity is maintained by defining a localised extent (2 km from the discharge point localised in the Project Area) of impact to water quality which will return to baseline conditions following completion of planned discharges (as defined in the OPP).
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to water quality including acceptability demonstration for aspects with the potential to impact water quality. External context gained from the public consultation period allowed Beach to update the OPP (PC265, PC266, PC267). Acceptable level 6 was defined based on the updated impact and risk evaluations and acceptability demonstrations which included consideration of external context. The inclusion of external context to define this acceptable level ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable level 6 is consistent with the intergenerational principle of ESD by aligning with the EPBC Act, to prevent a substantial change in water quality which may adversely impact on biodiversity, ecological integrity, social amenity, or human health. Potential impacts equivalent to or better than this acceptable level will ensure the protection of water quality in the Commonwealth marine area to conserve the health, diversity and productivity of the environment for current and future generations.
			Principles of ESD (biodiversity principle).	Acceptable level 6 is consistent with the biodiversity principle of ESD given that in meeting this level the objects of the EPBC Act, which considers protection, and promotion of biological diversity, are also met. Potential impacts equivalent to or better than this acceptable level will prevent a substantial change in water quality which may adversely impact on biodiversity, ecological integrity, social amenity, or human health.
Sediment quality	**Planned discharge – drill cuttings and fluids (Section 6.7)** **Planned discharge – cement (Section 6.8)**	**Acceptable level 7:** Localised change in sediment quality (between 1 km and 2 km from the discharge point located in the Project Area[1]) for sediments highly represented throughout the region from planned discharges (as defined in the OPP) is acceptable. These discharges will contain chemical additives subject to Beach's chemical selection process.	EPBC Act	The objects of the EPBC Act are to provide for the protection of the environment and to promote the conservation of biodiversity. It is an offence under the EPBC Act if an action results or will result in a significant impact on the environment. The significant impact guidelines for MNES defines an action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that the action will result in adversely affecting biodiversity, ecological integrity, social amenity, or human health. Acceptable level 7 ensures the protection of biodiversity by defining a localised extent of impact (between 1 km and 2 km from the discharge point located in the Project Area[1]) within an area that contains sediments highly represented throughout the region. These limitations will ensure biological diversity is maintained and therefore aligns with the objects of the EPBC Act.
			Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018)	The ANZG establishes sediment quality guideline values to help ensure physical and chemical stressors do not exceed harmful levels (ANZG, 2018). The key objective of the ANZG is maintenance of biological diversity and advise a precautionary approach for assessment (ANZG, 2018). Acceptable level 7 states that chemical additives contained in planned discharges will be subject to Beach's chemical selection process to ensure chemicals used are environmentally acceptable whilst also meeting technical requirements. The use of Beach's chemical selection process considers aquatic toxicity, bioaccumulation, and persistence data for each chemical, along with the discharge concentration, duration, frequency, rate, and volume to assess chemicals that may or will be discharged to the marine environment. This approach aligns with international industry best practice for chemical assessment and will ensure that discharges to the marine environment are aligned with the key objective of ANZG.
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to sediment quality including acceptability demonstration for aspects with the potential to impact sediment quality. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable level 7 was defined based on the updated impact and risk evaluations and acceptability demonstrations which included consideration of external context. The inclusion of external context to define this acceptable level ensures consistency with the integration principle of ESD.

[1] The 2 km localised extent from the discharge point is derived from a conservative 2 km exposure radius, which accounts for the potential benthic deposition of drill cuttings and fluids transported through the water column.

Receptor sub-category	Project aspect interactions	Acceptable level of impact and risk to the receptor sub-category	Sources used to define acceptable level	How the sources define the acceptable level
		[1] Seabed disturbance from upper well section drilling fluids and cuttings discharges is expected to be within 1 km of the well location (RPS 2023). This area of disturbance is included in the total project seabed disturbance footprint (Table 6 5) as long-term seabed disturbance, where relevant acceptable levels and EPOs for seabed disturbance are defined in Section 6.2.6.	Principles of ESD (intergenerational principle)	Acceptable level 7 is consistent with the intergenerational principle of ESD by aligning with the EPBC Act, by defining limitations in the spatial extent and location of impacts to sediment quality to prevent adverse impacts on biodiversity, ecological integrity, social amenity, or human health. Potential impacts equivalent to or better than this acceptable level will ensure the protection of sediment quality in the Commonwealth marine area to conserve the health, diversity and productivity of the environment for current and future generations.
			Principles of ESD (biodiversity principle).	Acceptable level 7 is consistent with the biodiversity principle of ESD given that in meeting this level the objects of the EPBC Act, which considers protection, and promotion of biological diversity, are also met. Potential impacts equivalent to or better than this acceptable level will prevent a substantial change in sediment quality which may adversely impact on biodiversity, ecological integrity, social amenity, or human health.
Air quality	**Emissions – atmospheric emissions (Section 6.5)**	**Acceptable level 8:** Temporary change in air quality from atmospheric pollutants emitted during Project activities (as defined in the OPP) will comply with MARPOL Annex VI (Prevention of Air Pollution from Ships) enacted in the *Navigation Act 2012*.	*Navigation Act 2012*	This Act regulates ship-related activities and invokes certain requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) including MARPOL Annex VI (Prevention of Air Pollution from Ships). Acceptable level 8 is based on the compliance of atmospheric pollutants emitted during Project activities in accordance with MARPOL Annex VI (Prevention of Air Pollution from Ships) enacted in the *Navigation Act 2012.* The direct reference to MARPOL Annex VI and this Act in the acceptable level ensures OPP vessel related activities (including emissions) meet these requirements.
			National Environment Protection Measures (Implementation) Act 1998	This Act and associated regulations provide for the implementation of National Environment Protection Measures (NEPMs) to protect, restore and enhance the quality of the environment in Australia and ensure that the community has access to relevant and meaningful information about pollution. The National Environment Protection Council has made NEPMs relating to ambient air quality standards. Acceptable level 8 ensures temporary change in air quality is achievable through compliance with MARPOL Annex VI (Prevention of Air Pollution from Ships). By complying with MARPOL Annex VI, ambient air quality for personnel on vessels will be protected in accordance with NEPM ambient air quality standards for the adequate protection of human health and well-being.
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to air quality including the acceptability demonstration for atmospheric emissions. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable level 8 was defined based on the updated impact and risk evaluations and acceptability demonstrations which included consideration of external context. The inclusion of external context to define this acceptable level ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable level 8 is consistent with the intergenerational principle of ESD by ensuring temporary change in air quality from atmospheric emissions is compliant with MARPOL Annex VI and inherently NEPM ambient air quality standards to the protection of human health and well-being. Potential impacts equivalent to or better than this acceptable level will ensure the protection of air quality in the Commonwealth marine area to conserve the health, diversity and productivity of the environment for current and future generations.
			Principles of ESD (biodiversity principle).	Acceptable level 8 is consistent with the biodiversity principle of ESD through compliance with MARPOL Annex VI. The prevention of unnecessary air pollution from Project vessels, ensures changes to air quality can be reduced. This in turn protects offshore air quality which is a component of the Commonwealth marine area which is a MNES under the EPBC Act. Potential impacts equivalent to or better than this acceptable level will prevent long-term change in air quality which may adversely impact on biodiversity, social amenity, or human health.
GHG emissions	**Emissions – greenhouse gases (Section 6.6)**	**Acceptable level 9:** Project activities will not interfere with Australia's GHG commitments under the Paris Agreement and enacted in the *Climate Change Act 2022* and managed by the safeguard mechanism.	Paris Agreement	Australia, as a signatory to the Paris Agreement, is committed to its goals. These goals include limiting global warming to well below 2°C above pre-industrial levels, with efforts to limit the increase to 1.5°C. The Agreement emphasises the importance of protecting ecosystems, including oceans, and safeguarding biodiversity in addressing climate change. It also acknowledges the critical need to ensure food security, given the vulnerability of food production systems to climate change impacts. As a signatory, Australia is obligated to contribute to achieving these global climate goals through Australia's GHG commitments as per the *Climate Change Act 2022*. Acceptable level 9 ensures Australia's GHG commitments as per the *Climate Change Act 2022* will not be interfered with to meet the goals of the Paris Agreement.
			Climate Change Act 2022	The key legislative instrument that enacts Australia's commitments under the Paris Agreement is the *Climate Change Act 2022*. Under the *Climate Change Act 2022*, Australia's Nationally Determined Contributions (NDC) was updated in 2022, committing Australia to a target of net zero emissions by 2050 and reduce Greenhouse gas emissions by 43% from 2005 levels. Acceptable level 9 ensures Australia's GHG commitments as per the *Climate Change Act 2022* will not be interfered with to meet Australia's NDC.
			Safeguard Mechanism	The Safeguard Mechanism was developed to ensure that Australia's largest GHG emitters keep their net emissions below an emissions limit (a baseline) and stays within the 2030 emissions budget established by the 2030 NDC. The Safeguard Mechanism applies to facilities that emit more than 0.1 Mt CO_2-e per annum. The Safeguard Mechanism is the Government's primary legislation for achieving industrial emissions reduction in line with Australia's NDC.

Receptor sub-category	Project aspect interactions	Acceptable level of impact and risk to the receptor sub-category	Sources used to define acceptable level	How the sources define the acceptable level
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on GHG emissions. External context gained from the public consultation period allowed Beach to update the OPP (PC326, PC218). Acceptable level 9 was defined based on the updated impact and risk evaluations and acceptability demonstrations which included consideration of external context. The inclusion of external context to define this acceptable level ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable Level 9 aligns with the intergenerational principle of ESD by supporting Australia's commitments under the *Climate Change Act 2022*, which are in line with the Paris Agreement. Both the intergenerational principle of ESD and the Paris Agreement prioritise protecting the environment for future generations by addressing climate change. By ensuring that Project activities do not interfere with Australia's GHG commitments, Acceptable Level 9 contributes to maintaining a healthy environment for current and future generations, the objective of the intergenerational principle of ESD.
			Principles of ESD (biodiversity principle).	Acceptable level 9 is consistent with the biodiversity principle of ESD by supporting Australia's commitments under the *Climate Change Act 2022*, which are in line with the Paris Agreement. The Agreement emphasises the importance of protecting ecosystems, including oceans, and safeguarding biodiversity in addressing climate change. By ensuring that Project activities do not interfere with Australia's GHG commitments, Acceptable Level 9 contributes to safeguarding biodiversity.
Ecological environment				
Benthic habitats and communities	**Physical presence – seabed disturbance (Section 6.2)** **Planned discharge – drill cuttings and fluids (Section 6.7)** **Planned discharge – cement (Section 6.8)**	**Acceptable level 10**: No impacts on unique seafloor habitats[2] to the south-east region, including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests. **Acceptable level 11**: Impacts on benthic habitats and communities within the Project Area that are highly represented throughout the region and are not unique seafloor habitats is acceptable.	EPBC Act	The objects of the EPBC Act are to provide for the protection of the environment and to promote the conservation of biodiversity. It is an offence under the EPBC Act if an action results or will result in a significant impact on the environment. The significant impact guidelines for MNES defines an action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that the action will modify an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results. Acceptable levels 10 and 11 ensures no impacts on unique seafloor habitats of the south-east region for the protection of important areas of habitat. Acceptable level 11 also specifically highlights that only benthic habitats and communities that are to be impacted will be highly represented throughout the region. These limitations will ensure biological diversity is maintained and therefore aligns with the objects of the EPBC Act.
			South-east Marine Parks Network Management Plan (DNP, 2025)	The objectives of the South-east Marine Parks Network Management Plan (DNP, 2025)are: • the protection and conservation of biodiversity and other natural, cultural and heritage values of marine parks in the south-east network • ecologically sustainable use and enjoyment of the natural resources within marine parks in the south-east network (where this is consistent with first objective). Acceptable levels 10 and 11 ensures the protection of unique seafloor habitats which are values of marine parks in the south-east network. The prevention of impacts on unique seafloor habitats ensures consistency with the objectives of the South-east Marine Parks Network Management Plan for the protection of natural values of marine parks in the south-east network.
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to benthic habitats and communities including acceptability demonstration for aspects with the potential to impact this receptor. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable levels 10 and 11 were defined based on the updated impact and risk evaluations and acceptability demonstrations which included consideration of external context. The inclusion of external context to define this acceptable level ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable levels 10 and 11 are consistent with the intergenerational principle of ESD by aligning with the EPBC Act, by preventing impacts on unique seafloor habitats of the south-east region which in turn preserves biodiversity and ecological integrity for current and future generations. Potential impacts equivalent to or better than this acceptable level will ensure the protection of benthic habitats and communities in the Commonwealth marine area to conserve the health, diversity and productivity of the environment for current and future generations.
			Principles of ESD (biodiversity principle).	Acceptable levels 10 and 11 are consistent with the biodiversity principle of ESD given that in meeting this level the objects of the EPBC Act, which considers protection, and promotion of biological diversity, are also met. Potential impacts equivalent to or better than this acceptable level will prevent impacts to unique seafloor habitats which may adversely impact on biodiversity, ecological integrity, social amenity, or human health.
Intertidal and subtidal habitats (including seagrass, algae,	**Loss of containment – hydrocarbons and chemicals (Section 7.4)**	**Acceptable level 5:** Unplanned loss of containment – hydrocarbons and chemicals is unacceptable	EPBC Act	The objects of the EPBC Act are to provide for the protection of the environment and to promote the conservation of biodiversity. It is an offence under the EPBC Act if an action results or will result in a significant impact on the environment. The significant impact guidelines for MNES defines an action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that the action will modify an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results. Acceptable level 5 was defined on the premise that the absence of these unplanned events would result in no impact to intertidal and subtidal habitats, and therefore, Project activities are acceptable if these unplanned events do not occur.

---

[2] Unique seafloor habitats of the south-east region including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests (DNP, 2025).

Receptor sub-category	Project aspect interactions	Acceptable level of impact and risk to the receptor sub-category	Sources used to define acceptable level	How the sources define the acceptable level
mangrove, saltmarsh)			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to intertidal and subtidal habitats including the acceptability demonstration for loss of containment – hydrocarbons and chemicals. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable level 5 was defined based on the updated impact and risk evaluations and acceptability demonstration which included consideration of external context. The inclusion of external context to define this acceptable level ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable level 5 is consistent with the intergenerational principle of ESD by aligning with the EPBC Act, to provide for the protection of intertidal and subtidal habitats from unplanned events loss of containment – hydrocarbons and chemicals. For the acceptable level to be met, unplanned events of loss of containment – hydrocarbons and chemicals will be prevented to ensure Project activities will not impact intertidal and subtidal habitats and therefore will protect the natural values of the environment for current and future generations.
			Principles of ESD (biodiversity principle).	Acceptable level 5 is consistent with the biodiversity principle of ESD given that in preventing unplanned events of loss of containment – hydrocarbons and chemicals the objects of the EPBC Act, which considers protection, and promotion of ecological integrity, are also met. Potential impacts equivalent to or better than acceptable level 5 will prevent impacts on the intertidal and subtidal habitats, which in turn ensures the ecological integrity of these places.
Marine fauna (including plankton, invertebrates, and threatened and migratory species)	**Emissions – light (Section 6.3)** **Underwater sound (Section 6.4)** **Physical presence – interaction with marine fauna (Section 7.2)** **Accidental discharge – hazardous and non-hazardous materials (Section 7.3)** **Loss of containment – hydrocarbons and chemicals (Section 7.4)**	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species. **Acceptable level 12:** Death or injury to listed threatened, migratory or cetacean species from unplanned interactions with marine fauna is unacceptable. **Acceptable level 13:** Unplanned accidental discharge of hazardous and non-hazardous materials is unacceptable. **Acceptable level 5:** Unplanned loss of containment – hydrocarbons and chemicals is unacceptable	EPBC Act	The objects of the EPBC Act are to provide for the protection of the environment and to promote the conservation of biodiversity. The EPBC Act protects listed threatened species to assist its recovery and identify actions required for conservation and recovery of the threatened species. Migratory species listed under international agreements to which Australia is a party are protected under the EPBC Act. It is an offence under the EPBC Act if an action results or will result in a significant impact on the environment. The significant impact guidelines for MNES defines an action is likely to have a significant impact on a threatened species if there is a real chance or possibility that it will: • Interfere with the recovery of the species • modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • adversely affect habitat critical to the survival of a species. The significant impact guidelines for MNES defines an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will: • seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species • substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species. To address potential impacts to marine fauna, acceptable levels 1, 2 and 3 have been defined to incorporate the protection of listed EPBC Act marine fauna species in accordance with the objectives of conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species; and definitions of significant impacts on EPBC Act listed threatened and migratory marine fauna. The unplanned interaction with marine fauna, accidental discharge of hazardous and non-hazardous materials and loss of containment – hydrocarbons and chemical events have the potential to impact on marine fauna. Acceptable levels 12, 13 and 5 were defined on the premise that the absence of these unplanned events would result in no impacts to marine fauna, and therefore Project activities are acceptable if these unplanned events to not occur.
			Threatened species recovery plans or conservative advice	Recovery plans and conservation advice are adopted for species listed under the EPBC Act. The objectives of recovery plans and conservation advice for species which may be impacted are incorporated into these acceptable levels. Primary or long-term objectives of species recovery plans include: • Minimise anthropogenic threats to improve the population status of species, leading to the removal of the species from the threatened species list of the EPBC Act • Ensuring that anthropogenic activities do not hinder recovery in the near future, or impact on the conservation status of the species in the future. Relevant objectives of conservation advice include: • Minimise further loss of habitat critical to the survival of species throughout Australia (including habitat predicted to become habitat critical in the future because of climate change). Acceptable level 3 ensures impacts from the Project will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species, therefore will meet the objectives of these plans.
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to marine fauna including acceptability demonstration for aspects with the potential to impact marine fauna. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable levels 1, 2, 3, 5, 12 and 13 have been defined based on the updated impact and risk evaluations and

Receptor sub-category	Project aspect interactions	Acceptable level of impact and risk to the receptor sub-category	Sources used to define acceptable level	How the sources define the acceptable level
				acceptability demonstrations which included consideration of external context. The inclusion of external context to define these acceptable levels ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable levels 1, 2, 3, 5, 12 and 13 are consistent with the intergenerational principle of ESD by aligning with the EPBC Act, to provide for the protection of marine fauna that have the potential to be impacted by the Project. Potential impacts equivalent to or better than this acceptable level will ensure Project activities will not significantly impact EPBC Act listed marine fauna species which may forego the health, diversity and productivity of the environment for current and future generations.
			Principles of ESD (biodiversity principle).	Acceptable levels 1, 2, 3, 5, 12 and 13 are consistent with the biodiversity principle of ESD given that in meeting these levels the objects of the EPBC Act, which considers protection, and promotion of biological diversity, are also met. Potential impacts equivalent to or better than these acceptable levels will prevent significant impacts on marine fauna, which in turn ensures the conservation and biodiversity of Australian marine fauna.
Socio-economic values				
Other marine users (including offshore petroleum industry, offshore renewable industry, defence activities, shipping, commercial fisheries, tourism and recreation)	**Physical presence – interaction with other users (socio-economic) (Section 6.1)**	**Acceptable level 14:** No interference with other marine users to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties as conferred by the titles granted to Beach.	OPGGS Act	Section 280(2)(a) and (b) of the OPGGS Act outlines that a person (the first person) carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry on those activities in a manner that does not interfere with a range of other marine activities including navigation or fishing, to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person. Acceptable level 14 incorporates this requirement stating no interference with other marine users to a greater extent than is necessary to meet the rights and performance of the duties as conferred by the titles granted to Beach.
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to other marine users including the acceptability demonstration for physical presence – interaction with other users. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable level 14 was defined based on the updated impact and risk evaluations and acceptability demonstration which included consideration of external context. The inclusion of external context to define this acceptable level ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable level 14 is consistent with the intergenerational principle of ESD by preventing unnecessary interference with other marine users. By only allowing interference that is essential for the project, the rights of current and future marine users are protected.
			Principles of ESD (biodiversity principle).	The biodiversity principle of ESD is not considered relevant to other marine users, given the rights of other marine users is focused on human activities, rather than the ecological integrity of the biological environment.
Cultural values and sensitivities				
Maritime archaeological heritage First Nations	**Physical presence – seabed disturbance (Section 6.2)** **Planned discharge – drill cuttings and fluids (Section 6.7)** **Planned discharge – cement (Section 6.8)**	**Acceptable level 15**: No impacts on underwater cultural heritage with values as conferred by the *Underwater Cultural Heritage Act 2018* (Cth).	*Underwater Cultural Heritage Act 2018*	The objective of the UCH Act is to provide for the identification, protection and conservation of Australia's underwater cultural heritage. The Act protects archaeological remains of vessels and aircraft (including Aboriginal and Torres Strait Islander traditional watercraft) that have been wholly or partially submerged in Australian waters for 75 years or longer. Other types of underwater cultural heritage, including First Nations archaeological heritage associated with dry-land habitation on the submerged Pleistocene landscapes on the Australian continental shelf and remains of shipwrecks or aircraft younger than 75 years (DCCEEW, 2024). No maritime or First Nations archaeological heritage is known to exist within the Project Area (Section 4.2.5 and 4.6.3.6). Acceptable level 15 incorporates the UCH Act objective by preventing impacts on underwater cultural heritage and thereby ensuring the protection and conservation of underwater cultural heritage.
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to underwater cultural heritage including the acceptability demonstration for aspects with the potential to impact this receptor. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable level 15 was defined based on the updated impact and risk evaluations and acceptability demonstration which included consideration of external context. The inclusion of external context to define this acceptable level ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable level 15 is consistent with the intergenerational principle of ESD by aligning with the UCH Act, to provide for the protection of underwater cultural heritage for current and future generations.
			Principles of ESD (biodiversity principle).	The biodiversity principle of ESD is not considered relevant to maritime archaeological heritage and underwater cultural heritage, as these heritage values primarily focus on the preservation and understanding of human-made artifacts and historical contexts, rather than the ecological integrity of the biological environment.

Receptor sub-category	Project aspect interactions	Acceptable level of impact and risk to the receptor sub-category	Sources used to define acceptable level	How the sources define the acceptable level
First Nations values and sensitivities	**Physical presence – seabed disturbance (Section 6.2)** **Planned discharge – drill cuttings and fluids (Section 6.7)** **Planned discharge – cement (Section 6.8)** **Loss of containment – hydrocarbons and chemicals (Section 7.4)**	**Acceptable level 16**: No impacts on declared areas or objects of particular significance with values as conferred by the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth).	*Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (ATSHIP Act)	The ATSHIP Act provides protection to places and objects of particular significance from injury or desecration (DCCEEW, 2023). The ATSIHP Act states that an area will be taken to be injured or desecrated if: • it is used or treated in a manner inconsistent with Aboriginal tradition • by reason of anything done in, on or near the area, the use or significance of the area in accordance with Aboriginal tradition is adversely affected, or • passage through or over, or entry upon, the area by any person occurs in a manner inconsistent with Aboriginal tradition. An object will be taken to be injured or desecrated if it is used or treated in a manner inconsistent with Aboriginal tradition. Acceptable level 16 incorporates the ATSHIP Act objective by stating Project activities will not impact Aboriginal areas and objects defined under the ATSHIP Act.
			Principles of ESD (integration principle)	The public, including relevant stakeholders, have had the opportunity to provide feedback on potential impacts to First Nations values and sensitivities including the acceptability demonstration for aspects with the potential to impact this receptor. External context gained from the public consultation period allowed Beach to update the OPP. Acceptable level 16 was defined based on the updated impact and risk evaluations and acceptability demonstration which included consideration of external context. The inclusion of external context to define this acceptable level ensures consistency with the integration principle of ESD.
			Principles of ESD (intergenerational principle)	Acceptable level 16 is consistent with the intergenerational principle of ESD. This consistency is achieved by aligning with the objective of the ATSHIP Act, which considers the protection of significant Aboriginal areas and objects. By setting the acceptable level as having no impacts on declared areas or objects of particular significance as conferred under the ATSHIP Act, this level will provide for the protection of Aboriginal areas and objects defined under the ATSHIP Act for current and future generations.
			Principles of ESD (biodiversity principle).	Acceptable level 16 aligns with the biodiversity principle of ESD by safeguarding significant Aboriginal areas and objects whose values are inherently connected to biodiversity. Meeting Acceptable level 16 ensures that this connection, as recognised under the ATSHIP Act, remains unbroken.

5.9 **Environmental Performance Outcomes**

Environmental Performance Outcomes (EPOs) are measurable performance levels designed to manage environmental aspects of an activity, ensuring impacts and risks remain within acceptable levels (NOPSEMA 2024).

Beach has developed EPOs for the project in accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024). These EPOs are aligned with ESD principles and relevant to identified environmental impacts and risks and establish environmental performance levels equal to or exceeding defined acceptable levels.

EPOs are based on the evaluated predicted levels of impact and risk in the OPP. The basis of EPO environmental performance levels ensures levels of impacts or risks will not exceed the upper range of predicted levels of environmental impact or risk in the OPP (Figure 5-3).

The Project's EPOs are consistent with ESD principles as they incorporate ESD considerations into acceptable levels (Section 5.8.5), the demonstration of acceptability process (Section 5.8), and are equal to or better than the defined acceptable levels (NOPSEMA 2024).

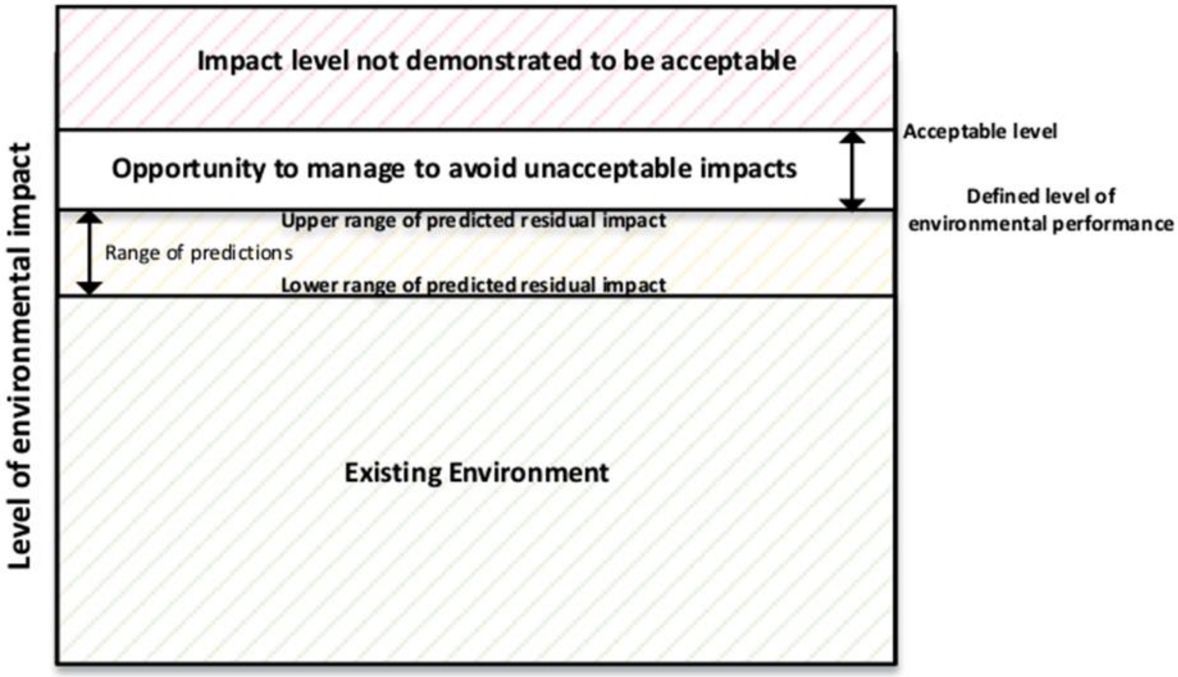


Figure 5-3: Framework for the Acceptable Level of Impact and Associated Levels of Environmental Performance (NOPSEMA 2024)

6 Environmental Impact Evaluation – Planned Activities

6.1 **Physical Presence – Interaction with Other Users (Socio-economic)**

6.1.1 Hazard Identification

The presence of vessels and infrastructure within the Project Area has the potential to interact with other marine users. Relevant stages and associated activities that relate to physical presence of vessels and infrastructure with the potential to interact with other users are defined below in Table 6-1 and described in Section 6.1.2.

Table 6-1: Activities Undertaken During the Project which may Interact with other users

Stage	Activity
Operations	Hydrocarbon extraction and export
Support Operations (all stages)	MODU operations; vessel operations

It is noted that MODU and vessel operations within the Project Area are considered part of a petroleum activity. MODU and vessel operations outside of the Project Area are excluded from the scope of this OPP, as these operations are fall under maritime legislation such as the *Navigation Act 2012*.

6.1.2 Hazard Description

6.1.2.1 Operations

Infrastructure required for hydrocarbon extraction and export operations includes the proposed wells, and subsea systems. The physical presence of this infrastructure is expected to be present for at least 20 years in the Project Area (based on the estimated end of field life in 2045). To avoid direct interactions between infrastructure and other users, safety zones can be administered by NOPSEMA prohibiting other user vessels to enter or be present in the safety zones.

The following safety zones will be gazetted for the life of the Project:

- 500 m around the OGPP tie in locations; and
- 500 m around wells (up to 9 wellheads across VIC/P43 and VIC/P73).

Gazetted safety zones for proposed wells, and OGPP tie in locations in the Project Area restricts other users from accessing these future specified areas. Restriction of access from these specified areas will displace other users for approximately 20 years from safety zones in the Project Area.

6.1.2.2 Support Operations

Short-term support operations are associated with all stages of the Project. The type and number of vessels in the Project Area at any one time, and the duration of presence, will differ depending on the project stage. For a single activity, there will be no more than three vessels operating simultaneously. The longest duration for a single activity requiring support vessel operations is 40 days to drill a single well utilising a MODU and two support vessels. In the event of concurrent activities, five vessels may operate simultaneously for a period of up to 20 days during concurrent drilling and installation activities. In this case, a MODU with two support vessels and an installation vessel with a support vessel could be undertaking concurrent drilling and installation activities.

MODU anchors could be prelaid and may be in place for up to three months prior to the MODU entering the field. Surface buoys associated with the anchors will be in place until the MODU is anchored on location. These can be up to 2 km from the well location and will have a navigation light.

MODU operations are required during drilling, well intervention and workovers and plug and abandonment activities. The MODU will be stationary whilst undertaking these activities. To avoid direct interactions between the MODU and other marine users, cautionary and exclusion zones will be applied during MODU operations in the Project Area:

- 2 km cautionary zone around MODU, anchors, mooring chains, and surface buoys during the drilling stage
- 500 m petroleum safety zone (PSZ) or exclusion zone around the MODU and each well during drilling, operation and decommissioning stages.

Vessel operations are required during all stages of the Project. Vessel operations in the Project Area will require temporary exclusion or cautionary zones for third party vessels whilst undertaking Project activities:

- 500 m Safe Navigation Area (SNA) around vessel(s), and any towed equipment during the seabed survey.

6.1.3 Impact Analysis and Evaluation

Socioeconomic receptors identified as susceptible to changes to functions, interests, or activities from the physical presence of the MODU, vessels, and subsea systems are:

- Commonwealth & state managed fisheries
- Industry
- Tourism and recreation
- Cultural values and sensitivities

6.1.3.1 Commonwealth and State Managed Fisheries

Beach has studied Commonwealth catch effort data (ABARES 2024) and consulted extensively with fishers as part of its ongoing operations in the Planning Area. Five Commonwealth Fisheries with effort intensity data or reporting grids for seasons between 2016 and 2023 overlap the Project Area, including:

- Bass Strait Central Zone Scallop Fishery (BSCZSF)
- Eastern Tuna and Billfish Fishery (ETBF)
- Southern and Eastern Scalefish and Shark Fishery (SESSF) includes the following subsections:
    - Commonwealth Trawl Sector (SESSF – CTS) (Danish-seine)
    - Commonwealth Trawl Sector (SESSF – CTS) (otter-board trawl)
    - Gillnet Hook Trap Sector Shark Gillnet sub-sector (SESSF – GHTS: SGSHS)
    - Gillnet Hook Trap Sector Shark Hook sub-sector (SESSF – GHTS: SGSHS)

  - Gillnet Hook Trap Sector Scalefish Hook sub-sector (SESSF – GHTS: SHS)
  - Southern Bluefin Tuna Fishery (SBTF)
  - Southern Squid Jig Fishery (SSJF)

In addition, three State Managed Fisheries with catch effort overlap the Project Area:

- Victorian Rock Lobster Fishery
- Victorian Giant Crab Fishery
- Victorian Wrasse (Ocean) Fishery

The interference to the above receptors has the potential to result in changes to the functions, interests, or activities of other users.

Bass Strait Central Zone Scallop Fishery (BSCZSF)

No fishing intensity data available from 2016 through 2023 fishing seasons overlaps the Project Area. However, the Project Area is partially overlapped by 1 reporting grid since 2016 (0.9% overlap) reported during the 2019 fishing season. Little or no fishing activity from the Bass Strait Central Zone Scallop Fishery is expected within the Project Area with the majority of fishing intensity data occurring to the east of King Island (Figure 4-68). Therefore, activities from the Project are unlikely to have an impact to fishers within the fishery.

Eastern Tuna and Billfish Fishery (ETBF)

No fishing intensity data available from 2016 through 2023 fishing seasons overlaps the Project Area. However, the Project Area is partially overlapped by 3 reporting grids, ranging between 1.5% and 9.2% overlap. Each grid is overlapped during only one fishing season since 2016, two of which during the 2017 season (7.7 and 9.2% overlap) and the other during the 2023 season (1.5% overlap). Little fishing activity from the Eastern Tuna and Billfish Fishery is expected within the Project Area with significant fishing intensity data shown to occur in off NSW and Queensland (Butler et al. 2024). Therefore, activities from the Project are unlikely to have an impact to fishers within the fishery.

Southern and Eastern Scalefish and Shark Fishery – Commonwealth Trawl Sector (SESSF – CTS)

No fishing intensity data available from 2016 through 2023 fishing seasons overlaps the Project Area for the Danish-seine method of the Commonwealth Trawl Sector (CTS). However, the Project Area is overlapped by reporting grids from available data since 2016. In 2020, the Project Area is partially overlapped by 4 grids ranging from 0.9 to 9.1% overlap. In 2018 and 2019 the Project Area is overlapped by only 2 grids (1.4% and 0.9% overlap) with only one grid overlapping in years 2016, 2017, 2021, 2022 and 2023 (1.5% overlap). Beach commissioned a report from SETFIA on Trawl and Gillnet fishing activity (SEFTIA 2019) which confirmed no Danish seine sub-sector fishing in the project area. The majority of fishing intensity data occurs in the Gippsland area and to the east of Tasmania (

Figure 4-70). Therefore, activities from the Project are unlikely to have an impact to fishers within the fishery.

The Project Area overlaps an area designated as low intensity fishing (<0.5 hours/km^2) for combined data (2016 through 2023) for the otter-board trawl method of the CTS by 0.8%. The Project Area does not overlap moderate or high intensity fishing areas. Little or no fishing activity from the otter-board trawl segment of the CTS is expected within the Project Area. Fishing activity is primarily along the continental shelf spanning from South Australian offshore waters to NSW offshore waters plus the west and east coasts of Tasmania (Figure 4-71). SEFTIA (2019) states that trawl fishing in the SESSF Commonwealth Trawl Sector (CTS) otter-board trawl sub-sector does not occur in the Project Area as the grounds are too rough. Therefore, activities from the Project are unlikely to have an impact to fishers within the fishery.

Southern and Eastern Scalefish and Shark Fishery – Gillnet Hook Trap Sector Shark Gillnet sub-sector (SESSF – GHTS SGSHS)

The Project Area overlaps an area designated as low intensity fishing (net length <300 m/km^2) and moderate intensity (net length 600-1200 m/km^2) for combined data (2016 to 2023) for the Gillnet Hook Trap Sector Shark Gillnet sub-sector by 0.7% and 0.4% respectively. The Project Area does not overlap high intensity fishing areas. Low activity from the Gillnet Hook Trap Sector Shark Gillnet sub-sector is expected in the vicinity of the Project Area with the majority of high intensity effort in the eastern Bass Strait (Figure 4-73). Therefore, activities from the Project are unlikely to have an impact to fishers within the fishery.

Southern and Eastern Scalefish and Shark Fishery – Gillnet Hook Trap Sector Shark Hook sub-sector (SESSF – GHTS SGSHS)

No available fishing intensity data available from 2016 through 2023 fishing seasons overlaps the Project Area. However, the Project Area is partially overlapped by 4 reporting grids (between 0.9 and 9.2% overlap) since 2016. Little fishing activity from the Gillnet Hook Trap Sector Shark Hook sub-sector is expected within the Project Area with significant fishing intensity data shown to occur in South Australia and north-eastern Tasmania (Figure 4-74). Therefore, activities from the Project are unlikely to have an impact to fishers within the fishery.

Southern and Eastern Scalefish and Shark Fishery – Scalefish Hook Sector (SESSF – GHTS SHS)

No fishing intensity data available from 2016 through 2023 fishing seasons overlaps the Project Area. However, the Project Area is partially overlapped by 3 reporting grids (between 0.9% and 9.2% overlap) from 2015 to 2023. Little fishing activity from the Scalefish Hook Sector is expected within the Project Area with significant fishing intensity data shown to occur off the Gippsland coast (Butler et al. 2024). Therefore, activities from the Project are unlikely to have an impact to fishers within the fishery.

Southern Bluefin Tuna Fishery (SBTF)

No fishing intensity data available for the SBTF longline or purse-seine methods from 2016 through 2023 fishing seasons overlap the Project Area. However, the Project Area is partially overlapped by 3 reporting grids for the SBTF longline method from available data, two from the 2016 fishing season (7.7 and 9.2% overlap) and one from the 2022 fishing season (1.5% overlap). No reporting grids for the SBTF purse seine method overlap the Project Area since 2016 based on available data. Little or no fishing activity from the Southern Bluefin Tuna Fishery is expected within the Project Area with the majority of fishing intensity occurring in New South Wales and South Australia (Butler et al. 2024). Therefore, activities from the Project are unlikely to have an impact to fishers within the fishery.

Southern Squid Jig Fishery (SSJF)

The Project Area overlaps an area designated as low intensity fishing (<0.5 hours/km^2) for combined data (2016 through 2023 fishing seasons) for the Southern Squid Jig Fishery by 3.0%. The Project Area does not overlap moderate or high intensity fishing areas. Low activity from the Southern Squid Jig Fishery is expected in the vicinity of the Project Area with the majority of high intensity to both the west and east of the Project Area (

Figure 4-76). Therefore, activities from the Project are unlikely to have an impact to fishers within the fishery.

Victorian Rock Lobster Fishery

The greatest numbers of vessels within Victorian Rock Lobster fishery are adjacent to the coastline, primarily west of Wilsons Promontory. Reporting grids overlapping the Project Area show low levels of activity (up to 17 vessels per grid between 2013 and 2023) (Figure 4-82). Therefore, activities from the Project are expected to have a minimal impact to fishers within the fishery.

Victorian Wrasse (Ocean) Fishery

VFA (2024) data shows the highest level of fishing activity in the Victorian Wrasse (Ocean) Fishery between 2013-2023 occurred off Port Fairy and Flinders Island. The Project Area overlaps one reporting grid for the fishery which has 1 day fished between 2013-2023. The Project Area overlaps only 1.8 km^2 of this reporting grid. Therefore, activities from the Project are unlikely to have an impact on fishers within the fishery.

Victorian Giant Crab Fishery

There have been less than 5 dedicated fishers active in the fishery and up to 20 fishers annually reporting Giant Crab catch as by-product from Rock Lobster fishing (VFA 2021a). The Project Area overlaps 8 reporting grids with fishing effort between 2013-2023 which show low levels of activity (up to 15 vessels per grid) (Figure 4-74). However, the greatest fishing intensity for the Giant Crab fishery occurs south of the Project Area along the continental shelf at depths between approximately 150 to 300 m (SETFIA and Fishwell Consulting 2020 in ConocoPhillips 2024) (Figure 4-74).

As the Project Area is located in water depths ranging from 63 m to 159 m, the overlap of Project activities with giant crab fishing is likely to be minimal. Therefore, activities from the Project are unlikely to have an impact to fishers within the fishery.

Summary of potential impacts to Commonwealth and State Managed Fisheries

Beach will continue consultation and, as with all activities, will provide stakeholders prior notification of operations and their timings. We will also request the formal issue of Notice to Mariners prior to activities commencing.

The application of safety zones around wells and OGPP tie in locations; cautionary and exclusion zones around the MODU; and SNAs around vessels undertaking Project activities in the Project Area; will prevent the risk of snagging and damaging fishing equipment as commercial fishing vessels will be excluded from these areas. The location of the flowline and umbilicals outside these areas will be clearly marked on marine charts and fishers will be made aware of their positions to enable avoidance.

Beach's Fair Ocean Access Procedure was developed with input from commercial fishing industry organisations (including Bass Strait Scallop Industry Association, Scallop Fisherman's Association of Tasmania, South East Trawl Fishing Industry Association and Tasmanian Seafood Industry Council). The procedure details the process whereby a commercial fisher can claim compensation for an economic loss associated with Beach's offshore activities where impacts cannot be avoided.

The application of safety zones, cautionary and exclusion zones, and SNAs in the Project area will ensure potential interactions with other users are limited to restricted access to these localised areas. As detailed above, Commercial and state managed fisheries have only recorded low levels of fishing effort within the Project Area. The Project Area does not overlap high relative intensity fishing areas and overlaps medium relative intensity only in one fishery, the Gillnet Hook Trap Sector Shark Gillnet sub-sector (0.4% overlap of the entire medium intensity areas for the fishery). As a result, low levels of commercial fishing activity have the potential to be prevented from the localised restriction of access of Commonwealth and state managed fisheries to specified areas in the Project Area. Localised restriction of potential low commercial fishing effort in the Project Area is considered to result in minor changes to the functions, interests, or activities of Commonwealth and state managed fisheries. These minor changes are evaluated as Minor (1) consequences that are considered lower-order impacts that is acceptable with the application of good industry practice.

6.1.3.2 Defence Activities

The Department of Defence have identified that the Project Area overlaps restricted airspace. Helicopter operations within the Project Area, to transfer personnel from the mainland to the MODU or vessels, may interact with Defence operations that restricts airspace within the Project Area. Helicopters currently access the Thylacine platform approximately once per week and to date there have been no negative interactions. Beach will ensure specified permissions for aircraft movement in restricted airspace will be attained from Air Traffic Control, if helicopter operations are required for the transfer of personnel to the MODU located in the Project Area overlapping restricted airspace. With specified permissions in place, helicopter operations will have negligible impacts to Defence operations.

6.1.3.3 Shipping

The Project Area includes major shipping routes (Section 4.5.6). The application of safety zones, cautionary and exclusion zones, and SNAs in the Project Area will prevent commercial vessels from entering localised areas within the Project Area. Commercial vessels are expected to avoid these localised areas with minor shipping route deviations. Any required deviations are expected to have negligible impact on travel times or fuel use of commercial vessels. All infrastructure will be identified on navigational charts and through Notice to Mariners advice. Vessel and MODU activities associated with the existing Otway Gas Development have been ongoing for over 10 years and to date there has been no interactions or incidents.

Minor shipping route deviations to commercial shipping vessels may occur during the Project. However prior notification through stakeholder consultation and the issuing of a notice to mariners will inform other users of safety zones around wells and OGPP tie in locations; cautionary and exclusion zones around the MODU; and SNAs around vessels undertaking Project activities in the

Project Area. Minor shipping route deviations to avoid localised safety, cautionary and exclusion zones and SNAs within the Project Area will have negligible or minor changes to the functions, interests, or activities of commercial vessels. These minor changes are evaluated as Minor (1) consequences that are considered lower-order impacts that is acceptable with the application of good industry practice.

6.1.3.4 Tourism and Recreational Diving and Fishing

Interaction with tourism and recreational diving and fishing is considered unlikely due to the offshore location of the Project Area, the lack of emergent features and water depths outside of recreational diving depths. The Project Area is approximately 17 km from the coast at its closest point and is situated in water depths of approximately 63 m to 160 m. Vessel based tourism and recreation activities occurs along the Victorian coastline in water depths approximately less than 11 m (Section 4.5.8). Consultation with local vessel charterers and providers of SCUBA tank fills has confirmed that diving activity is generally concentrated around The Arches Marine Sanctuary (17 km from the Project Area) and the wreck sites of the Loch Ard (18 km from the Project Area) and sometimes at the Newfield and Schomberg shipwrecks (16 and 17 km from the Project Area, respectively). The Project Area does not overlap these areas and as a result interaction with tourism and recreational diving and fishing is not expected to occur within the Project Area,

6.1.3.5 Cultural Values and Sensitivities

No First Nations people’s cultural activities have been identified to occur within the Project Area via stakeholder consultation or during Beach’s current Otway or Bass Operations.

Notices to Mariners will be issued for the Drilling Program and First Nation’s people or groups are consulted in relation to the Project activities as detailed in Section 10 of this OPP.

For potential interaction with First Nations people’s cultural values and sensitivities refer to Section 7.4

6.1.4 Impact Evaluation Summary

The impact evaluation for the potential for interaction with other users, is summarised in Table 6-2.

Table 6-2: Impact Evaluation Summary for Interaction with Other Users

Summary	
Summary of impact	The potential impacts to other users from the physical presence of the MODU, vessels, wells and subsea systems is expected to result in minor consequences of temporary and localised restricted access to specified safety zones within the Project Area.
Extent and duration of impact	For the life of the project, there will be mandatory 500 m petroleum safety zones gazetted around wells and OGPP tie in locations, from which third-party users will be prohibited entry. During drilling and installation activities there will be a temporary 500 m exclusion zone around the MODU and construction vessel from which third-party users will be prohibited entry) for campaigns of up to in the order of 30 to 40 days duration. In addition, there will be a 2 km cautionary zone around the MODU plus a 500 m Safe Navigation Area (SNA) around vessel(s) and any towed equipment during the seabed survey.
Level of certainty	At the time of writing this OPP, there is uncertainty with regards to the specific locations for wells and subsea systems. However, it is certain the locations for wells and subsea systems will be within the Project Area. The impact evaluation considers

Summary	
	any potential interaction with other users for the entire Project Area. This approach ensures all potential hazards and impacts have been evaluated for interaction with other users with potential activities in the Project Area. Further certainty on the location of wells and subsea systems will be known during the development of future EPs under this OPP. As a result, future EPs under this OPP will assess the potential interaction with other users based on well and subsea system locations that have greater certainty. Beach has a high level of certainty about the potential impacts to other users in the Project Area and has long-term experience in the area on the application of good industry practice to ensure impacts associated with interaction with other users are acceptable. Beach will continue stakeholder consultation and request issue of Notice to Mariners prior to activities commencing. These will inform other users and stakeholders of Project activities within the Project Area and minimise impacts on other users' activities.
Is the impact considered lower-order or higher-order?	Impacts from interaction with other users have been evaluated to result in Minor (1) consequences. Minor (1) consequences are considered lower-order impacts that are acceptable with the application of good industry practice.
Impact consequence	
Minor	

6.1.5 Demonstration of Acceptability

Table 6-3 demonstrates how and why predicted environmental impacts from physical presence – interaction with other marine users meets the defined acceptable levels (Table 5-4).

Table 6-3: Demonstration of Acceptability – Physical Presence – Interaction with Other Users

Demonstration of Acceptability		
Impact and risk comparison with relevant defined acceptable levels	The acceptable level relevant to the physical presence – interaction with other marine users includes acceptable level 14 (as detailed in Table 5-4). A Minor (1) consequence level was assigned for this aspect based on the impact analysis and evaluation. Minor (1) consequences resulting from interactions with other users: • will not result in interference with other marine users to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties as conferred by the titles granted to Beach. As a result, the predicted environmental impact for other marine users is better than the defined acceptable level 14.	
Principles of ESD	Integration principle	Section 6.1.3 identifies and evaluates environmental impacts associated with the physical presence – interaction with other users. As part identifying the potential impacts; conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities (described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental impact. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks.

Demonstration of Acceptability		
		For Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders on the Project and associated activities. No objections or claims were raised against this aspect during Phase 1: Initial Project Consultation (Section 10.2.3). The public, including relevant stakeholders, had the opportunity to provide further advice and responses for this OPP during the public consultation period (18/3/2024 – 20/5/2024). External context gained from the public consultation period allowed Beach to update the OPP. No public comment relating to this aspect was provided during the public consultation period. As a result, the impact assessment is considered acceptable to the public and therefore is of an acceptable level. The potential environmental impact against this aspect was assessed as having a Minor (1) impact consequence level which is considered a lower-order environmental impact. Lower-order environmental impacts are considered 'broadly acceptable' and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental impacts against this aspect were assessed as having a Minor (1) consequence level which is considered a lower-order environmental impact and below the defined acceptable level 14. Lower-order environmental impacts cannot result in serious or irreversible environmental damage. Despite uncertainty in the locations for wells and subsea systems, potential impacts were evaluated for any interactions within the Project Area. With significant experience operating in the Otway and Bass based on their existing offshore developments and associated activities including the Beach Otway Drilling Campaign in 2021/2022, Beach has high confidence in the potential environmental impacts and effectiveness of controls against this aspect.
	Intergenerational principle	The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts for interaction with other marine users is better than the defined acceptable level 14; the health, diversity, or productivity of the environment for future generations is expected to be maintained.
	Biodiversity principle	The potential environmental impacts against this aspect were assessed as having a Minor (1) consequence level which is considered a lower-order environmental impact and below the defined acceptable level 14. Lower-order environmental impacts cannot result in effects to biological diversity or ecological integrity.
Internal context	Beach Policy compliance	The defined acceptable levels, EPOs and controls proposed for this aspect are consistent with Beach Environmental Policy objectives. As a result, potential environmental impacts and risks from Project can be managed to align with Beach Environmental Policy objectives.
External context	Stakeholder engagement is being carried out as part of this OPP process.	

<table>
<tr><th colspan="2">Demonstration of Acceptability</th></tr>
<tr><td></td><td>Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable.
During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect.
During the public consultation period (18/3/2024 – 20/5/2024) (Section 10.2.4), comments were raised against this aspect. The assessment of merit for comments against this aspect found the responses provided in the public comment report to be sufficient to address the comments against this aspect. Given the thorough assessment and responses outlined in the public comment report, the impact evaluation for this aspect remains acceptable as is, demonstrating that public comments have been adequately addressed.</td></tr>
<tr><td>Other requirements</td><td>Other requirements associated with this aspect includes compliance with Australian legislative requirements.
Management of this aspect is aligned with the legislative requirements below.
<table>
<tr><th>Requirement</th><th>Demonstration</th></tr>
<tr><td>Navigation Act 2012 (Cth)
Notice to mariners
Several Marine Orders (MO) are enacted under this Act which relate to offshore petroleum activities, including:
• MO 21: Safety and emergency arrangements
• MO 30: Prevention of collisions
• MO 31: SOLAS and non-SOLAS certification</td><td>These requirements are addressed through the adoption of the following control measures:
CM01 Navigation safety
Beach Marine Assurance System ensures that the MODU and vessels meet relevant maritime laws and includes pre-commencement MODU and vessel inspections of class certification requirements under the <i>Navigation Act 2012</i> and associated Marine Orders.
All vessels operating within the project area will adhere to the navigation safety requirements including:
• International Regulations for Preventing Collisions at Sea 1972
• Chapter 5 of International Convention for the Safety of Life at Sea 1974
• International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978
• <i>Navigation Act 2012</i> and any subsequent Marine Orders that specify standards for crew training and competency, navigation, communication, and safety measures
CM02 Notifications
The Australian Hydrographic Office will be notified of the Project activities and installed subsea infrastructure prior to commencement to facilitate the issuing of Notice to Mariners and maintain nautical charts.
Relevant stakeholders are notified prior to the activity so that third party marine users are aware of vessel location and timing.</td></tr>
</table></td></tr>
</table>

Demonstration of Acceptability		
	OPGGS Act 2006 (Cth) Section 280 – requires that a person carrying out activities in an offshore area under the permit, lease, licence, authority or consent must carry out those activities in a manner that does not interfere with navigation or fishing (among others). Section 616(2) – requires establishment and maintenance of petroleum safety zones	This requirement is addressed through the adoption of the following control measures: **CM03 Fair Ocean Access Procedure** Beach's Fair Ocean Access Procedure was developed with input from commercial fishing industry organisations. The procedure details the process whereby a commercial fisher can claim compensation for an economic loss associated with Beach's offshore activities where impacts cannot be avoided. An information sheet on the procedure is available in Appendix D. **CM04 Stakeholder consultation** Beach will undertake consultation with relevant persons for all petroleum activities in accordance with the OPGGS (Environment) Regulations and detailed in Section 10 of this OPP. Observation, incidents, and opportunities for improvement regarding the interaction with other users will be reported to other petroleum titleholders. **CM05 Petroleum safety zones** The Project will comply with OPGGS Act 2006 – Section 616(2) petroleum safety zones, which includes establishment and maintenance of petroleum safety zones around wells, offshore structures or equipment which prohibits vessels entering without written consent. **CM06 Temporary exclusion/cautionary zones** 500m temporary exclusion and 2 km cautionary zones will be established and maintained around drilling and installation activities.
	Environmental Protection (Sea Dumping) Act 1981 (Cth) Sea dumping permits	This requirement is addressed through the adoption of the following control measures: **CM07 Decommissioning** Decommissioning of subsea wells and infrastructure in compliance with Section 572 of the OPGGS Act.

6.1.6 Environmental Performance

In accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 6-4) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 6-3 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 6-4 are met.

Table 6-4: Environmental Performance Outcomes: Physical Presence – Interaction with Other Users

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 14: No interference with other marine users to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties as conferred by the titles granted to Beach.	EPO1:	Implement CM5 and CM6 for the establishment and maintenance of petroleum safety zones, temporary exclusion zones and cautionary zones.
	EPO2:	Decommissioning of Project facilities in compliance with Section 572 (3) of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth).

6.2 **Physical Presence – Seabed Disturbance**

6.2.1 Hazard Identification

During all stages of the Project, seabed disturbance is an outcome resulting from activities which interact with the seabed. Stages and associated activities which will interact with the seabed are defined below in Table 6-5 and described in Section 6.2.2.

Table 6-5: Activities Undertaken During the Project which may Result in Seabed Disturbance

Stage	Activity
Surveys	Geotechnical survey
Drilling and completions	MODU Positioning Drilling Method
Installation and commissioning	Installation
Operations	Inspection, maintenance and repair Well intervention and workovers
Decommissioning	Removal of subsea infrastructure Well plugging and abandonment
Support operations	Vessel operations ROV operations

6.2.2 Hazard Description

6.2.2.1 Surveys

Geotechnical surveys may be required to collect data to inform installation activities, in order to confirm the seabed sediments. Depending on the area surveyed, geotechnical surveys may take up to 10 to 20 days. Seabed disturbance can result from placing survey equipment on the seafloor, or when collecting seabed samples.

Geotechnical surveys typically involve in-situ testing and piston/push sampling. Following sampling, all equipment is withdrawn from the seabed creating short-term seabed disturbance. A small hole (<1 m^2) may temporarily remain, which will rapidly collapse and infill with the movement of surface sediments in ocean current given the highly mobile seabed of the region. Approximately 74 samples are expected during a single campaign under the Project, resulting in a total area of 74 m^2 of seabed disturbance during a single campaign.

6.2.2.2 Drilling

1. MODU Positioning

Drilling operations will be undertaken using a semi-submersible MODU. The MODU will use a mooring system to remain in position that will result in short-term seabed disturbance.

Each mooring will consist of:

- 8 to 12 anchors, each covering an area of approximately 30 – 60 m^2.
- 8 to 12 x 2500 m lengths chain (Chain width of ~0.3 m). Approximately 1000 to 1,200 m of the chain length is grounded chain, resulting in total disturbance area of 4,320 m^2 per well.

Thus, the total area of short-term seabed disturbance per well is up to approximately 5,040 m^2 (0.0050 km^2)

2. Drilling Method

Drilling of the wells will result in short-term seabed disturbance from the discharge of drilling fluids and cuttings to the seabed during drilling of the upper well sections. The upper well sections of each well will be drilled riserless (with seawater scuffs) with drilling fluids and cuttings discharged in the near vicinity of the hole. Seabed disturbance from upper well section drilling fluids and cuttings discharges is expected to be within 1 km of the well location (RPS 2023).

Drill cuttings from the bottom hole sections will be discharged at the sea surface from the MODU after being processed and will disperse further and settle on to the seabed. These impacts have been evaluated as part of Section 6.7 Planned Discharge – Drill Cuttings and Fluids.

6.2.2.3 Installation and Commissioning

Subsea systems infrastructure, including umbilicals, flowlines and subsea structures (wellheads, manifolds, skids), will be placed on the seabed resulting in long-term seabed disturbance. Localised placement of stabilisation material may be required to assure stability adjacent to well and structure tie-in locations.

As a conservative estimate, based on the maximum 9 wells anticipated for the Project, the total seabed disturbance footprint from 9 subsea systems including wells, flowlines and stabilisation support is ~4.1 km^2.

6.2.2.4 Operations

1. Inspection, Maintenance and Repair (IMR)

IMR activities may result in small areas of disturbance to the seabed due to placement of stabilisation mattresses and disturbance to sediments around the infrastructure. This will result in highly localised and short-term seabed disturbance.

2. Well Intervention and Workovers

Well intervention and workover operations may necessitate actions such as well servicing, temporary suspension, plugging, or permanent abandonment. These activities can disturb the seabed and their frequency depends on the well's performance. Seabed disturbance footprint for well intervention and workovers is anticipated to be the same as for drilling (refer to Section 6.2.2.2).

6.2.2.5 Decommissioning

A MODU or lightweight intervention vessel will be used to remove subsea infrastructure including flowlines, umbilicals, subsea structures and plug and abandonment of wells. Decommissioning of subsea infrastructure is expected to take up to approximately 30 days per tie-back, with P&A of wells estimated at up to approximately 30 days per well.

The seabed disturbance footprint for decommissioning will be similar to the footprints for drilling (Section 6.2.2.2) and installation (Section 6.2.2.3). Following well plugging and abandonment, wellheads will be cut below seabed and removed to eliminate seabed disturbance from scouring.

6.2.2.6 Support Operations

Vessel anchoring in deeper waters for support vessels is unlikely. Occasions where support vessels may anchor include during an emergency, or while working on the flowline routes to conserve fuel. Should support vessel anchoring be required, the level of seabed disturbance is dependent on the anchoring, however, use of a single anchor could result in a total disturbance area of up to 1300 m^2 (NERA, 2018).

The use of an ROV or AUV during may result in temporary seabed disturbance when temporarily parked on the seabed. In the event a ROV is required to temporarily park on the seabed, the short-term seabed disturbance footprint is estimated to be 2.5 m × 1.7 m (4.25 m^2).

6.2.2.7 Total Project Seabed Disturbance Footprint

The total area of seabed disturbance from Project activities identified in Table 6-5 is summarised below in Table 6-6. The impact assessment for seabed disturbance considers the total Project seabed disturbance footprint. As a result, concurrent or sequential activities are considered assessed given the entire Project seabed disturbance footprint is evaluated for potential impacts.

Table 6-6: Total area of Seabed Disturbance from Each Stage and Activity

Stage	Activity	Description of pathway	Predicted impact for footprint	Footprint area
Short-term seabed disturbance				

Stage	Activity	Description of pathway	Predicted impact for footprint	Footprint area
Surveys	Geotechnical survey	Seabed disturbance will occur during geotechnical survey from the physical footprint of taking a CPT, core, or sediment sample.	Geotechnical samples for wells, and anchor locations • ~74 locations x 1 m^2 ◦ Subtotal = 74 m^2 Proposed flowline route 10 samples along route • 10 x 30 m^2 ◦ Subtotal = 300 m^2	0.37 km^2
Drilling	MODU positioning	Anchors will be used to maintain position of the MODU during normal operations.	Maximum of 12 anchors and chains. Footprint of up to: • 420 m^2 per anchor and chain. • 45,360 m^2 (9 x 12 x 420) for Drilling Program. Based on 9 wells (including 8 new wells and re-entry/completion at Artisan 1)	45.36 km^2
Operations	Inspection, maintenance and repair	Emergency anchoring or temporary wet parking of equipment or an ROV will take place within the area where long-term seabed disturbance is expected.	N/A	N/A
			Total short-term footprint	**~45.73 km^2**
Long-term seabed disturbance				
Installation and Commissioning	Installation	New subsea infrastructure	Estimated as a 0.1 km corridor along ~41 km of flowline route. All subsea infrastructure included in corridor. • 41 km x 0.1 km ◦ Subtotal = 4.1 km^2	4.1 km^2
Drilling	Drilling	New wells - drilling of the upper hole section including initial penetration of the seabed	Per well: ~0.67 m^2 footprint (8 new wells)	0.005 km^2
		Drilling discharges (i.e. cement and drill	Per well: ~3.14 km footprint (8 new wells)	25.12 km^2

Stage	Activity	Description of pathway	Predicted impact for footprint	Footprint area
		cuttings) may be present up to 1 km from the well and are described and assessed in Section 6.7.		
Support operations	Vessel anchoring	Emergency anchoring or temporary wet parking of equipment or an ROV will take place within the area where long-term seabed disturbance is expected.	N/A	N/A
			Long-term footprint	**29.22 km^2**
Total seabed disturbance footprint for Project				**74.95 km^2**

6.2.3 Impact Analysis and Evaluation

Seabed disturbance from the Project can result in impacts to:

- Water quality, resulting in:
    - Change in water quality
- Benthic habitats and communities resulting in:
    - Injury/mortality to fauna.
    - Change in habitat.

Seabed disturbance from the Project also has the potential to result in indirect changes to the functions, interests, or activities of the following receptors:

- Commonwealth and state commercial fisheries
- Subsea infrastructure including UXO.
- Cultural values and sensitivities.

6.2.3.1 Water Quality

Seabed disturbances during the Project (refer to Table 6-6) has the potential to suspend seabed sediments into the water column which will temporarily change the water quality, increasing turbidity levels, until suspended sediments settle back on the seabed. Each Project activity described in Table 6-6, is expected to generate a temporary plume of suspended sediment within areas of soft sand habitats. Given the hydrodynamics in open ocean areas such as the Project Area, suspended sediments are expected to quickly disperse and settle out of the water column within tens of metres of the seabed disturbance area. Change in water from increase in turbidity is expected to be localised and temporary, as suspended sediment loads will be limited to the small footprint for each Project activity

(Table 6-6). The potential change in water quality is expected to be similar to those caused by natural factors, such as strong water currents (NERA, 2018).

Localised and temporary changes to water quality from seabed disturbance during the Project at levels considered similar to natural changes to water quality from water currents has been evaluated as a Minor (1) consequence. Minor (1) consequences are considered lower-order impacts that are acceptable with the application of good industry practice.

6.2.3.2 Benthic Habitats and Communities

Benthic habitats and communities within the Project Area may temporarily change during short-term seabed disturbance activities or will be subject to long-term changes from the physical presence of seabed systems infrastructure during the Project. Benthic habitats expected to be found within the Project Area include carbonate sands, low relief exposed limestone, sponge beds and unconsolidated sediment (IMAS 2017). Benthic communities in the Project Area are expected to consist of numerous marine invertebrates, sessile epifauna and bryozoans. It is unlikely that extensive areas of rocky reefs or outcrops (where sponges, coral and more diverse fauna may be present) occur within the Project Area. Prior to the commencement of the seabed disturbance activities, a seabed survey will be conducted to obtain further information on the benthic habitat and species in the Project Area. It is expected that benthic habitats and communities within the Project Area are highly represented throughout the region (see Section 4.4.1 for further details).

The footprint for short-term changes in habitat is estimated to be ~45.73 km^2, whereas the footprint for long-term changes in habitat is estimated to be 4,17 km^2. The extent of short-term and long-term changes in habitat is considered small in relation to the highly represented benthic habitats found in the Project Area and the Otway Basin.

Injury or mortality to benthic fauna communities may occur from the short-term or long-term changes in habitat, specifically sessile taxa. Ecological receptors likely to be present within the Project Area that may be impacted by seabed disturbance include:

- Benthic and filter-feeding epifauna (e.g. sponges, macroalgae, coral, bryozoans, molluscs, ascidians)
- Crustaceans (e.g. giant crabs, rock lobster, shrimp, krill)
- Echinoderms (e.g. urchins, sea cucumbers), and
- Annelids (e.g. polychaete worms).

The physical presence of seabed system infrastructure may also lead to the emigration of resident mobile biota and colonisation of sessile benthic biota such as sponges and gorgonians on the hard surfaces of seabed infrastructure (Dernie et al. 2003). The biological impacts to benthic habitats and communities depends upon the equipment, footprint, seabed substrate, the frequency and the ecosystem's resilience (Watson et al. 2022). Furthermore, the recovery timeframe following seabed disturbance also varies on several factors, including the species and seabed substrate disturbed (Hiddink et al. 2017), the time of year, larval recruitment, and the local hydrodynamics (Dernie et al. 2003). There is limited information on the recovery of benthic habitats after the removal of anchors and other equipment.

A study on the recovery of seabed following bottom trawling activities identified faster recovery times for coarse-sediment (sand) compared to fine-sediment regions (Hiddink et al. 2017). Dernie et al. (2003) identified that benthic community recovery time following physical disturbance in soft sediment habitats varied from 64 days for low intensity disturbances, up to 208 days following higher intensity disturbance. For Project activities, it is expected that following short-term seabed disturbances and decommissioning (refer to Table 6-6), disturbed areas will recolonise quickly as impacted areas for each activity are small and the benthic habitat is consistent with the low intensity disturbances recovery period, as identified by Hiddink et al. 2017 and Dernie et al. 2003. Impacts are not expected to cause long-lasting changes to population characteristics.

The extent of the impact is predicted to be ~74.95 km^2 (including subsea infrastructure) for the Project. Given the above, change in habitat from seabed disturbance is likely to result in Minor (1) consequences. The impact from Minor (1) consequences is therefore acceptable based on:

- The area of impact is predicted to be small per well location (including typical subsea infrastructure) compared to the extent of the distribution of the benthic habitats and communities found within the Project Area.
- The PMST Report did not identify any marine protected areas, KEFs, threatened benthic species or ecological communities, critical habitats or BIAs relevant to the benthic environment within the Project Area.
- Impacts are localised, with the impacted area of seabed predicted to return to pre-impacted state with no long-term effects to habitat, population characteristics or productivity.
- Studies on benthic habitat and assemblages within the Project Area did not identify the area as unique, with similar benthic habitats found elsewhere in the region.
- Seabed surveys will be undertaken to allow for the consideration of seabed habitat type in the final selection of well locations to avoid area of high relief outcrops, reefs or sponge beds.
- Seabed disturbance associated with the Project is not predicted to impact marine ecosystem integrity or functioning.

6.2.3.3 Commonwealth and State Commercial Fisheries

Seabed disturbance has the potential to result in a change to benthic habitat and, subsequently, to associated commercially valued benthic species. Potential changes to commercially valued benthic species in the Project Area may result in indirect changes to the functions, interests, or activities of Commonwealth and state commercial fisheries. There are two commercially fished marine benthic invertebrate species which are present within the Project Area which could be indirectly susceptible to seabed disturbance: the giant crab, and the southern rock lobster (Section 4.4.7.1).

Southern rock lobster live in rocky reefs (VFA 2023b) a habitat unlikely to be disturbed by Project activities as rocky reefs are not an appropriate substrate for anchoring or drilling of a well. Giant crab have recorded movements up and down the continental shelf depending on food availability (Levings et al. 2001), with seabed disturbance in potential giant crab habitats in the Project Area potentially leading to emigration of the mobile biota to other areas along the continental shelf.

The extent of the impact is predicted to be ~74.95 km^2 (including subsea infrastructure) for the Project. Given the above, the impact from seabed disturbance is likely to result in Minor (I) consequences. to the functions, interests, or activities of Commonwealth and state commercial fisheries The impact from Minor (1) consequences is therefore acceptable based on:

- Giant crab and southern rock lobster are mobile species and are generally less vulnerable than sessile taxa to sedimentation, as they are able to move to areas with less sediment accumulation or by more efficiently physically removing particles (Fraser et al. 2017).
- The Project Area intersects the following giant crab and southern rock lobster fisheries areas:
  - Southern rock lobster
    - 14 of the 200 Victorian southern rock lobster reporting blocks (up to 20 active vessels – Figure 4-78).
    - The Project Area does not overlap the Tasmanian southern rock lobster reporting blocks.
  - Giant crab
    - 9 of the 48 Victorian giant crab reporting blocks (up to 13 active vessels – Figure 4-74).
    - 1 of the 386 Tasmanian giant crab reporting blocks (confidential fishing effort due to less than 5 vessels being active within the fishery – Figure 4-81).
- The southern rock lobster fishery has a stock status listed as sustainable for Victoria, Tasmania and South Australia (FRDC 2020). The giant crab fishery has a stock status listed as sustainable for Victoria and South Australia and depleted for Tasmania (FRDC 2020; 2020a). The depleted stock status for the Tasmanian giant crab fishery is based on data obtain from 2013-2014, and there has been insufficient data for the fishery since 2013 to determine if the stock is recovering (FRDC 2020a).
- Due to the spatial area of seabed which may be disturbed within the wider extent of available fishing grounds and the short duration of Project activities which would interact with the seabed, impacts to benthic species of commercial importance are predicted to be localised and insignificant at a population level.
- As rock lobster live in rocky reefs (VFA 2023b) it is unlikely that their habitat would be disturbed as rocky reefs are not an appropriate substrate for anchoring or drilling of a well.
- Seabed surveys will be undertaken to allow for the consideration of seabed habitat type in the final selection of well locations to avoid area of high relief outcrops, reefs or sponge beds.
- The area of impact is predicted to be small compared to the extent of available and utilised commercial fishing areas for both the Victorian and Tasmanian giant crab and southern rock lobster fisheries.

6.2.3.4 Unexploded ordnance (UXO)

As detailed in Section 4.5.5 the Project Area overlaps UXO Zone 1052 King Island which is within the 'slight potential' category, meaning there is confirmed history of military activities that may have resulted in numerous residual hazardous munitions, components, or constituents, but where confirmed UXO affected areas cannot be defined (DoD 2022).

The extent of the impact is predicted to be ~74.95 km^2 (including subsea infrastructure) for the Project. Given the above, the impact from seabed disturbance is likely to result in Minor (1) consequences. The impact from Minor (1) consequences is therefore acceptable based on:

- For parts of the Project Area, Beach undertook site surveys ahead of the Otway Drilling Campaign in 2021/2022, with no UXO identified.
- A seabed survey will be undertaken to identify any UXO with any known locations included in the Drill Rig Mooring Plan (CM06) and Drilling Program (CM09).

6.2.3.5 Cultural values and sensitivities

As detailed in Section 4.6 no First Nations underwater cultural heritage has been identified in the Project Area. However, First Nations people specifically Eastern Maar highlights that although the edge of the continental shelf is under sea, it was occupied for thousands of years and rising sea levels have not washed away the history, physical evidence, or connection to that part of Sea Country (Section 4.6.3.5). At present, oil and gas infrastructure exists across the Otway Basin and memories and songlines relating to the historical occupation of the present-day seabed are still acknowledged and recognised (Biosis 2023).

Management of intangible cultural heritage can include reducing impacts and risks to environmental features that are associated with intangible cultural heritage (Australia ICOMOS Burra Charter, 2013). As per the draft Guidelines for Working in the Near and Offshore Environment to Protect Underwater Cultural Heritage (DCCEEW 2023) Beach has consulted with First Nations groups and relevant underwater culture heritage researchers and organisations to understand what data could be obtained from the seabed survey that will be undertaken prior to the seabed disturbing activities (refer to Table 6-6) to identify First Nations submerged cultural heritage and submerged cultural landscapes. Data from seabed surveys will be provided to an appropriately qualified underwater archaeologist to identify submerged cultural heritage. Should any submerged cultural heritage be identified, Beach will consult with the relevant First Nations groups (see Section 4.6.2) and determine any exclusion areas or further cultural heritage management procedures that may be required. Thus, impacts to First Nations underwater cultural heritage are not predicted.

6.2.4 Impact Evaluation Summary

The impact evaluation for seabed disturbance is summarised in Table 6-7.

Table 6-7: Impact evaluation summary for seabed disturbance

Summary	
Summary of impact	The potential localised seabed disturbance impacts in the Project Area are expected to result in minor consequences to water quality, benthic habitats, Commonwealth and State commercial fisheries, and UXO.

	Benthic habitats and communities in the Project Area include carbonate sands, low relief exposed limestone, sponge beds and unconsolidated sediment supporting bryozoans, which are highly represented throughout the planning area and Otway Basin region. There are no marine protected areas, KEFs, threatened benthic species or ecological communities, critical habitats, or BIAs relevant to the benthic environment within the Project Area. The total seabed disturbance footprint is ~74.95 km^2 over the duration of the Project. Minor consequences to water quality, benthic habitats, Commonwealth and State commercial fisheries, UXO and cultural values and sensitivities are based on the following conclusions: • Localised and brief increase in turbidity in an area where suspended sediments occur naturally from strong water currents • Seabed disturbance footprint is small compared to the extent of the distribution of the benthic habitats and communities found within the Project Area • Following short-term seabed disturbances and decommissioning (refer to Table 6-6), disturbed areas will recolonise quickly as impacted areas for each activity are small • Impacts to benthic species of commercial importance are predicted to be localised and insignificant at a population level considering the wider extent of available fishing grounds and species habitat • Beach is committed to undertake seabed surveys to identify any UXO to avoid UXO impacts • Beach is committed to undertake seabed surveys, commission an appropriately qualified underwater archaeologist to identify submerged cultural heritage and where appropriate engage with First Nations groups to avoid impacts to cultural values and sensitivities. The Minor (1) consequences to water quality, benthic habitats, Commonwealth and State commercial fisheries, UXO and cultural values and sensitivities from seabed disturbance is considered acceptable, given controls are in place to ensure potential impacts are better than the defined acceptable levels 1, 6, 14, 15 and 16.
Extent and duration of impact	Localised – the seabed disturbance footprint is small compared to the extent of the distribution of the benthic habitats and communities found within the Project Area. Short-term seabed disturbance is less than 2.5% of the Project Area and long-term seabed disturbance is less than 1.5% of the Project Area. Temporary – Following short-term seabed disturbances and decommissioning (refer to Table 6 2), disturbed areas will recolonise quickly as impacted areas for each activity are small.
Level of certainty	At the time of writing this OPP, there is uncertainty with regards to the locations of unidentified UXOs and cultural heritage values and sensitivities. The uncertainty of these unidentified objects in the Project Area will be managed through the implementation of the following controls: • Beach is committed to undertake seabed surveys to identify any UXO to avoid UXO impacts • Beach is committed to undertake seabed surveys and commission an appropriately qualified underwater archaeologist to identify submerged cultural heritage and where appropriate engage with First Nations groups to avoid impacts to cultural values and sensitivities.to avoid impacts to cultural values and sensitivities. These controls adhere with industry standards and the *Cultural Heritage Act 2018* and Guidelines on the application of the Underwater Cultural Heritage Act 2018 (DCCEEW 2023).

	Beach has a high level of certainty about the potential impacts from seabed disturbance and how to address uncertainty with regards to unidentified UXOs and submerged cultural heritage. Beach has long-term experience in the area on the application of good industry practice to ensure impacts associated with seabed disturbance are acceptable.
Is the impact considered lower-order or higher-order?	Potential impacts from seabed disturbance have been evaluated to result in Minor (1) consequences. Minor consequences are considered lower-order impacts that is acceptable with the application of good industry practice.
Impact consequence	
Minor	

6.2.5 Demonstration of Acceptability

Table 6-8 demonstrates how and why predicted environmental impacts from physical presence – seabed disturbance meets the defined acceptable levels (Table 5-4).

Table 6-8: Demonstration of Acceptability – Physical Presence – Seabed Disturbance

Demonstration of Acceptability		
Impact and risk comparison with relevant defined acceptable levels	The acceptable level relevant to the physical presence – seabed disturbance includes acceptable levels 10, 11, 15 and 16 (as detailed in Table 5-4). A Minor (1) impact consequence level was assigned for this aspect based on the impact analysis and evaluation. Minor (1) consequences resulting from seabed disturbance: • will not impacts on unique seafloor habitats to the south-east region, including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests. • will only impact on benthic habitats and communities within the Project Area that are highly represented throughout the region and are not unique seafloor habitats • will not impact on underwater cultural heritage with values as conferred by the *Underwater Cultural Heritage Act 2018* (Cth) • will not impact on declared areas or objects of particular significance with values as conferred by the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth). As a result, the predicted environmental impact for the seabed is better than the defined acceptable levels 10, 11, 15 and 16.	
Principles of ESD	Integration principle	Section 6.2.3 identifies and evaluates environmental impacts associated with the physical presence – seabed disturbance. As part identifying the potential impacts; conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities (described in Section 4) were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental impact. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks. During Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders for feedback in relation to the Project, the planning area, environmental impact and risk evaluations, and the acceptability evaluation.

		No objections or claims were raised against this aspect during Phase 1: Initial Project Consultation (Section 10.2.4). The public, including relevant stakeholders, had the opportunity to provide further advice and responses for this OPP during the public consultation period (18/3/2024 – 20/5/2024). External context gained from the public consultation period allowed Beach to update the OPP. No public comment relating to this aspect was provided during the public consultation period. As a result, the impact assessment is considered acceptable to the public and therefore is of an acceptable level. The potential environmental impact against this aspect was assessed as having a Minor (1) impact consequence level which is considered a lower-order environmental impact. Lower-order environmental impacts are considered 'broadly acceptable' and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental impacts against this aspect were assessed as having a Minor (1) impact consequence level which is considered a lower-order environmental impact and below the defined acceptable levels 10, 11, 15 and 16. Lower-order environmental impacts cannot result in serious or irreversible environmental damage. Despite uncertainty on the presence of unidentified UXO and cultural heritage in the Project Area, Beach is confident that seabed surveys and commissioning an appropriately qualified underwater archaeologist to identify UXOs and submerged cultural heritage will prevent impacts to underwater cultural heritage. With significant experience operating in the Otway and Bass based on their existing offshore developments and associated activities including the Beach Otway Drilling Campaign in 2021/2022, Beach has high confidence in the potential environmental impacts and effectiveness of controls against this aspect.
	Intergenerational principle	The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts from seabed disturbance is a lower-order environmental impact and below the defined acceptable levels 10, 11, 15 and 16 ; the health, diversity, or productivity of the environment for future generations is expected to be maintained.
	Biodiversity principle	Section 6.2.3 identifies and evaluates environmental impacts associated with the physical presence – seabed disturbance. As part of identifying the potential impacts; conservation values and sensitivities including MNES in Section 4 were reviewed. The potential environmental impacts against this aspect were assessed as having a Minor (1) impact consequence level which is considered a lower-order environmental impact and below the defined acceptable levels 10, 11, 15 and 16 . Lower-order environmental impacts cannot result in affects to biological diversity or ecological integrity.
Internal context	Beach Policy compliance	The defined acceptable levels, EPOs and controls proposed for this aspect are consistent with Beach Environmental Policy objectives. As a result, potential environmental impacts and risks

<table>
<tr><td></td><td></td><td>from Project can be managed to align with Beach Environmental Policy objectives.</td></tr>
<tr><td>External context</td><td colspan="2">Stakeholder engagement is being carried out as part of this OPP process.
Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable.
During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect.
During the public consultation period (18/3/2024 – 20/5/2024) (Section 10.2.4), comments were raised against this aspect. The assessment of merit for comments against this aspect found the responses provided in the public comment report to be sufficient to address the comments against this aspect. Given the thorough assessment and responses outlined in the public comment report, the impact evaluation for this aspect remains acceptable as is, demonstrating that public comments have been adequately addressed.</td></tr>
<tr><td>Other requirements</td><td colspan="2">Other requirements associated with this aspect includes compliance with Australian legislative requirements.
Management of this aspect is aligned with the legislative requirements below.
<table>
<tr><th>Requirement</th><th>Demonstration</th></tr>
<tr><td>OPGGS Act 2006 (Cth):
Section 460(2) – a person carrying on activities in an offshore area under the permit must carry out those activities in a manner that does not interfere with…the conservation of the resources of the sea and seabed to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.</td><td>This requirement is addressed through the adoption of the following control measures:
CM07 Decommissioning
Decommissioning of subsea wells and infrastructure in compliance with Section 572 of the OPGGS Act.
CM08 Project Execution Plans
Infrastructure will be positioned on the seabed within design footprint to reduce seabed disturbance and avoid unique seafloor habitats in the Project Area.
CM09 MODU and Vessel Anchoring Plan
A MODU and vessel anchoring plan will identify suitable areas for anchors to be placed within the Project Area to avoid unique seafloor habitats.</td></tr>
<tr><td>Underwater Cultural Heritage Act 2018 (Cth) and Assessing and Managing Impacts to Underwater Cultural Heritage in Australian Waters – Guidelines on the application of the Underwater Cultural Heritage Act 2018 (DCCEEW 2023)
All actions involving seabed contact…have potential to cause adverse impact to located or unlocated UCH… proponent is responsible for</td><td>CM10 Seabed assessments
Seabed assessments undertaken of each well location and tie-back route prior to final selection to identify seabed composition, benthic habitats and communities and ensure areas of high relief outcrops, reefs, sponge beds, maritime archaeology, UXOs, submerged cultural heritage and landscapes are avoided where practicable within technical and safety constraints.
Seabed assessment data will be provided to the following appropriately qualified specialists to identify sensitive benthic receptors:
• Marine benthic ecologist to identify seabed habitat types including areas of high relief</td></tr>
</table>
</td></tr>
</table>

	meeting the protection requirements of the UCH Act.' Requirements include: • No adverse impact to UCH without a permit; • Notify the discovery of all suspected UCH exposed through the proposed action within 21 days of discovery. An adequate process of UCH assessment, impact mitigation and management is to be undertaken ahead of (and in certain cases concurrent with and/or following) any proposed actions in the near and offshore environment	outcrops, reefs or sponge beds that are likely to be associated with site-attached fish. • Underwater archaeologist to identify shipwrecks and other maritime archaeological heritage. • Geophysical data analyst to identify location of unexploded ordinances. • Underwater archaeologist to identify submerged cultural heritage and landscapes. Reports from each specialist evaluation of seabed assessment data will be provided to Beach. Beach will assess the reports and identify any areas of overlap, potential risks from Project activities, and determine any exclusion areas that may be required. **CM11 Cultural heritage assessments** Imagery and data from seabed surveys and assessments will be provided to appropriately qualified underwater archaeologists to identify any maritime archaeological and submerged cultural heritage and landscapes and inform protection priorities, management measures and reporting requirements. Should any maritime archaeological and submerged cultural heritage and landscapes be identified, Beach will report the findings in accordance with the *Underwater Cultural Heritage Act 2018*, and will consult with the relevant First Nations groups and determine any exclusion areas or further cultural heritage management procedures that may be required.

6.2.6 Environmental Performance

In accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 6-9) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 6-8 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 6-9 are met.

Table 6-9: Environmental Performance Outcomes: Physical Presence – Seabed Disturbance

Defined Acceptable Level	**Environmental Performance Outcomes**	
Acceptable level 10: No impacts on unique seafloor habitats[1] to the south-east region, including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests. **Acceptable level 11**: Impacts on benthic habitats and communities within the Project Area that are highly represented throughout the region and are not unique seafloor habitats is acceptable.	EPO3:	Implement CM08 Project Execution Plans and CM09 MODU and Vessel Anchoring Plan to ensure placement of infrastructure and anchors will avoid unique seafloor habitats in the Project Area.
	EPO2:	Decommissioning of Project facilities in compliance with Section 572 (3) of the Offshore Petroleum and Greenhouse Gas Storage (OPGGS) Act 2006 (Cth)

	EPO4:	Implement CM 10 Seabed assessments to identify seabed composition, benthic habitats and communities and ensure areas of unique seafloor habitats, maritime archaeology, UXOs, submerged cultural heritage and landscapes are avoided where practicable within technical and safety constraints.
Acceptable level 15: No impacts on underwater cultural heritage with values as conferred by the *Underwater Cultural Heritage Act 2018* (Cth). **Acceptable level 16**: No impacts on declared areas or objects of particular significance with values as conferred by the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth).	EPO5:	No impact on underwater cultural heritage.
	EPO6:	Implement CM11 Cultural heritage assessments to identify any maritime archaeological and submerged cultural heritage and landscapes to inform protection priorities, and develop and implement management measures and reporting requirements, where required, to prevent potential impacts.

[1] Unique seafloor habitats of the south-east region including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests (DNP, 2025).

6.3 **Emissions – Light**

6.3.1 Hazard Identification

During the Drilling and Completions and Support operations phases of the Project, localised and temporary light emissions will change ambient light levels. There will be no permanent lighting associated with the Project. Temporary light emissions from flaring during drilling and completions and navigational lighting for support operations to comply with navigational and safety requirements, will be emitted during the Project when the MODU or vessels are on location in the Project Area [**PC244, PC245**]. Stages and associated activities which will produce light emissions are defined below in Table 6-10 and described in Section 6.3.2.

Table 6-10: Activities Undertaken During the Project Which Will Result in Light Emissions

Stage	**Activity**	
Drilling and completions	Drilling and completions	Well Completion, Unload and Test
Support operations (all stages)	Support operations (all stages)	MODU operations; vessel operations

6.3.2 Hazard Description

6.3.2.1 Drilling and Completion

1. Well Completion, Unload and Test

Well unloading and testing may introduce localised and temporary light emissions if flaring is required.

Flaring associated with well flowback during the potential testing of the wells via the MODU may occur in the initial or future drilling campaigns if the base case of unloading the wells to the OGP is not feasible.

The duration of flaring for unloading a well of well construction fluid to the MODU is in the order of one to two days per well and up to approximately 65 MMscf per day being flared.

6.3.2.2 Support Operations

Vessel and MODU operations will introduce localised and intermittent light emissions from navigational and safety lighting while active in the Project Area.

Vessel and MODU operations may be undertaken 24 hours a day with lighting required at night for navigation and to ensure safe operations in working areas. Halogens, fluorescent and metal halide lights are generally used offshore. These emit white light and would be similar to lighting used in other offshore activities (i.e. shipping and fishing).

The MODU will be present in the Project Area during several Project phases including drilling and completions, operations (well intervention and workovers) and decommissioning. The longest duration the MODU is expected to be in position is approximately 40 days.

The type and number of vessels in the Project Area at any one time, and the duration of presence, will differ depending on the project stage. For a single activity, there will be no more than three vessels operating simultaneously. The longest duration for a single activity requiring support vessel operations is 40 days to drill a single well utilising a MODU and two support vessels.

For concurrent activities, five vessels could operate in the Project Area at any one time, for example, pipelay or diving/tie-in activities may occur concurrently during MODU positioning. Concurrent operations will be kept to a minimum and are unlikely to occur for more than 13 days.

6.3.2.3 Light Modelling

The spatial extent of Project light emissions was determined using light modelling conducted for the Project (Appendix O) as well as the National Light Pollution Guidelines for Wildlife (the Guidelines) (DCCEEW 2023a). Based on these sources, 2 light EMBAs were deemed relevant to the Project which are detailed in Table 6-11.

Table 6-11: Light EMBAs Relevant to the Project

Distance	Source	Light emitting scenarios included
20 km	National Light Pollution Guidelines for Wildlife (DCCEEW 2023a)	Routine light emissions from both MODU and vessels Precautionary threshold for light impacts to wildlife
63 km	Appendix O (Xodus 2024)	Light emissions from flaring during drilling and completions from any location in the Project Area (65 MMscf per day)

The 20 km EMBA for routine light emissions is based on the National Light Pollution Guidelines for Wildlife (the Guidelines) (DCCEEW 2023a). The guidelines recommend undertaking a light impact assessment where important habitat for list species sensitive to light are located within 20 km of the light source. The 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings demonstrated to occur at 15-18 km and fledgling seabirds grounded in response to artificial light 15 km away (DCCEEW 2023a). Seabird grounding, as described in Rodriguez et al (2014), relates to impacts of onshore fixed light sources such as streetlights and buildings and the effect this can have on young fledgling birds making their first flight from their nests to the open ocean.

This 20 km light EMBA is considered to be highly conservative based on the following studies. These studies used a MODU as the basis for assessing routine light emissions from MODU and vessels given the MODU would be the largest and tallest piece of infrastructure used:

- Beach commissioned Xodus to conduct a light assessment study for the Project (Appendix O). The study predicted that the area of potential impact from routine facility lighting would be up to 10 km from the MODU as there was no measurable changes to ambient light intensity levels beyond this distance.
- A light assessment study was undertaken for the Browse FLNG development (Woodside 2014) to assess the likely light density levels from a MODU. This study predicted light density levels at representative of background levels beyond 12.6 km from the MODU.

The 63 km EMBA for flaring light emissions is based on the light assessment study conducted for the Project (Appendix O). The threshold for this distance corresponding to ambient light levels is an illuminance of 0.001 lux, the equivalent of a new moon (Appendix O). The 63 km EMBA threshold distance was calculated based on a horizontal boom at a height of 49 m extending horizontally approximately 14 m from the MODU deck with a peak flare rate of 65 MMscf per day. This calculation is considered conservative as it does not account for atmospheric or topographic interactions such as shadowing, absorption or scattering which would naturally occur to some degree. It is therefore likely to overestimate the illuminance distance.

6.3.3 Impact Analysis and Evaluation

Light emissions from the Project can cause a change in ambient light resulting in direct impacts to:

- Change in fauna behaviour of:
  - Fish and plankton
  - Seabirds and shorebirds
  - Marine reptiles
- Changes in aesthetic and conservation values for:
  - Coastal communities
  - Conservation values and sensitivities
- Changes to cultural values and sensitivities

- Changes to the functions, interests, or activities of other users for:
    - Commonwealth and state commercial fisheries

Socio-economic impacts to commercial fisheries have not been evaluated further as there are no expected impacts to commercially fished species at a population level (See Section 6.3.3.1)

The process outlined in The National Light Pollution Guidelines for Wildlife (DCCEEW 2023a) is used to assess potential impacts, including:

- The guidelines identify marine turtles, seabirds and migratory shorebirds as potentially being impacted by artificial light to a level significant enough to require assessment. In addition to this, impacts on fish/plankton and coastal communities are assessed.
- The guidelines detail that important habitats are those areas necessary for an ecologically significant proportion of a listed species to undertake important activities such as foraging, breeding, roosting or dispersal. For this assessment the two light EMBAs were used to identify any areas where turtles, shorebirds and seabirds may be foraging, breeding, roosting, or migrating. The EPBC Protected Matters Report for these EMBAs are in Appendix E.

For the purposes of this OPP, species listed as Threatened under the EPBC Act, coastal communities, conservation values and sensitivities, and cultural values and sensitivities that are likely to occur in the light EMBAs were considered to have conservation significance warranting impact evaluation. Relevant receptors were determined by the PMST Reports, reputable peer-reviewed literature, susceptibility to light, and from comments received during Phase 2: Project OPP Public Comment Period [**PC229**].

6.3.3.1 Fish and Plankton

Intermittent light emissions during the Project have the potential to cause temporary behavioural changes to fish and plankton within localised artificial light halos surrounding the MODU and vessels. Behavioural changes to fish and plankton are expected to be limited to temporary and localised avoidance or aggregation behaviours (DCCEEW 2022).

Avoidance of fish and plankton from offshore light emissions from vessels—including fishing boats, cargo vessels, recreational watercraft, jetties and oil and gas platforms—have been observed where zooplankton and their vertebrate predators descend away from the surface; these effects occurred at depths of up to 200 m, and up to 200 m horizontally from the light source (Berge et al. 2020). Since most zooplankton need to ascend to forage on phytoplankton near the water's surface, light pollution may lead to an overall reduction in zooplankton, with cascading effects on their predators, and so on up the food chain (DCCEEW 2022).

Temporary and localised avoidance behaviours from short-finned eels are also expected from Project light emissions. Koster et al. (2021) tracked Australasian short-finned eels off Victoria and found mean night-time swimming depth of all eels showed diel vertical migration in time with the phase of the moon, with the mean depth increasing with increasing moon irradiation. As anguillid eels do not feed during their spawning migration, it has been suggested that the function of the vertical migrations relates to predator avoidance, swimming efficiency, thermal regulation, and control of maturation. Thus, short-finned eels are expected to avoid rather than be attracted to light emissions when migrating as part of inherent predator avoidance behaviours.

Fish and plankton may be directly or indirectly attracted to offshore light emissions. Experiments using light traps have found that some fish and zooplankton species are attracted to light sources (Meekan et al. 2001), with traps drawing catches from up to 90 m (Milicich et al. 1992). Lindquist et al (2005) concluded from a study of larval fish populations around an oil and gas platform in the Gulf of Mexico that an enhanced abundance of clupeids (herring and sardines) and engraulids (anchovies), both of which are highly photopositive, was caused by the platforms' light fields. The concentration of organisms attracted to light results in an increase in food source for predatory species and marine predators are known to aggregate at the edges of artificial light halos. Shaw et al (2002), in a similar light trap study, noted that juvenile tunas (Scombridae) and jacks (Carangidae), which are highly predatory, may have been preying upon concentrations of zooplankton attracted to the light field of the platforms. This could potentially lead to temporary increased predation rates compared to unlit areas.

The potential impacts to fish and plankton from light emissions are expected to be limited to temporary attraction or avoidance behaviours within localised artificial light halos. These temporary and localised behavioural changes to fish and plankton from light emissions associated with the Project will have no change in critical behaviours of these species, such as breeding or migration, or population persistence of prey species.

As a result, the change in fauna behaviour to fish and plankton from intermittent light emissions generated during the Project are evaluated as Minor (1) consequences based on:

- The localised extent of the impacts to fish, plankton and invertebrates is predicted to be limited to 200 m from the light source.
- Light emissions from the Project Area will be temporary based on the intermittent operations of MODU and vessels in the Project Area.
- Lighting on the MODU and support vessels will be limited to regulatory requirements for navigation and safety purposes.

6.3.3.2 Seabirds and Shorebirds

Intermittent light emissions during the Project have the potential to cause temporary behavioural changes to seabirds and shorebirds within the light glow generated by navigational lighting and flaring activities. Bright lighting (including from navigational lighting and flaring) can disorientate birds, Behavioural disorientation in seabirds and shorebirds from light emissions may result in entrapment, stranding, grounding, and interference with navigation (CoA 2023). These behavioural changes increase the likelihood of seabird and shorebird injury or mortality through collision with the vessel, or mortality from starvation due to disrupted migration or foraging at sea (Wiese et al. 2001). Seabirds and shorebirds that are active at night while undertaking critical behaviours such as migrating, foraging, or returning to colonies are most at risk from light emissions (CoA 2023).

Behavioural disorientation is also more likely to occur to young birds (fledglings). In general, fledglings are even more vulnerable to behavioural disorientation from light emissions than adults. Fledglings have been observed being affected by lights up to 15 km away, with counts of fledgling mortalities from grounding shown to be largely underreported (Rodriguez et al. 2014). Artificial lights are thought to override the natural cues from the moon and star light on the horizon, which has the potential to attract fledging seabirds back onshore after reaching the sea (Warham 1996), or to prevent fledging's from imprinting the location of their natal colony prior to migration (DCCEEW 2023a). Furthermore, fledglings may not undertake their first flight if their nesting habitat never becomes dark (DCCEEW 2023a). The impacts of artificial light upon the viability of breeding seabird populations are largely unknown (Griesemer and Holmes 2011).

Seabird and shorebirds species most vulnerable to behavioural disorientation from light emissions are species with critical behaviours that are conducted nocturnally. Review of the EPBC Act PMST species of birds that may undertake critical behaviours nocturnally within the routine light and/or flaring EMBAs (Appendix E) include:

- Albatrosses are known to nocturnally forage at sea, however forage most actively during daylight and are less active at night (Phalan et al. 2007).
- Petrels have been observed foraging at night, however forage primarily during the day in nearshore areas (Brooke 2004).
- Shearwaters are known to actively forage at night in proximity to breeding colonies, however in Australian waters are observed to typically forage during daylight, returning to colonies after feeding (AAD 2020).
- Little penguins are known to exhibit a wide foraging range, with individuals able to spend weeks away at sea foraging (McCutcheon et al. 2011).
- Orange-bellied parrots are thought to mostly travel at night when migrating between mainland Australia and Tasmania (Nicholls 2022).

These seabird and shorebird species are considered susceptible to impacts from light emissions from the Project and are listed in Table 6-12 including details of biologically important behaviours for each of these species within the light and flaring EMBAs. Figure 6-1 through to Figure 6-4 illustrates the overlap between BIAs for susceptible seabird and shorebird species and the light and flaring EMBAs.

Table 6-12: Seabirds and Shorebirds with BIAs or Undertaking a Biologically Important Behaviour within the Light EMBAs

Receptor	**Biologically Important Behaviour**	**Light EMBA (20 km)**	**Flaring EMBA (63 km)**
Albatross			
Antipodean albatross	Foraging, feeding or related behaviour likely to occur within area	✓	✓
	Foraging BIA	✓	✓
Black-browed albatross	Foraging, feeding or related behaviour likely to occur within area	✓	✓
	Foraging BIA	✓	✓
Buller's albatross, Pacific albatross	Foraging, feeding or related behaviour likely to occur within area	✓	✓
	Foraging BIA	✓	✓

Receptor	**Biologically Important Behaviour**	**Light EMBA (20 km)**	**Flaring EMBA (63 km)**
Campbell albatross, Campbell black-browed albatross	Foraging, feeding or related behaviour likely to occur within area	✓	✓
	Foraging BIA	✓	✓
Indian yellow-nosed albatross	Foraging BIA	✓	✓
Northern Buller's albatross	Foraging, feeding or related behaviour likely to occur within area	✓	✓
Northern royal albatross	Foraging, feeding or related behaviour likely to occur within area	✓	✓
Salvin's albatross	Foraging, feeding or related behaviour likely to occur within area	✓	✓
Shy albatross	Foraging, feeding or related behaviour likely to occur within area	✓	✓
	Foraging likely BIA	✓	✓
Southern royal albatross	Foraging, feeding or related behaviour likely to occur within area	✓	✓
Wandering albatross	Foraging, feeding or related behaviour likely to occur within area	✓	✓
	Foraging BIA	✓	✓
White-capped albatross	Foraging, feeding or related behaviour known to occur within area	✓	✓
Petrels			
Common diving-petrel	Foraging BIA	✓	✓
Northern giant-petrel	Foraging, feeding or related behaviour likely to occur within area	✓	✓
Southern giant-petrel	Foraging, feeding or related behaviour likely to occur within area	-	✓
White-faced storm-petrel	Foraging BIA	-	✓
Shearwaters			
Flesh-footed shearwater	Foraging, feeding or related behaviour likely to occur within area	✓	✓
Short-tailed shearwater	Foraging BIA	✓	✓
	Breeding known to occur within area	-	✓
Wedge-tailed shearwater	Breeding BIA	✓	✓
Other birds			
Australasian gannet	Foraging BIA	-	✓
Orange-bellied parrot	Migration route likely to occur within area	✓	✓
Little penguin	Breeding known to occur within area	-	✓

1. Albatrosses

The PMST Reports for the light EMBAs (Appendix E) identified 14 albatross species which have a presence within the light EMBAs. Twelve of these species have foraging BIAs or foraging behaviours identified within the light EMBAs (Table 6-12). Though the National Recovery Plan for Albatrosses and Petrels (CoA 2022) identifies light emissions as a threat, it classifies marine infrastructure interactions including those associated with artificial light as having no risk category priority and affecting 'Nil' species in Australian jurisdiction. In addition, no actions are identified.

All albatross species are migratory with widespread distributions throughout the Southern hemisphere and have been shown to travel large distances when foraging. For example, the wandering albatross has been shown to cover distance between 3,600 and 15,000 km in a single foraging trip during the breeding season on subantarctic islands (Jouventin and Weimerskirch 1990). The recognised foraging BIAs for albatross species generally cover large areas. For example, the entire South-east Marine Region is recognised as a foraging BIA for the Indian yellow-nosed, Campbell and black-browed albatross species. Albatrosses forage most actively during daylight and are less active at night because their ability to see and capture prey from the air is reduced (Phalan et al. 2007).

The potential for light emissions to cause behavioural disorientation to albatrosses foraging at night is expected to be limited to individuals. Due to the expansive distribution of albatross foraging BIAs in southern Australian waters, the absence of breeding BIAs and colonies in the light and flaring EMBAs, and albatross foraging behaviours occurring primarily during daylight hours; the potential of behavioural disorientation from temporary Project light emissions are expected to be limited to individuals and therefore no impacts to albatrosses will occur at a population level.

2. Petrels

The PMST reports for the light EMBAs (Appendix E) identified 7 petrel species which have a presence or BIA within the light EMBAs. Four of these species have foraging BIAs and/or foraging behaviours identified within the light EMBAs (Table 6-12). Though the National Recovery Plan for Albatrosses and Petrels (CoA 2022) identifies light emissions as a threat, it classifies marine infrastructure interactions including those associated with artificial light as having no risk category priority and affecting 'Nil' species in Australian jurisdiction. In addition, no actions are identified.

Petrel species have a widespread distribution throughout the Southern hemisphere, with wide, recognised foraging areas.

The common diving-petrel is listed as marine and does not have a recovery plan or conservation advice. Brooke (2004) details that common diving-petrels spend the night in burrows during the breeding season and seem to forage in nearshore areas primarily during the day, although they also have been observed foraging at night on vertically migrating plankton. They are thought to be fairly sedentary, remaining more or less in the area of their breeding colony year-round, although they may venture into the open ocean to forage outside of the breeding season and migrate to more tropical climates (Brooke 2004). In general, they undertake a unimodal foraging trip duration strategy (consistent short daily foraging trips) during both incubation and chick-rearing periods, unlike other small seabirds within their family (Fromant et al. 2021). However, studies on common diving-petrels within the Bass Strait have shown higher foraging efforts compared to other populations (with foraging trips averaging 71 ± 3 km), potentially due to the sparse distribution of prey (mostly coastal krill) (Formant et al. 2021). There is potential for light emissions from the activity to overlap with the occasional foraging times of the common diving-petrel. The common diving-petrel's foraging BIA is overlapped by the light EMBAs with the largest light footprint (63 km around the Project Area during flaring) overlapping <2% of the species' foraging BIA (Figure 6-2).

The northern giant-petrel was identified in the light and flaring EMBA PMST reports as likely to be foraging within the light EMBAs (Table 6-12). It is thought to be a predominantly diurnal forager, feeding its chicks during both day and night, however individuals provisioning young typically forage inshore and near nesting areas (DCCEEW 2023a). Breeding occurs on Macquarie Island between New Zealand and Antarctica, over 2,000 km from the Project and light EMBAs.

The southern giant-petrel was identified in the light and flaring EMBA PMST reports as foraging likely within the flaring EMBA (Table 6-12). Light is not identified as a key threatening process for the southern giant-petrel (CoA 2022). Like the northern giant-petrel, this species also feeds its chicks during both day and night and breeds exclusively on Antarctic and sub-Antarctic islands, the closest of which being Macquarie Island, still over 2,000 km from the Project and light EMBAs (DCCEEW 2024p).

The white-faced storm petrel is widely distributed throughout Australia, with the Australian population estimated to be about 25% of the global population (CoA 2020a). The species is migratory, moving from their temperate breeding grounds to tropical and subtropical locations in late March (Underwood and Bunce 2004). A foraging BIA for the white-faced storm petrel was identified within the flaring EMBA (Figure 6-3). The white-faced storm-petrel is a listed marine species. Light has not been identified as threatening process for this species (DCCEEW 2023a).

The potential for light emissions to cause behavioural disorientation to petrels foraging at night is expected to be limited to individuals. Due to the expansive distribution of petrel foraging BIAs in southern Australian waters, the absence of breeding BIAs and colonies in the light and flaring EMBAs, and petrel foraging behaviours occurring primarily in nearshore areas during the day; the potential of behavioural disorientation from temporary Project light emissions are expected to be limited to individuals and therefore no impacts to petrels will occur at a population level.

3. Shearwaters

The PMST Reports for the light EMBAs (Appendix E) identified 4 shearwater species which have a presence or BIA within the light EMBAs. Three of these species (flesh-footed shearwater, short-tailed shearwater, and wedge-tailed shearwater) have BIAs and/or biologically important behaviours identified within the light EMBAs (Table 6-12).The flesh-footed shearwater was identified in the flaring EMBA PMST report as foraging likely within the flaring EMBA, no BIAs exist for this species within the light and flaring EMBAs. The flesh-footed shearwater routinely attends fishing vessels to feed on baited hooks, discarded scraps and prey attracted to the surface by such vessels (DoE 2023b). However, incidental deaths from fishing activities typically involve ingesting baited hooks or hooks embedded in scraps, which won't be a factor in the Project. While flesh-footed shearwaters may be attracted to the localised artificial light halos created by vessel or flaring activities, they are primarily active at night near their breeding colonies, which are far from the Project Area (including Lord Howe Island, Saint Paul Island, Western Australia, Smith Island, and New Zealand) (TSSC 2014). As a result, the flesh-footed shearwater has been observed to be accustomed to vessel navigational lighting. Therefore, the addition of light emissions from the Project is not expected to change existing behaviours of the flesh-footed shearwater being attracted to vessels for opportunistic feeding. Potential impacts to flesh-footed shearwaters are expected to be limited to the attraction of foraging individuals and no impacts will occur at a population level given the absence of breeding BIAs in the light and flaring EMBAs.

The light and flaring EMBAs overlap the short-tailed shearwater foraging BIA (Figure 6-2). The light and flaring EMBA PMST reports identified breeding behaviours are known to occur for the short-tailed shearwater, but as detailed in Figure 6-2 the light EMBAs do not overlap any sites declared as a breeding BIA for the short-tailed shearwater. This species is listed as marine and migratory and does not have a recovery plan or conservation advice. When present in Australian waters (September to May) the species are known to typically forage during daylight, returning to the colonies after feeding (AAD 2020). Though not designated as BIAs, breeding has been recorded at additional locations such as Middle Island and Griffiths Island (Baker and Hamilton 2013) which are within the flaring EMBA but more than 50 km from the Project Area. Because these breeding locations are not considered BIAs, behavioural changes to short-tailed shearwaters at these breeding sites are not expected to result in population impacts. According to the light emissions modelling conducted for the Project (Appendix O), during short-term flaring activities Middle Island (along the coast of Warrnambool) may be exposed to a maximum of 0.0014 lux, which is approximately equivalent illuminance to a moonless clear night sky (0.001 lux). During routine facility lighting, illuminance from the Project may only reach less than 0.0001 lux at Middle Island, which equates to less light than a moonless overcast night sky. This change in ambient light levels at these locations is therefore not expected to be discernible from other artificial light sources and will be intermittent and temporary (up to 2 days per well). Potential impacts to short-tailed shearwaters as a result of Project light emissions are expected to be limited to foraging individuals and therefore no impacts to short-tailed shearwater will occur at a population level.

The light EMBA overlaps the wedge-tailed shearwater breeding BIA at Muttonbird Island, Victoria (

Figure 6-3). The species have been recorded to predominantly forage during the day and form large aggregations referred to as "rafts" just offshore from their breeding colony just on dusk and enter and leave the colony at night to avoid predators (Warham 1996). This species is listed as marine and migratory and does not have a recovery plan or conservation advice. Light has not been identified as a threat to this species (DCCEEW 2023a). The breeding BIA at Muttonbird Island is 18 km from the Project Area within Port Campbell National Park, which is predicted to be exposed to a maximum of 0.011 lux during flaring activities, approximately equivalent illuminance to that of a quarter moon (Appendix O). This change in ambient light levels is not expected to be discernible from other light sources in the area and will be of intermittent and temporary duration (up to 2 days per well). By comparison, Phillip Island Important Bird Area receives a maximum light pollution level of 5.3 nW/sr*cm^2 and reports between 0.39% and 0.70% of shearwater fledglings affected by grounding events (Rodriguez et al. 2014). This is equivalent to 0.035 lux and therefore more than triple the maximum illuminance subjected to the Muttonbird Island breeding BIA from Project activities. Consequently, given wedge-tailed shearwaters predominantly forage during the day and would be exposed only to a temporary change in ambient light levels within the flaring EMBA, the potential of behavioural disorientation from temporary Project light emissions are expected to be limited to individuals and therefore no impacts to wedge-tailed shearwaters will occur at a population level.

4. Little Penguin

The little penguin (*Eudyptula minor*) is known to breed within the flaring and light EMBAs according to the PMST reports (Appendix E) despite not overlapping breeding or foraging BIAs (Figure 6-2). Despite the colony of little penguins at Manly, Sydney Harbour, being protected as an endangered population, the Australian population is considered stable at approximately one million birds (Birdlife Australia 2025). The species is known to exhibit a wide foraging range, with individuals able to spend weeks away at sea foraging (McCutcheon et al. 2011). The closest breeding BIA to the Project exists at Christmas Island located of off nearby King Island, approximately 80 km from the Project Area (see Figure 6-2). However, additional breeding sites which are not designated BIAs have been recorded within the flaring EMBA at Middle Island in Warrnambool and within the light EMBA at Twelve Apostles and Port Campbell (Norman et al. 2017). Breeding typically occurs from September to February. Studies suggest that penguins were habituated to artificial lights and were unaffected by a 15 lux increase in artificial illumination (Rodriguez et al. 2016). According to the light modelling report (Appendix O), Port Campbell and Warrnambool would be subjected to 0.011 lux and 0.001 lux illuminance, respectively, during flaring activities. As such, Port Campbell would be subjected to the highest illuminance, 0.011 lux, during flaring activities which is equivalent to that of a quarter moon (Appendix O). This change in ambient light levels is not expected to be discernible from other artificial light sources and due to its intermittent and temporary duration (up to 2 days per well) it is not expected to cause impact at a population level. Therefore, as the little penguin is exposed only to a change in ambient light levels within the flaring EMBA, behavioural changes to the little penguin are unlikely.

5. Orange-bellied Parrot

The likely distribution and probable migration route identified for the Critically Endangered orange-bellied parrot (*Neophema chrysogaster*) overlap the light and flaring EMBAs. The flaring EMBA (63 km around the Project Area during flaring) overlaps the likely distribution range by ~7.4%, the probable migration route by ~8.6% and the non-breeding range by ~7.3% (Figure 6-4). No BIAs or areas deemed as habitat critical to the survival of the species were identified within the light or flaring EMBAs.

The orange-bellied parrot is a ground feeding parrot which breeds in south-west Tasmanian. They migrate from Tasmania to Victoria between late February and early April (Australian Museum 2022b). In Victoria, the orange-bellied parrot mostly occurs in sheltered coastal habitats, such as bays, lagoons and estuaries, or, rarely, saltworks. The parrot's breeding habitat is restricted to south-west Tasmania, where breeding occurs from November to mid-January mainly within 30 km of the coast (Brown and Wilson 1980). During winter, on mainland Australia, orange-bellied parrots are found mostly within 3 km of the coast (DELWP 2016).

The 2023-24 breeding season showed a record number of 92 orange-bellied parrots return to breeding grounds breaking last years census of 82 birds. Of these 64 orange-bellied parrots were wild-born, with the remaining 28 captive-bred released (NRE Tasmania 2024). Thirty-seven birds were female and the remaining 55 males. As of December 2024, a total of 25 nestlings and one fledgling were counted (NRE Tasmania 2024).

The National Recovery Plan for the orange-bellied parrot (DELWP 2016) identifies that the behaviour of this species may be modified by the presence of barriers such illuminated structure and boats, with the impacts of barriers greatest where they occur on migration routes, though there is little more than anecdotal evidence to support this (Holdsworth 2006). Intermittent Project light emissions do not present the same risk as that associated with long-term or permanent illuminated structures or illuminated commercial vessels which are positioned within the migration route, year-round. In addition, in the 15 years of operating the Thylacine A Wellhead Platform, Beach has not recorded any orange-bellied parrots being present. During the Otway Drilling Campaign in 2021/2022, no birds were identified to be attracted or grounded due to MODU or vessel lighting or flaring. Despite light emissions generated from support vessels servicing the Thylacine A Wellhead Platform and the Otway Drilling Campaign in 2021/2022, the 2021 orange-bellied parrot breeding season still showed a record number (at that time) of 70 orange-bellied parrots return to breeding grounds (NRE Tasmania 2023). Light emissions from the support vessels servicing the Thylacine A Wellhead Platform and the Otway Drilling Campaign in 2021/2022 are considered equivalent to the light emissions associated with the Project. Given the observed increase in orange-bellied parrot migration during periods of light emissions from the Thylacine A Wellhead Platform and the Otway Drilling Campaign in 2021/2022, it is anticipated that the Project's light emissions will not adversely impact migration numbers. The light and flaring EMBA overlaps the probable migration route of the orange-bellied parrot by 2.2% and 8.6%, respectively. Whereas the flaring EMBA overlaps the non-breeding range from Port Fairy east to Cape Otway, overall a 7.3% overlap of total non-breeding range area, not including the infrequent non-breeding range on the entire NSW coast. Changes in ambient light in the non-breeding range associated with short-term flaring (up to 2 days per well) in these areas are predicted to result in an increase in light intensity between 0.001 lux (Warrnambool) and 0.011 lux (Port Campbell National Park) (Appendix O). These values represent an approximately equivalent of illuminance from a moonless clear night sky (0.001 lux) to a quarter moon night sky (0.01 lux).

In summary, significant behavioural changes to the orange-bellied parrot while on migration or within the non-breeding range are not predicted based on:

- the intermittent and temporary duration of flaring activities that could change ambient light levels within the probable migration range
- no records of orange-bellied parrots during previous offshore activities involving routine lighting and flaring
- the observed increase in orange-bellied parrot migration during periods of light emissions from the Thylacine A Wellhead Platform and the Otway Drilling Campaign in 2021/2022, it is anticipated that the Project's light emissions will also not adversely impact migration numbers
- a Light Management Plan will be in place to minimise external light emissions as required by the National Light Pollution Guidelines
- light emissions from the Project will result in a localised and short-term change in ambient light with levels returning to existing ambient levels following the completion of the activities.

6. Seabirds and Shorebirds Consequence Evaluation

The potential impacts to seabirds and shorebirds from intermittent Project light emissions are limited to potential behavioural disorientation of individuals not resulting in population effects. As a result, the change in fauna behaviour to seabirds and shorebirds from intermittent light emissions generated during the Project was evaluated as Minor (1) consequences based on:

- Lighting on survey vessels, the MODU and support vessels will be limited to that which is required for navigational and safety purposes and of a temporary nature (30 to 40 days for a single activity).
- Due to the expansive distribution of albatross foraging BIAs in southern Australian waters, the absence of breeding BIAs and colonies in the light and flaring EMBAs, and albatross foraging

behaviours occurring primarily during daylight hours; the potential of behavioural disorientation from temporary Project light emissions are expected to be limited to individuals and therefore no impacts to albatrosses will occur at a population level.

- Due to the expansive distribution of petrel foraging BIAs in southern Australian waters, the absence of breeding BIAs and colonies in the light and flaring EMBAs, and petrel foraging behaviours occurring primarily in nearshore areas during the day; the potential of behavioural disorientation from temporary Project light emissions are expected to be limited to individuals and therefore no impacts to petrels will occur at a population level.

- The addition of light emissions from the Project is not expected to change existing behaviours of the flesh-footed shearwater being attracted to vessels for opportunistic feeding. As a result, potential impacts to flesh-footed shearwaters are expected to be limited to the attraction of foraging individuals and no impacts will occur at a population level given the absence of breeding BIAs in the light and flaring EMBAs.

- The addition of light emissions from the Project is not expected to change existing behaviours of the short-tailed shearwater being attracted to vessels for opportunistic feeding. Breeding locations will be exposed only to a change in ambient light levels within the flaring EMBA. As a result, potential impacts to short-tailed shearwaters are expected to be limited to foraging individuals and therefore no impacts to short-tailed shearwaters will occur at a population level.

- For wedge-tailed shearwaters, the breeding BIA at Muttonbird Island is subject to temporary and intermittent light emissions equivalent to that of a quarter moon. Compared to the Phillip Island Bird Area which has a baseline maximum light pollution more than three times greater than this, Given this species predominantly forages during the day, the potential of behavioural disorientation from temporary Project light emissions are expected to be limited to individuals and therefore no impacts to wedge-tailed shearwaters will occur at a population level.

- The little penguin is exposed only to a change in ambient light levels within the flaring EMBA, therefore behavioural changes to the little penguin are unlikely.

- Based on the observed increase in orange-bellied parrot migration during periods of light emissions from the Thylacine A Wellhead Platform and the Otway Drilling Campaign in 2021/2022, it is anticipated that the Project's light emissions will also not adversely impact migration numbers.

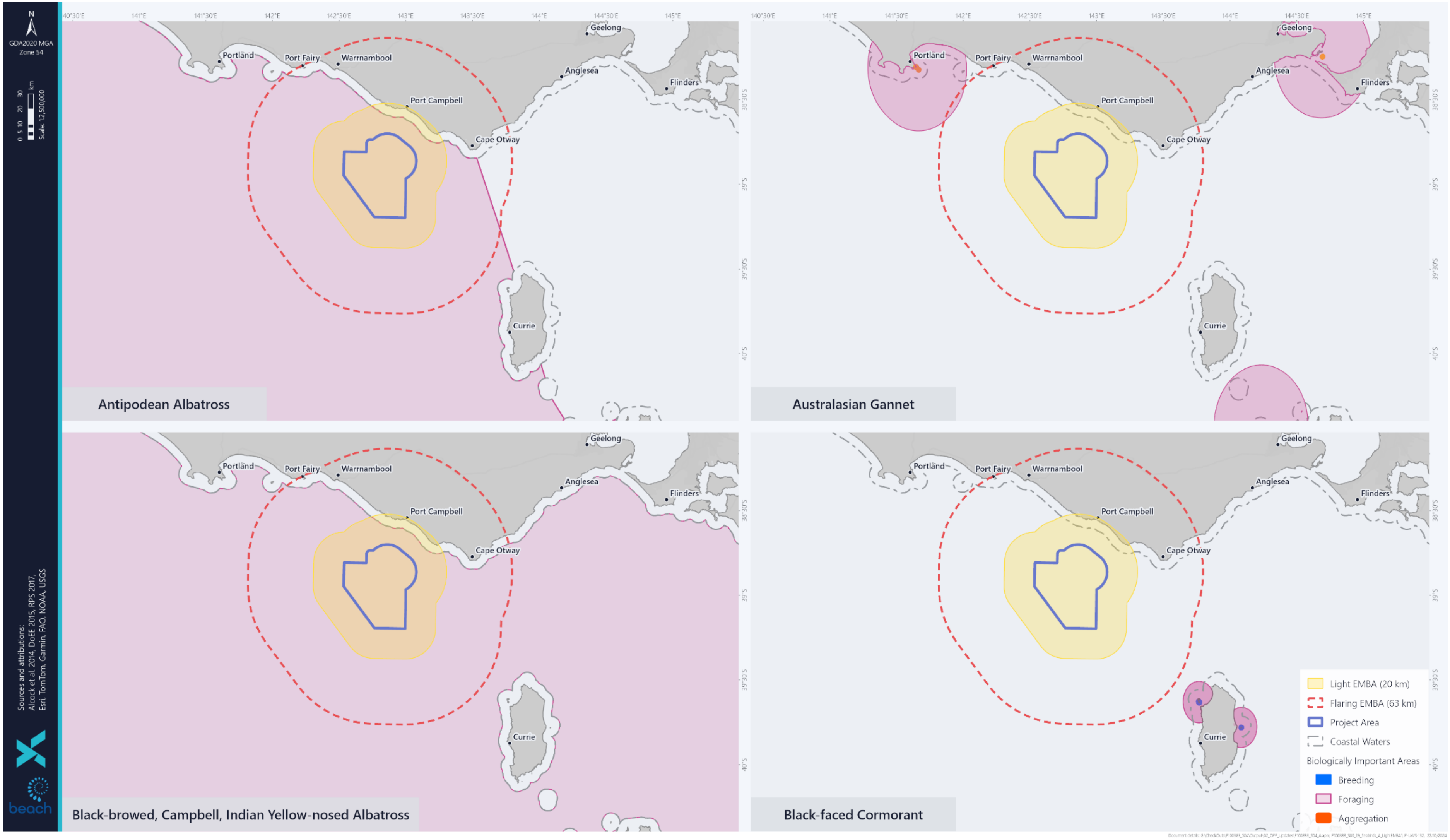
- Light emissions are identified as a threat in the National Recovery Plan for albatrosses and petrels (2022) (CoA 2022) but classifies marine infrastructure interactions including those associated with artificial light as having no risk category priority and affecting ‘Nil’ species in Australian jurisdiction

- Light pollution is listed as a threat to seabirds in the Wildlife Conservation Plan for Seabirds (CoA 2020a), with potential for consequences affecting individuals but not whole populations. Light emissions will be managed in a manner to not contravene the objectives of this plan.

- Light emissions will be managed in a manner to not impact on the recovery of the orange-bellied parrot as per the recovery plan (DELWP 2016):

Illuminated structures and illuminated boats have been identified as a potential barrier to migration and movement for the orange-bellied parrot (DELWP 2016). The light and flaring EMBAs overlap only

2.2% and 8.6% of the probable migration route, respectively. Therefore, the temporary activities of the MODU and vessels when undertaking the petroleum activity do not present the same risk as that associated with long-term or permanent illuminated structures or illuminated commercial vessels which are positioned within the migration route year-round. This critically endangered species may migrate over a portion of the Project Area and light EMBAs from February-April and when returning in November. Impacts associated with flaring, which may change ambient light in the area, will be temporary and of short duration and are not expected to result in in impacts to migration numbers.



Sources and attributions: Alcock et al. 2014, DoEE 2015, RPS 2017, Esri, TomTom, Garmin, FAO, NOAA, USGS

Figure 6-1: Light EMBAs and BIAs for the Antipodean Albatross, Australasian Gannet, Black-browed/Indian Yellow-nosed Albatrosses and Black-faced Cormorant

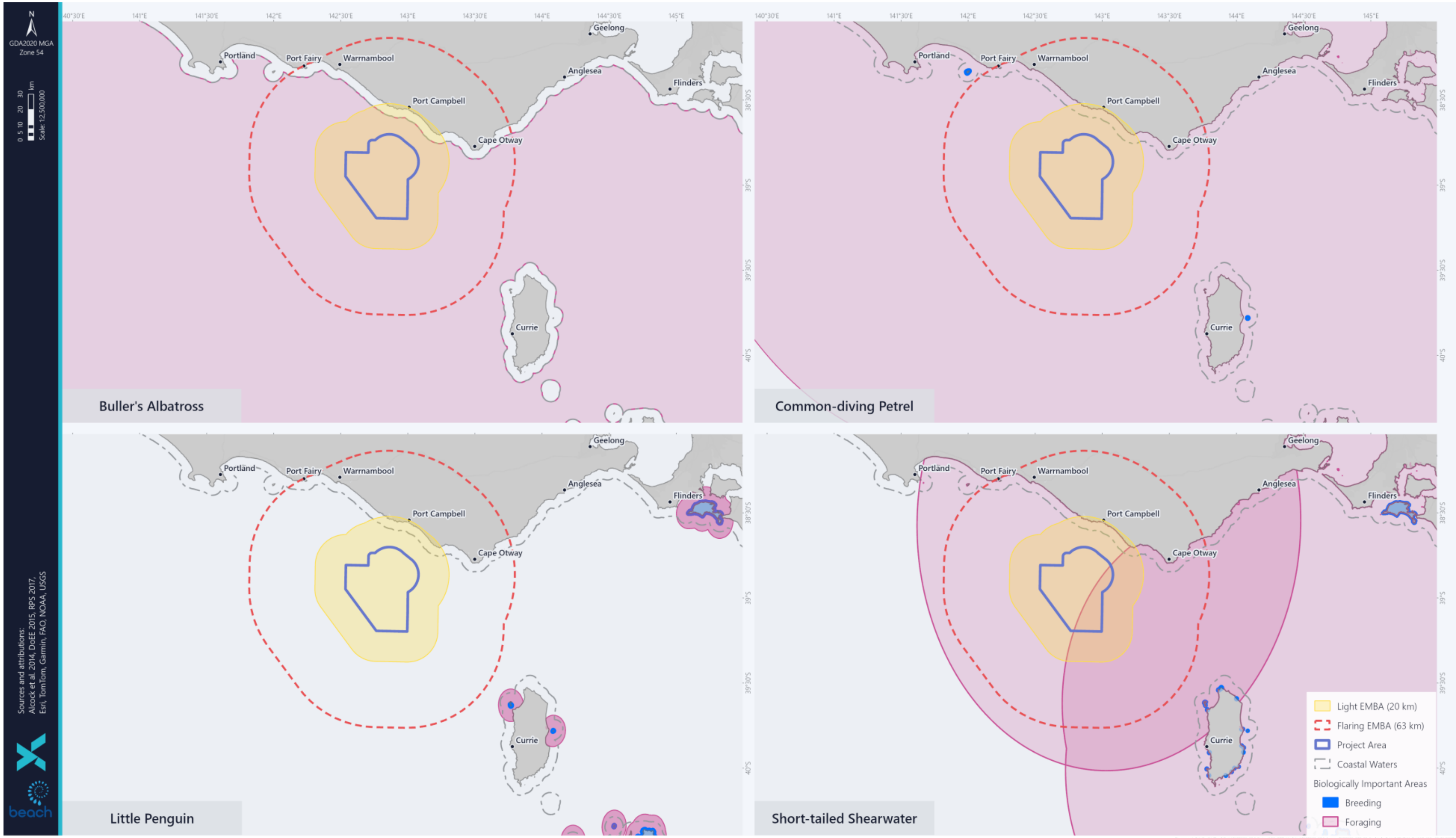


Figure 6-2: Light EMBAs and BIAs for the Buller's Albatross, Common-diving Petrel, Little Penguin and Short-tailed Shearwater

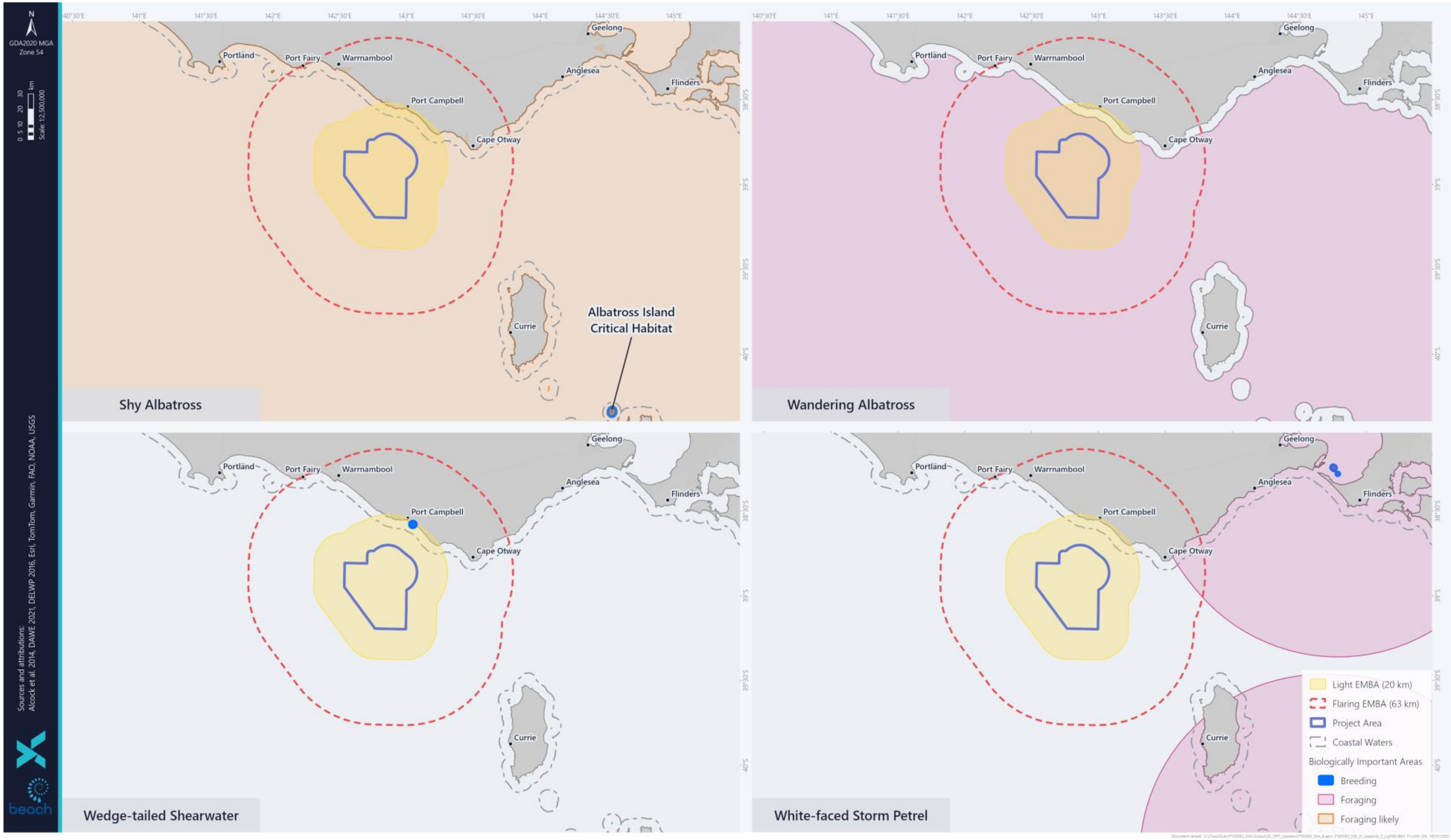
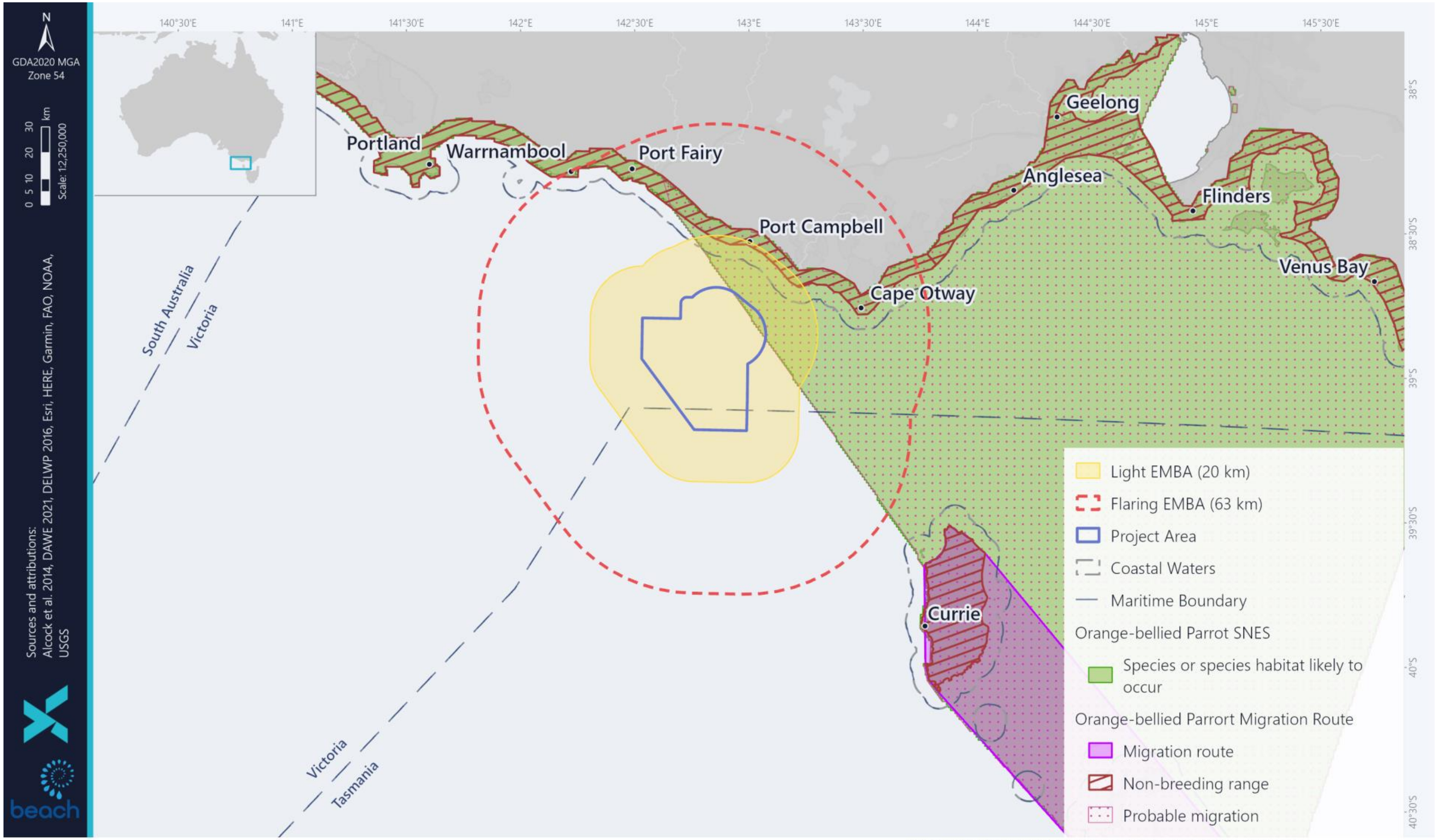


Figure 6-3: Light EMBAs and BIAs for the Shy Albatross, Wandering Albatross, Wedge-tailed Shearwater and White-faced Storm Petrel



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_S04_A.aprx, P100383_S00_32_OBP_Light, P-UWS-132, 26/10/2024

Figure 6-4: Light EMBAs and distribution, migration routes and breeding ranges for the Orange-bellied Parrot

6.3.3.3 Marine Reptiles

Artificial light can disrupt turtle nesting and hatching behaviours and is listed as a key threat in the Recovery Plan for Marine Turtles in Australia (CoA 2017). Offshore light emissions can attract hatchlings and disrupt dispersal behaviours of marine turtles at night by interfering with natural lighting and silhouettes (DCCEEW 2023a; CoA 2017).

Behaviours critical to marine turtle survival are generally contained within the areas defined by marine turtle BIAs and habitat critical to the survival of marine turtle species. The Project Area and light EMBAs do not overlap marine turtle BIAs or habitat critical to the survival of marine turtle species and there are no documented nesting activities along Victorian coastlines. However, the PMST report identified the loggerhead turtle with a presence of 'breeding likely to occur' within the light EMBAs. However, the main Australian breeding areas are generally confined to southern Queensland and Western Australia (Cogger et al. 1993). Loggerhead turtles show a strong fidelity to their breeding areas (Limpus 2008). They forage in all coastal states, though are uncommon in Victoria and hence are expected to be occasional visitors in the light EMBAs (CoA 2017a). Species or habitat is 'known to occur' for the leatherback turtle and 'may occur' for the green turtle within the light EMBAs (Appendix E). Consequently, population level impacts to marine turtles from routine light and flaring emissions are not predicted to occur. Potential impacts due to light emissions from the Project would be limited to temporary behavioural changes to individual marine turtles transiting through the light EMBAs at night, within 20 km of the MODU and vessels during routine operations and within 63 km of flaring sources within the Project Area during flaring activities. [**PC229**]. The potential impacts to marine reptiles from light emissions are expected to be limited to temporary and localised attraction of occasional visiting individuals at night. As a result, the change in fauna behaviour to marine reptiles from intermittent Project light emissions are evaluated as Minor (1) consequences based on:

- Lighting on the MODU and support vessels will be limited to that which is required for navigational and safety purposes.
- Artificial light is listed as a key threat in the Recovery Plan for Marine Turtles in Australia (CoA 2017), however, no BIAs or habitat critical to survival for marine turtles were identified within the light EMBAs.
- All turtle species are expected to be occasional visitors to the light EMBAs. [**PC229**]

6.3.3.4 Coastal Communities

Light emissions from the Project have the potential to impact coastal communities.

Light emissions as a result of routine operations are expected to have a minor impact on coastal communities and will be indistinguishable from other marine traffic within the area and given the temporary nature of the light emissions associated with the Project. Given the maximum predicted duration for drilling at each location is 30-40 days, the low levels of ambient light changes from the routine light will be short-term and fully recoverable. According to the light emissions modelling conducted for the Project (Appendix O), the coastal receptor which may be exposed to the highest level of illuminance from routine facility lighting is Port Campbell National Park at 0.0002 lux, which equates to less light than a new moon (0.001 lux). Warrnambool, the largest settlement within the light EMBAs, may be exposed to <0.0001 lux from routine facility lighting, equating to less than a moonless overcast night sky (0.0001 lux).

There are several coastal communities and areas conducive to tourism located on the Victorian coast which are within the flaring EMBA (Figure 4-12). Light emissions as a result of short-term flaring (up to 2 days per well) are expected to have a negligible impact on coastal communities due to the low levels of illuminance. According to the light emissions modelling conducted for the Project (Appendix O), the coastal receptor which would be exposed to the highest level of illuminance from short-term flaring is Port Campbell National Park at 0.0111 lux, which is approximately the same as a quarter moon (0.01 lux). Warrnambool, the largest settlement within the flaring EMBA, may be exposed to 0.0014 lux, or approximately the same illuminance as a new moon (0.001 lux).

Given the above, the impact from light emissions is likely to result in Minor (1) consequences to coastal communities based on:

- Illuminance from flaring at the closest possible locations to the coast would be comparable to natural ambient light levels of less than a quarter moon (0.01 lux).
- The MODU and vessel will have a Lighting Management Plan to minimise external light emissions as required by the National Light Pollution Guidelines.
- Visibility of routine lighting and the flare when flaring would be reduced by the prevailing weather conditions within the region, and would be comparable to ongoing shipping traffic and historical drilling and flaring activities and within the region.

6.3.3.5 Conservation Values and Sensitivities

Light emissions from the Project have the potential to impact conservation values and sensitivities as well as National Heritage. Relevant receptors identified within the light EMBAs are presented below in Table 6-13.

Table 6-13: Marine Protected Areas, National Parks and National Heritage Places within Light and Flaring EMBAs

Receptor	**Marine Protected Area**	**Intersection with flaring EMBA**	**Intersection with light EMBA**
Australian Marine Park	Apollo Multiple Use Zone	✓	-
	Zeehan Multiple Use Zone	✓	-
	Zeehan Special Purpose Zone	✓	-
State Marine Reserve	Twelve Apostles Marine National Park	✓	✓
	Marengo Reefs Marine Sanctuary	✓	-
	Merri Marine Sanctuary	✓	-
	The Arches Marine Sanctuary	✓	✓
State Terrestrial Reserve	Great Otway National Park	✓	✓
	Port Campbell National Park	✓	✓
Key Ecological Feature	Bonney Coast Upwelling	✓	-
	West Tasmanian Canyons	✓	✓
National Heritage Place	Great Ocean Road and scenic environs	✓	✓

Light pollution associated with offshore mining operations (including oil and gas) and other offshore activities is listed as a pressure on the conservation values of the South-east Marine Region (DNP 2013). As described in Section 4.2.2.2, conservation values for the Apollo and Zeehan AMPs include seafloor features and habitat for conservation significant bird and mammal species (DNP 2013). Evaluation of light-sensitive fauna including seabirds is conducted in Section 6.3.3.2.

Light emissions are not identified as a key management objective for conservation of natural values associated with the Twelve Apostles Marine National Park (Parks Victoria 2006d), Marengo Reefs Marine Sanctuary (Parks Victoria 2007a), Merri Marine Sanctuary (Parks Victoria 2007c) or The Arches Marine Sanctuary (Parks Victoria 2006d). Conservation values for marine protected areas are detailed in Section 4.2.8. According to the management plans, light-sensitive receptors relevant to the values of the Twelve Apostles Marine National Park and Marengo Reefs, Merri and The Arches Marine Sanctuaries include invertebrates and fish. Based on the evaluation of light-sensitive fauna in Section 6.3.3.1, impacts to invertebrates and fish within the marine reserves are not predicted based on impacts to invertebrates and fish from light only being predicted up to 200 m from the light source. The Project Area where MODU and vessel lighting will occur is ~18 km from the nearest reserve, Twelve Apostles Marine National Park.

The light EMBA overlaps 2 KEFs, the Bonney Coast Upwelling and West Tasmanian Canyons. The values associated with KEFs are described in Section 4.2.12 Light-sensitive receptors in the Bonney Coast Upwelling KEF include fish and invertebrates as well as seabirds, which may be present in the KEF due to increased food availability. Light-sensitive receptors in the West Tasmanian Canyons KEF include fish associated with sponges near canyon heads. Potential impacts to seabirds and shorebirds from intermittent light emissions generated during the Project was evaluated as Minor (1) consequences (Section 6.3.3.2). Impacts to fish within the West Tasmanian Canyons KEF are expected to also be of Minor (1) consequences based on the greatest diversity being between 200 m and 350 m depth (CoA 2015) and, as detailed in Section 6.3.3.2, impacts to fish from light are not predicted in water depths greater than 200 m.

Terrestrial receptors including The Great Ocean Road and Scenic Environs National Heritage Place, and Great Otway and Port Campbell National Parks are within the light EMBAs (Table 6-13; Appendix E). Light emissions as a result of routine facility lighting and short-term flaring (up to 2 days per well) are expected to have a negligible impact on these receptors due to the low levels of illuminance reaching the coast. According to the light emissions modelling conducted for the Project (Appendix O), during short-term flaring activities Port Campbell National Park may be exposed to 0.011 lux, which is approximately the same as a quarter moon (0.01 lux). During routine facility lighting, illuminance from the Project may only reach 0.0002 lux, which equates to less light than a new moon (0.001 lux). Cape Otway Light Station Lookout is modelled to be exposed to even less illuminance than this at 0.0029 lux when flaring and less than 0.0001 lux from routine facility lighting (less than a moonless overcast night sky; Appendix O). The Great Ocean Road and Scenic Environs National Heritage Place overlaps the boundaries of the National Parks and therefore subject to the same level of illuminance.

Given the above, the impact from light emissions is likely to result in Minor (1) consequences to conservation values and sensitivities. The impact from Minor (1) consequences is therefore acceptable based on:

- Lighting on the MODU and support vessels will be limited to that which is required for navigational and safety purposes.

- Visibility of routine lighting and the flare when flaring would be reduced by the prevailing weather conditions within the region, and would be comparable to ongoing shipping traffic and historical drilling and flaring activities and within the region.
- Illuminance from flaring at the closest possible locations to the coast would be comparable to natural ambient light levels of less than a quarter moon (0.01 lux).
- The Project will not affect the national heritage management objectives to protect, conserve, present and transmit to all generations the National Heritage Values, with no long-term or irreversible impacts on the principle or aesthetic characteristics or social and tourism values.
- Impacts to the principal and aesthetic characteristics of the Great Ocean Road and Scenic Environs are predicted to be limited to intermittent visibility of navigation and operational lighting and short-duration flaring from some locations along the Great Ocean Road and Great Ocean Walk at night.
- Impacts to invertebrates and fish associated with the Twelve Apostles Marine National Park, Marengo Marine Sanctuary, Merri Marine Sanctuary, The Arches Marine Sanctuary and West Tasmanian Canyons KEF are not predicted based on light impacts to invertebrates and fish occurring within a distance of 200 m.
- The National Recovery Plan for Albatrosses and Petrels 2022 (CoA 2022) identifies light emissions as a threat, it classifies marine infrastructure interactions including those associated with artificial light as having no risk category priority and affecting 'Nil' species in Australian jurisdiction. In addition, no actions are identified.
- Albatross forage most actively during daylight and are less active at night because their ability to see and capture prey from the air is reduced (Phalan et al. 2007).
- As the light EMBAs overlaps a number of seabird foraging and breeding BIAs, the migratory route for the critically endangered orange-bellied parrot and areas where birds are likely or known to be foraging, breeding, or roosting, the MODU and vessel will have a Lighting Management Plan to minimise external light emissions as required by the National Light Pollution Guidelines.
- Light pollution is listed as a threat to seabirds in the Wildlife Conservation Plan for Seabirds (CoA 2020a), with potential for consequences affecting individuals but not whole populations.

6.3.3.6 Cultural Values and Sensitivities

Based on Section 4.6, the following First Nations cultural values and sensitivities have been identified as potentially affected by light emissions:

- Birds including orange-bellied parrot and short-tailed shearwater (muttonbird)
- Fish (including eels)

The marine fauna listed above are connected to places associated with songlines or connected to individuals through ceremony (Section 4.6.3.5). The connection of marine fauna to places or individuals are considered cultural intangible values.

Light emissions have the potential to impact marine fauna that have songlines, or spiritual connection to First Nations people. It is considered that impacts to species at a population level may prevent First Nations people's obligations to maintain spiritual connections and care for culturally significant species and their habitats. As evaluated in Section 6.3.3.2, potential impacts to birds including the orange-bellied parrot, short-tailed shearwater and fish including eels from light emissions will not impact these species at a population level. Minor behavioural changes to birds and fish are expected from the intermittent light emissions generated during the Project.

As described in detailed in Section 6.3.3.2, light emissions will be managed in a manner to not impact on the recovery of the orange-bellied parrot to ensure the proposed activity is not inconsistent with the Recovery Plan for this species. The recovery plan was developed in consultation with First Nations peoples to ensure all activities will respect the cultural knowledge and traditions of Indigenous people throughout the species range. Section 6.3.3.2 assesses the potential impacts to these receptors and concluded that light emissions will not result in impacts at a population level to birds and fish including eels. As such, light emissions from the Project are likely to result in Minor (1) consequences to cultural values and sensitivities based on:

- Lighting on the MODU and support vessels will be limited to that which is required for navigational and safety purposes.
- Based on the observed increase in orange-bellied parrot migration during periods of light emissions from the Thylacine A Wellhead Platform and the Otway Drilling Campaign in 2021/2022, it is anticipated that the Project's light emissions will also not adversely impact migration numbers.
- For short-tailed shearwaters, the behavioural response threshold range for fledgling shearwaters against flaring light emissions excludes the additional breeding locations (Middle Island and Griffiths Island) from the area that may cause behavioural changes to fledgling shearwaters. As a result, potential impacts to short-tailed shearwaters are expected to be limited to foraging individuals and therefore no impacts to short-tailed shearwater will occur at a population level.
- Short-finned eels are expected to avoid rather than be attracted to Project light emissions when migrating as part of inherent predator avoidance behaviours. This change in behaviour will prevent increase predation in short-finned eels and is considered Minor (1) consequence affecting individuals but not whole populations.
- The National Recovery Plan for Albatrosses and Petrels 2022 (CoA 2022) identifies light emissions as a threat, it classifies marine infrastructure interactions including those associated with artificial light as having no risk category priority and affecting 'Nil' species in Australian jurisdiction. In addition, no actions are identified.
- As the light EMBA overlaps a number of seabird foraging and breeding BIAs, the migratory route for the critically endangered orange-bellied parrot and areas where birds, including muttonbirds, are likely or known to be foraging, breeding, or roosting, the MODU and vessel will have a Lighting Management Plan to minimise external light emissions as required by the National Light Pollution Guidelines.
- No BIAs or spawning areas are identified within the light EMBA for fish or invertebrates and the area (200 m) where invertebrates may be attracted to light is small and temporary.

6.3.4 Impact Evaluation Summary

The impact evaluation for light emissions from the Project is summarised in Table 6-14.

Table 6-14: Impact Evaluation Summary for Emissions - Light

Summary	
Summary of impacts	Potential impacts from light emissions will result in Minor (1) consequences of behavioural change to marine fauna including temporary and localised avoidance or attraction affecting individuals but not whole populations. This in turns prevents impacts to conservation, and cultural values and sensitivities. The potential impact of light emissions to coastal communities is also expected to result in Minor (1) consequences given Project light emissions will be comparable to ongoing shipping traffic and historical flaring activities within the region.
Extent of impacts	The extent of the area potentially impacted by light emissions from the Project has been assessed as up to 63 km for flaring and 20 km for routine light. Flaring will only occur on a temporary basis of up to two days per well. Navigational lighting from MODU and vessel operations will generate intermittent light emissions from the Project Area and is limited to the drilling & completions and support operations stages of the Project when the MODU and vessels, which will require lighting to comply with navigational and safety requirements, when on location **[PC244, PC245].** During MODU and vessel operations lighting levels will be reduced to acceptable levels through implementation of controls and limiting of light to only that required for navigational, safety and emergency requirements.
Duration of impacts	Light impacts are temporary only lasting for the duration of each activity (1-2 days per well for flaring; and the longest duration for a single activity requiring support vessel operations is 40 days to drill a single well utilising a MODU and two support vessels)
Level of certainty	At the time of writing this OPP, there is uncertainty with regards to the specific locations for wells and subsea systems and therefore the location of MODU and vessel operations within the Project Area resulting in light emissions. To ensure all potential impacts were considered, the light and flaring EMBA was based on ranges (defined by project specific light modelling (Appendix O) from the perimeter of the Project Area to consider the greatest range/extent for the potential change in ambient light. This approach ensures all potential receptors have been evaluated for potential impacts from light emissions. Further certainty on the location of wells and subsea systems will be known during the development of future EPs under this OPP. As a result, future EPs under this OPP will assess a much more precise and accurate range of potential impact from light emissions. Beach has a high level of certainty about the potential impacts from light emissions in the light and flaring EMBAs and has long-term experience in the area on the application of good industry practice to ensure impacts associated with light emissions are acceptable.
Is the impact considered lower-order or higher-order?	Impacts from light emissions have been evaluated to result in Minor (1) consequences. Minor (1) consequences are considered lower-order impacts that are acceptable with the application of good industry practice.
Impact Consequence	
Minor	

6.3.5 Demonstration of Acceptability

Table 6-15 demonstrates how and why predicted environmental impacts from light emissions meets the defined acceptable levels (Table 5-5).

Table 6-15: Demonstration of Acceptability – Emissions – Light

Demonstration of Acceptability		
Impact and risk comparison with relevant defined acceptable levels	Acceptable levels relevant to light emissions include acceptable levels 1, 2, and 3 (as detailed in Table 5-4). A **Minor** impact consequence level was assigned for this aspect based on the impact analysis and evaluation. Minor impact consequences due to light emissions will not result in: • interference with the recovery of EPBC Act listed threatened species • modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline • inconsistencies with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species. As a result, the predicted environmental impact for light emissions is better than the defined acceptable levels 1, 2, and 3.	
Principles of ESD	Integration principle	Section 6.3.3 identifies and evaluates environmental impacts associated with light emissions. As part of identifying the potential impacts, conservation values and sensitivities, coastal communities, ecological environment, and cultural values and sensitivities described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental impact. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks. For Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders on the Project and associated activities. No objections or claims were raised against this aspect during Phase 1: Initial Project Consultation. For Phase 2: Project OPP Public Comment Period (Section 10.2.4), the public had the opportunity to provide further comment to this OPP during the period (18/3/2024 – 20/5/2024). Beach prepared the public comment report summarising all comments, an assessment of the merits of each comment, a statement of the response to each comment, and an outline of any changes made to the OPP as a result of the comment (Appendix P). The impact assessment for this aspect has been updated to reflect the merit provided by public comment reference numbers PC229, PC190, PC244, PC245 and PC249. As a result, the impact assessment now integrates responses to public comments of merit and therefore is of an acceptable level. The potential environmental impact against this aspect was assessed as having a Minor (1) impact consequence level which is considered a lower-order environmental impact. Lower-order environmental impacts are considered 'broadly acceptable' and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental impacts against this aspect were assessed as having a Minor (1) impact consequence level which is considered a lower-order environmental impact. Lower-order environmental impacts cannot result in serious or irreversible environmental damage. Control measures meet the requirements of the National Light Pollution Guidelines for Wildlife (DCCEEW 2023a). To account for uncertainty in the locations for wells and subsea systems, the light and flaring EMBAs were based on ranges defined by project specific light modelling (Appendix O) for the perimeter of the Project

Demonstration of Acceptability		
		Area. This method ensures there is high confidence in the impact assessment and effectiveness of controls for this aspect given the use of project specific light modelling (Appendix O) and the National Light Pollution Guidelines for Wildlife (DCCEEW 2023a). As a result, there is no uncertainty associated with this aspect.
	Intergenerational principle	The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts from light emissions is lower than the defined acceptable levels 1, 2, and 3; the health, diversity, or productivity of the environment for future generations is expected to be maintained.
	Biodiversity principle	Section 6.3.3 identifies and evaluates environmental impacts associated with light emissions. Environmental values and sensitivities including MNES as described in Section 4 were assessed. Given predicted environmental impacts from light emissions are lower than the defined acceptable levels 1, 2, and 3; there is no potential to affect biological diversity or ecological integrity.
Internal context	Policy compliance	The defined acceptable levels, EPOs and controls proposed for this aspect are consistent with Beach Environmental Policy objectives. As a result, potential environmental impacts from the Project can be managed to align with Beach Environmental Policy objectives.
External context	Stakeholder engagement is being carried out as part of this OPP process Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable. During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect. During Phase 2: Project OPP Public Comment Period (Section 10.2.4), comments were raised against this aspect. The assessment of merit for these comments found this aspect to require updates. Changes to the OPP to address PC229, PC190, PC244, PC245 and PC249 have been integrated into the impact evaluation for this aspect. The science of artificial light impacts is continually evolving. Any new guidance or advice will be assessed and incorporated into the impact evaluation and controls prepared for activity specific EPs under this OPP.	
Other requirements	**Requirement**	**Demonstration**
	Navigation Act 2012 (Cth) Several Marine Orders (MO) are enacted under this Act which relate to offshore petroleum activities, including: • MO 21: Safety and emergency arrangements • MO 27: Safety of Navigation and Radio Equipment • MO 30: Prevention of collisions	These requirements are addressed through the adoption of the following control measures: **CM01 Navigation safety** Beach Marine Assurance System ensures that the MODU and vessels meet relevant maritime laws and includes pre-commencement MODU and vessel inspections of class certification requirements under the *Navigation Act 2012* and associated Marine Orders. All vessels operating within the project area will adhere to the navigation safety requirements including:

Demonstration of Acceptability		
		• International Regulations for Preventing Collisions at Sea 1972 • Chapter 5 of International Convention for the Safety of Life at Sea 1974 • International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 Navigation Act 2012 and any subsequent Marine Orders that specify standards for crew training and competency, navigation, communication, and safety measures **CM02 Notifications** The Australian Hydrographic Office will be notified of the Project activities and installed subsea infrastructure prior to commencement to facilitate the issuing of Notice to Mariners and maintain nautical charts. Relevant stakeholders are notified prior to the activity so that third party marine users are aware of vessel location and timing.
	National Light Pollution Guidelines for Wildlife (DCCEEW 2023a) Aim of the guidelines is that artificial light will be managed so wildlife is: 1) not disrupted within, or displaced from, important habitat 2) able to undertake critical behaviours such as foraging, reproduction and dispersal. Outlines the following management principles to reduce light pollution: 1) Start with natural darkness and only add light for specific purposes. 2) Use adaptive light controls to manage light timing, intensity and colour. 3) Light only the object or area intended – keep lights close to the ground, directed, and shielded to avoid light spill. 4) Use the lowest intensity lighting appropriate for the task. 5) Use non-reflective, dark-coloured surfaces. 6) Use lights with reduced or filtered blue, violet and ultraviolet wavelengths	**CM12 MODU and vessel lighting** MODU and vessel lighting will be limited to the minimum required for navigational and safety requirements, with the exception of emergency events. **CM13 Lighting Management Procedure** Beach will contract appropriately qualified lighting practitioners, together with an appropriately qualified marine biologist or ecologist to develop and support the implementation of a Light Management Procedure as per the National Light Pollution Guidelines for Wildlife (CoA 2023). MODU and vessels will implement a Light Management Procedure as per the National Light Pollution Guidelines (DCCEEW 2023a) for Project activities. The Light Management Procedure will detail additional adaptive mitigations to manage light based on the information in the Seabird Light Mitigation Toolbox and Beach Energy's Vessel Light Management Procedure Guidance (CDN/ID 19012450). Specifically, the Light Management Plan for vessels and rigs is required to cover: • Requirements to minimise non-essential lights and outward facing lights ensuring safety navigational lighting and safe work condition requirements are met.

Demonstration of Acceptability		
	The following conservation advice or management plans identify artificial light as a threat: • National Recovery Plan for Albatrosses and Petrels (CoA, 2022) • Wildlife Conservation Plan for Seabirds (CoA, 2020a) • Wildlife Conservation Plan for Migratory Shorebirds (CoA, 2015a) • National Recovery Plan for the Orange-bellied Parrot (DELWP, 2016) • Recovery Plan for Marine Turtles in Australia, 2017-2027 (CoA, 2017) • Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA, 2008) • South-east Marine Region Profile (CoA, 2015c) South-east Marine Parks Network Management Plan (DNP, 2025)	• Program for managing grounded birds. • Reporting and recording requirements. Prior to commencement of an initial flaring event at each well, the area extending from the tip of the flare will be visually confirmed to be clear of birds [**PC249**]. Adaptive management will be detailed the light management procedure to be included in future EPs under this OPP when scheduling of the activity is known in greater detail.

6.3.6 Environmental Performance

In accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 6-) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 6-15 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 6- are met.

Table 6-16: Environmental Performance Outcomes: Emissions – Light

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 1: No interference with the recovery of EPBC Act listed threatened species.	EPO7:	No death or injury to listed threatened or migratory species from Project activities.
Acceptable level 2: No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline.	EPO8:	Biologically important behaviours can continue while Project Activities are being undertaken.
Acceptable level 3: Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species.	EPO9:	Implement CM13 Lighting Management Procedure as per the National Light Pollution Guidelines (DCCEEW 2023a) to ensure artificial light in biologically important areas will be managed such that biologically important behaviours within or outside a BIA can continue while Project activities are being undertaken.

6.4 **Underwater Sound**

6.4.1 Hazard Identification

Underwater sound emissions will be generated by various stages of the Project. The Project will generate both continuous and impulsive sound emissions, with different metrics used to describe the sound levels in decibels:

- continuous – continuous noise is a continual non-pulsed sound that can be transient (short duration) but without the rapid rise-time (pulse) (Southall et al. 2007), examples are vessel and drilling operations; and
- impulsive – impulsive noise is a series of pulsed sound events that are brief, broadband, atonal and transient, an example is acoustic emissions from geophysical equipment and discharges of air guns during vertical seismic profiling.

Stages and associated activities which will produce either continuous or impulsive sound emissions are defined in Table 6-17 and further described in Section 6.4.2.

Table 6-17: Activities Undertaken During the Project which will Generate Underwater Sound Emissions

Stage	**Activity**
Surveys	Geophysical survey
Drilling and Completions	MODU Positioning Drilling Method
Installation and Commissioning	Installation
Operations	Inspection, maintenance, and repair
Decommissioning	Removal of subsea infrastructure Well plugging and abandonment
Support Operations	MODU Operations Vessel Operations Helicopters ROV Operations

6.4.2 Hazard Description

6.4.2.1 Sound Metric Terminology

Sound travels as a wave with the amplitude of the wave related to the amount of acoustic energy it carries, or how loud the sound will appear to be. Figure 6-5 shows a representative sound wave and the sound measures used in this assessment. Table 6-18 provides definitions of the sound measures and other sound related terms used in this assessment.

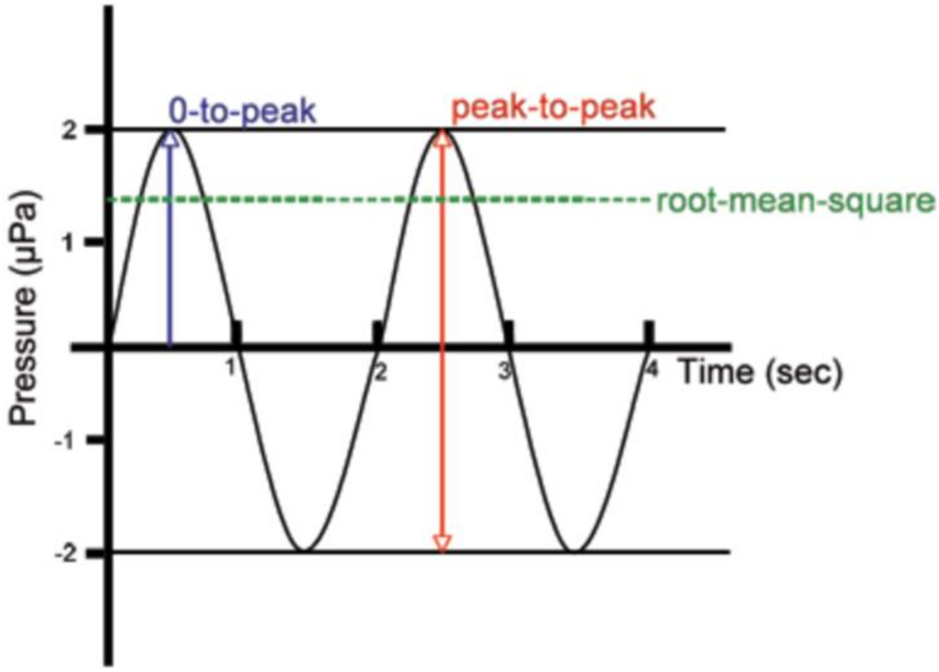


Figure 6-5: Representative Sound Wave and Sound Measures

Table 6-18: Sound Terminology

Term	Definition
0-to-peak or Peak sound pressure level (PK)	The peak pressure, also called the 0-to-peak pressure, is the range in pressure between zero and the greatest pressure of the signal. It is represented by PK and the unit dB re 1 µPa and summarised as dB PK.
Peak-to-peak sound pressure level (PK-PK)	The peak-to-peak pressure is the range in pressure between the most negative pressure and the most positive pressure of the signal. It is represented by PK-PK and the unit dB re 1 µPa or dB re 1 µPa2m2 and summarised as dB PK-PK.
Permanent threshold shift (PTS)	Permanent loss of hearing sensitivity caused by excessive noise exposure.
Received sound levels	The sound level measured at a receiver.
Root mean square sound pressure level (SPL)	The root-mean-square pressure is the square root of the average of the square of the pressure of the sound signal over a given duration. It is represented by sound pressure level (SPL) and the unit dB re 1 µPa and summarised as dB SPL.
Sound exposure level (SEL)	A measure of the sound energy that considers both received level and duration of exposure. SEL is specified in terms of either single pulse (SEL) or a defined accumulation period (SELcum). For this assessment 24hrs has been used for the accumulation period and is shown as SEL24h. Units are dB re 1 µPa2·s or dB re 1 µPa2m2s.
Source sound level	The sound pressure level or sound exposure level measured 1 metre from a theoretical point source that radiates the same total sound power as the actual source.
Temporary threshold shift (TTS)	Temporary loss of hearing sensitivity caused by excessive noise exposure.

6.4.2.2 Impulsive Sound

1. Surveys

Geophysical equipment will introduce impulsive sound into the marine environment. The geophysical surveys will typically use techniques such as MBES, SSS, SBP, USBL, and SVP, which produce acoustics, generating short, pulsed underwater sound. Depending on the area surveyed, geotechnical surveys may take up to 10 to 20 days to complete.

Table 6-19 summarises the expected sound levels and frequency ranges anticipated for the different techniques used in the geophysical surveys.

Table 6-19: Survey Equipment Source Levels, Frequency Ranges, and Relevant Literature Sources

Sound source	Frequency range	Source Levels	Literature
SBES: Single-beam echo sounder	120-710 kHz	SPL: 200-235 dB re 1µPa@ 1 m	Seiche 2020
MBES: Multi-beam echo sounder	200-500 kHz	SPL: 210-247 dB re 1µPa@ 1 m	Seiche 2020
SSS: Side-scan Sonar	70-400 kHz	SPL: 200-234 dB re 1 µPa @ 1 m	Seiche 2020
SBP: Sub-bottom profiler (with CHIRP)	2-16 kHz	SEL: 171.4 dB re 1 µPa2·s @ 1 m SPL: 191.7 dB re 1 µPa @ 1 m PK: 197.6 dB re 1 µPa @ 1 m PK-PK: 204.7 dB re 1 µPa @ 1 m	Martin et al., 2012
SBP: Sub-bottom profiler (with boomers)	200 Hz -16 kHz	SEL: 180 dB re 1 1µPa2·s @ 1 m SPL: 200.5 dB re 1 µPa @ 1 m PK: 210.8 dB re 1 µPa @ 1 m PK-PK: 227.7 dB re 1 µPa @ 1 m	Martin et al., 2012

2. Drilling and Completions

   a. MODU Positioning

The MODU will either mobilise to the Project Area with its own propulsion system or be towed by vessels and anchored or connected to pre-laid anchors prior to commencing activities. MODU positioning will require a maximum of 2 x support vessels on DP to tow and position the MODU into place within the Project Area. The continuous sound emissions produced by the support vessels and MODU are described in Section 6.4.2.3.

Transponders may be required to inform the anchor positioning. Transponders emit short ‘chirps’ sound transmissions with a duration that ranges from 3 to 40 milliseconds. Transponders will not emit any sound when on standby and may emit acoustic signals for about six hours per well if used. When required for general positioning, they will emit one chirp every five seconds (estimated to be required for four hours at a time). When required for precise positioning, they will emit one chirp every second (estimated to be required for two hours at a time).

The source levels of typical transponders are provided in Table 6-20.

Table 6-20: Transponder Source Levels, Frequency Range and Relevant Literature Source

Sound source	Frequency range	Source Levels	Literature
Transponders	21-31 kHz	SPL: 180-106 dB re 1µPa	Jiménez-Arranz et al. 2017

b. Vertical Seismic Profiling

VSP is a standard well logging technique that is routinely used to collect geophysical measurements within well bores. VSP is not expected to be used in relation to the OGV drilling campaign but may be used on future wells. VSP typically involves the use of a seismic energy source (e.g. a single air gun or a small air gun array) suspended in the water column and a receiver (e.g. hydrophone or geophone) suspended within the well bore. The seismic source may be suspended directly below the drilling MODU or may be offset (e.g. suspended behind a vessel). Vertical seismic profiling typically generates noise emissions between 8 hours and 24 hours per well.

Table 6-21 outlines the typical source levels for VSP (450 in^3 array at a centroid depth of 6 m).

Table 6-21: Vertical Seismic Profiling Source Level, Frequency Range, and Relevant Literature Source

Sound source	Frequency range	Source Levels	Literature
VSP: Vertical Seismic Profiling	10-25000 Hz	SEL: 170-220 dB re 1 µPa2·s @ 1 m PK: 237.8 dB re 1 µPa @ 1 m	McPherson and Wood 2017

6.4.2.3 Continuous Sound

1. Drilling and Completions

a. MODU Positioning

MODU positioning will require a maximum of 2 x support vessels on DP to tow and position the MODU into place within the Project Area. This process will take 9 to13 days to complete depending on constraints and weather restrictions. Table 6-23 outlines the expected source levels for support vessels for the Project.

b. Drilling Method

Drilling operations will introduce short-term, low-intensity continuous sound into the marine environment. Underwater sound levels produced from jack-up and semi-submersible MODUs during routine drilling operations (i.e. excluding vertical seismic profiling) are typically considerably lower than the sound emissions produced from the support vessels. Drilling is expected to take approximately 30 to 40 days per well.

As part of Beach's Drilling Campaign in 2021/2022, in the Otway Basin, JASCO undertook underwater sound monitoring to determine the source levels of the Ocean Onyx semi-submersible drill MODU over different drilling depths (McPherson et al. 2021). These sound levels have been considered representative of the drilling activities associated with the Project, as discussed in Section 6.4.2.3, and have been used for the assessment. The source levels are provided in

Table 6-22.

2. Decommissioning

Sound emissions may be generated by the removal of subsea infrastructure and well P&A methods such as mechanical cutting and wellhead cutting. The sound generated from these decommissioning activities are anticipated to be comparable. Decommissioning of subsea infrastructure is expected to take approximately 30 days per tie-back, and P&A of wells expected to take 30 days.

Pangerc et al. (2016) described the underwater sound measurement data during an underwater diamond wire cutting of a 32″ conductor (10 m above seabed in ~80 m depth) and found that at lower frequencies, the operation was generally indistinguishable above the background noise of the vessel. This is confirmed via acoustic modelling undertaken by JASCO (Koessler and McPherson 2021) who modelled a stationary vessel at Thylacine North 1 on DP (operating at 20% MCR) plus a stationary vessel on DP (operating at 20% MCR) using a ROV cutting tool at Geographe 4. This showed an increase of ~30 m for the behaviour exposure criteria compared to an installation vessel on DP and ~6 m for the TTS 24 h exposure criteria.

As the wellhead cutting will not be distinguishable from the drilling underwater sound emissions, it is considered inherently part of the assessment of drilling sound emissions and has not been discussed further.

3. Support Operations

Underwater sound emissions will be generated from the MODU, support vessels, helicopters and ROV operations. Support operations are associated with all stages of the Project and will introduce localised and short-term continuous sound into the marine environment.

a. MODU Operations

The MODU will generate sound from onboard equipment vibrations (e.g. pumps, generators, and machinery), and a smaller portion transmitted directly via the drill bit during drilling.

As part of Beach's Drilling Campaign in 2021/2022, in the Otway Basin, JASCO undertook underwater sound monitoring to determine the source levels of the Ocean Onyx semi-submersible drill rig and support vessels, and further validate their propagation models (McPherson et al. 2021). The mean monopole source levels for the MODU and support vessels measured in-field during Beach's Drilling Campaign in 2021/2022 (McPherson et al. 2021) were used to inform the MODU and vessel source levels in the JASCO underwater acoustic modelling studies used for this impact assessment (Koessler and McPherson 2021; Connell and Koessler 2023).

Table 6-22 describes the expected source levels for the MODU whilst anchored and whilst drilling and Table 6-23 outlines the expected source levels for support vessels in transit and under DP for the Project.

The MODU will have a thruster assisted capability to assist in reducing fatigue on the mooring system and to assist the MODU during transit. This system generates variable non-impulsive sound during infrequent operation up to six thrusters in response to feedback from the mooring system. A review of 33 months of historical operational data from the North Sea indicates thrusters are typically not active (>96% of the time) and utilisation is otherwise limited low loads across a small number of thrusters for short periods, (typically hours) in response to metocean conditions. Therefore, the MODU under DP has not been considered further.

Table 6-22: Drilling Source Levels, Frequency Ranges, and Relevant Literature Source

Sound source	Frequency range	Source Levels	Literature
MODU anchored		178.7 dB re 1µPa	McPherson et al. 2021
MODU while anchored and drilling	0.01-30 kHz	SPL: 162-180 dB re 1µPa	McPherson et al. 2021

b. Vessel Operations

The type and number of vessels in the Project Area at any one time, and the duration of presence, will differ depending on the project stage. For a single activity, there will be no more than three vessels operating simultaneously. The longest duration for a single activity requiring support vessel operations is 40 days to drill a single well utilising a MODU and two support vessels. For concurrent activities, five vessels could operate in the Project Area at any one time, for example, pipelay or diving/tie-in activities may occur concurrently during MODU positioning. Concurrent operations will be kept to a minimum and are unlikely to occur for more than 13 days.

Vessels generate sound emissions mainly by propeller and thruster cavitation, with a smaller fraction of noise produced by sound transmitted through the hull, such as by engines, gearing, and other mechanical systems. Acoustic emissions from thrusters when the vessel is keeping station under dynamic positioning have the greatest potential for impact due to relatively loud source levels.

Acoustic broadband source levels typically increase with increasing vessel size, with smaller vessels (<50 m) having source levels 160-175 dB (re 1µPa), medium size vessel (50-100 m) 165-180 dB (re 1µPa) and large vessels (>100 m) 180-190 dB (re 1µPa) (OSPAR 2009, Richardson, et al. 1995).

Table 6-23 outlines the expected source levels for support vessels in transit and under DP for the Project.

Table 6-23: Support Vessel Sound Sources, Frequency Ranges and Relevant Literature Sources

Sound source	Frequency range	Source Levels	Literature
OSV: Offshore Supply Vessels – slow transit	0.01-30 kHz	SEL: 173.1 dB re 1 µPa2m2s SPL: 183 dB re 1 µPa	Connell et al. 2023 McPherson et al. 2021
OSV: Offshore Supply Vessel - under DP	0.01-30 kHz	SEL: 194.1 dB re 1 µPa2m2s SPL: 186.6-193.9 dB re 1 µPa	Connell et al. 2023 McPherson et al. 2021

c. Helicopters

Helicopters will enter the project area for short periods of time to undertake crew change or other personnel transfer activities. On approach to the drill rig the helicopter will descend to the helideck where there is greatest potential to ensonify the water column. The level of underwater sound from helicopters is affected by helicopter altitude, aspect and strength of noise emitted, and the receiver depth, water depth and other variables (Richardson et al. 1995). Sound pressure will be greatest at the sea surface and rapidly diminish with increasing depth.

Helicopter engine sound is emitted at a range of frequencies generally below 500Hz (Richardson et al. 1995). Richardson et al. (1995) reported helicopter sound (for a Bell 214 helicopter) as being audible in air for 4 minutes before it passed over underwater hydrophones, but detectable underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m depth. The maximum received level was 109 dB re 1µPa2.s. Due to their short duration and near surface impacts only, helicopter noise emissions are not considered to be a credible source of noise impact and will not be evaluated further.

6.4.2.4 Underwater Sound Modelling

1. Impulsive Sound

Beach commissioned JASCO Applied Sciences (JASCO) to undertake acoustic modelling to assist in understanding the potential acoustic impact of geophysical survey equipment and VSP on key regional receptors in the Project Area.

Based on a review of the geophysical equipment used for the seabed survey it was identified that the boomer and SBP were most relevant to the assessment of potential impacts to receptors, due to their operating frequencies and source sound levels. The modelling approach accounted for the acoustic emission characteristics of a representative boomer (AP3000) and SBP (Edgetech X-star system).

The modelling study was undertaken at six locations within the Project Area including the Artisan, Geographe and Thylacine fields at water depths ranging from ~71 m to 130 m (McPherson and Wood 2017 Appendix I). Further modelling was undertaken at four of the sites to obtain maximum ranges to updated impact thresholds for cetaceans and pinnipeds (Wood and McPherson 2019, Appendix J). The locations and water depths are considered representative of the Project Area.

The sound levels at shelf edge locations for geophysical sources can be reasonably inferred from the additional modelling study of drilling and vessel noise that was undertaken at the shelf edge within 156 m water depth to enable adequate representation of deeper shelf edge locations (deep shelf geomorphic zone) between 130 m and 180m water depth (Ryan and Koessler 2023, Appendix G). The results for drilling sources at the shelf edge location indicates that the distances to noise thresholds are up to a maximum of 150% greater than the distances to thresholds for locations on the shelf. Therefore, this has been applied to the geophysical sources to conservatively represent shelf edge locations.

2. Continuous Sound

JASCO Applied Sciences (JASCO) undertook an acoustic modelling study of underwater sound levels associated with drilling, installation, IMR and vessel transit activities at two locations within the Project Area, Artisan and Thylacine fields, at water depths ranging from 71m to 102m (Koessler and McPherson 2021 Appendix F). This modelling was a revision of previous modelling conducted by McPherson et al. (2021) (Appendix H). Table 6-24 details the activities and locations within Project Area applicable to each of the studies and scenarios modelled.

The modelling for drilling was based on the Ocean Onyx semi-submersible MODU drilling in the Otway Basin which is representative of the drilling associated with the Project. The modelled scenario for drilling was resupply with an OSV on DP during MODU drilling operations as this is expected to be the highest noise level produced during drilling.

The modelling for a large pipelay/construction vessel undertaking installation as well as IMR activities was based on the Skandi Singapore and would be a representative sized vessel to undertake these activities. The approach used to estimate sound levels under dynamic positioning (DP) is based upon vessels under transit and is an approximation based on the Maximum Continuous Rating (MCR). The scenario selected to represent installation and IMR activities was the combined sound levels of two pipelay vessels on DP approximately 10 km distant from each other within the Project area. One vessel located at Thylacine North 1 laying pipe and another vessel at Geographe 1 operating a subsea cutting tool. This is considered to be representative of any simultaneous operations associated with Project installation or IMR activities.

The Thylacine Field location in 102m water depth was selected to estimate sound levels that would be representative of potential activity locations within the Project Area that are on the shelf given that this depth encompasses the middle shelf geomorphic zone of the Otway region between 70 and 130m (refer Section 4.3.3) and resulted in higher sound levels and when compared to the results from Artisan Field.

An additional modelling study (Ryan and Koessler 2023, Appendix G) was undertaken for both drilling and vessel activities at the most southerly identified potential well location at 156 m water depth to enable adequate representation of deeper shelf edge (deep shelf geomorphic zone) locations at between 130 m and 180 m water depth (refer Section 4.3.3).

From this additional study, the Installation and IMR sound levels at shelf edge locations can be reasonably inferred. The results for drilling and vessel sources at the shelf edge location indicates that the distances to noise thresholds can be up to a maximum150% greater than the distances to thresholds for locations on the shelf.

Based on this the results for Installation & IMR at the shelf location of Thylacine have been conservatively increased by 150% to represent shelf edge locations. Where modelling at shelf locations did not predict the noise effect criteria being reached, it is considered unlikely that the criteria would be reached for shelf edge locations. If this did occur, it would be at small distances that are encompassed by the larger defined sound EMBAs for continuous sound sources of the Project.

Table 6-24: Modelling Study Scenarios Selected for the Impact Assessment of Continuous Sources

Activity	**Location**	**Relevant Modelling Scenario**	**Relevant Modelling Report**
Drilling + Resupply	Thylacine North 1	Scenario A5: MODU Drilling + 4hr OSV Resupply for shelf locations (70-130m)	Beach Otway Project: Additional and Revised Modelling Study (Koessler and McPherson, 2021)
Drilling + Resupply – shelf edge	Well Location South	Scenario 3: MODU Drilling + 4hr OSV Resupply Ops for shelf edge locations (130-180m)	Beach Otway Project: Additional Modelling at Well Location South (Connell and Koessler, 2023)
Installation and IMR	Thylacine North 1 + Geographe 4	Scenario 15: Vessel stationary, operating on DP (Thylacine North 1) + Vessel stationary, operating on DP + ROV cutting tool (Geographe 4) (June) - shelf locations (70-130m)	Beach Otway Project: Additional and Revised Modelling Study (Koessler and McPherson, 2021)

Activity	Location	Relevant Modelling Scenario	Relevant Modelling Report
Installation and IMR – shelf edge	Well Location South	N/A: Vessel stationary, operating on DP (Thylacine North 1) + Vessel stationary, operating on DP + ROV cutting tool (Geographe 4) (June) – shelf edge locations (130-180m).	Inferred from the highest increase in distances to noise effect criteria from shelf to shelf edge locations (150%)
Vessel standby/ transit	Thylacine North 1	Scenario A3: OSV vessel on standby for 24 hrs – shelf locations (70-130m)	Beach Otway Project: Additional and Revised Modelling Study (Koessler and McPherson, 2021)
Vessel standby/ transit – shelf edge	Well Location South	Scenario 3: OSV vessel on standby for 24 hrs – shelf edge locations (130-180m)	Beach Otway Project: Additional Modelling at Well Location South (Connell and Koessler, 2023)

3. Justification

The three major environmental parameters in acoustic modelling are: (1) a bathymetric grid of the modelled area, (2) underwater sound speed as a function of depth, and (3) a geoacoustic profile based on the overall stratified composition of the seafloor.

As the modelling studies mentioned above were conducted within the Otway Basin (the Project Area), in the noise impact assessment, the following basis were used, corresponding to the three major environmental properties:

(1) The bathymetry varied little in the intermediate vicinity of the modelling site, with the majority shallower than 200 m.

(2) The sound speed profile used in these studies were derived from temperature and salinity profiles from the US GDEM model from the literature (Teague et al., 1990, Carnes 2009). A September Yearly average was selected for the impulsive acoustic modelling studies and June sound speed profile for the continuous modelling studies, which were conservatively selected as part of the approach. Therefore, the previous and current modelling studies conducted for various locations in the Otway Basin used the same sound speed profiles which are considered appropriate to represent the current condition/area for similar operational activities.

(3) The approach used to model the propagation loss in the previous studies was already corrected/updated based on the results of a measurement study conducted (McPherson et al. 2021). Therefore, it is considered an appropriate representation of Beach activities on the continental shelf of the Otway Basin.

As a continuation for Point (3) above, for the shelf edge with water depths 130-180 m, Beach had conducted additional acoustic modelling in the southern and western portions of the Project Area, for the scenario 'Drilling + Resupply' and 'Vessel standby', at 156 m water depth, to be representative of deeper shelf edge locations between 130 m and 180 m water depth. The shelf edge acoustic modelling during Installation and IMR was then inferred from the new study ('Drilling + Resupply - shelf edge') (Connell and Koessler, 2023).

Overall, the impact evaluation was conducted on the basis that the broadband level predictions/propagation loss as a very similar type of seabed environment is expected within the continental shelf portion of the Otway Basin (Project Area) because it is supported by measurements of very similar operational activities (McPherson et al. 2021).

The acoustic modelling studies have considered water depths covering continental shelf and shelf edge locations, and with an appropriate geoacoustic profile representative of the Project Area, and conservatively selected sound speed profiles and mean drilling sound levels. Beach also commits to undertaking further seabed assessments of the deep shelf and upper slope zones (~130 m to 180 m water depth, as well as 130 m to 200 m water depth) (Page 372). These assessments will then enable more accurate acoustic modelling to be conducted/updated (from the measurement study in 2021).

6.4.3 Impact Analysis and Evaluation

Underwater sound emissions from the Project can result in direct impacts to:

- Marine fauna, resulting in:
    - Change in behaviour, including:
    - Disturbance leading to behavioural changes or displacement of fauna. Masking or interfering with other biologically important sounds (including vocal communication, echolocation, signals and sounds produced by predators or prey).
    - Injury/mortality to fauna, including:
        - Recoverable injury
        - Mortality of potential mortal injuries - immediate or delayed death either due to injury or substantially reduced fitness.
        - Temporary threshold shift (TTS) – temporary reduction in the ability to perceive sound.
        - Permanent threshold shift (PTS) – permanent reduction in the ability to perceive sound.

6.4.3.1 Impulsive Sound

Receptors that may be impacted by impulsive sound include:

- Plankton
- Marine Invertebrates
- Fish
- Marine Mammals
- Marine reptiles
- Socio-economic receptors (i.e., commercial fisheries)
- Cultural values and sensitivities

Acoustic modelling was used to assess potential impacts to receptors from underwater acoustic emissions associated with the geophysical survey and VSP activities as identified in Section 6.4.2.2. The modelled received sound levels were compared to defined noise effect criteria detailed in Table 6-25, as determined by scientific research and academic papers. In lieu of any noise criteria specific to geophysical surveys, criteria that is applied to seismic surveys have been used.

1. Plankton

There is no data or studies that indicate geophysical survey and VSP equipment acoustic emissions impact plankton. In lieu of any data the noise effect criteria from the American National Standards Institute (ANSI) accredited report of sound exposure guidelines for fishes and sea turtles (Popper et al. 2014) is used.

Table 6-25 details the noise effect criteria from Popper et al. (2014) and the distances at which modelling estimated they could be reached for plankton. In summary:

- The noise effect criteria for injury to plankton for the boomer is predicted at a maximum distance of 4 m and 0.8 m for the SBP for the peak sound pressure level (PK) while the noise effect criteria based on the sound exposure level (SEL) is not reached.
- Neither noise effect criteria were reached for the VSP.

Based on these distances the mortality or mortal injury impacts to plankton (including fish eggs and larvae) will be well below natural mortality rates, which are very high, as report by Tang et al. (2014) of daily mortality rates of 11.6% (average minimum) to 59.8% (average maximum). In a review of mortality estimates (Houde and Zastrow 1993) the mean mortality rate for marine fish larvae was equivalent to a loss of 21.3% per day. In the experiment undertaken by McCauley et al. (2017) zooplankton mortality rate background levels were 19%.

Richardson et al (2017) notes that for seismic surveys, which would also apply to geophysical surveys and VSP operations, zooplankton communities can begin to recover in number during a survey, such that a continuous decline in zooplankton throughout the survey is unlikely and parts of the survey area would be replenished with zooplankton as the survey progresses. Impacts to phytoplankton, the food source for zooplankton, are not predicted and such they are still available for zooplankton to graze on.

Predicted impacts to plankton do not remove them from the food web and as such the nutrients and energy they contain are retained within the ecosystem. Even after plankton die, their carcasses remain in the water column for several days where they are scavenged before any remaining carcasses sink to the seafloor to be consumed by opportunistic benthic organisms (Kirillin et al. 2012, Tang et al. 2014, Dubovskaya et al. 2015). Thus, impacts to primary production and ecosystem function are not predicted.

The area of predicted impact overlaps the pygmy blue whale high density, known and possible foraging BIAs. Foraging is associated with the timing of the Bonney Coast Upwelling and the presence of the krill. Mortality or mortal injury effects to krill does not impact on pygmy blue whales being able to feed on them as the krill will still be available within the water column. If zooplankton are impacted, they may remain in the water column for several days and are likely scavenged or otherwise sink to the seafloor to be consumed by benthic organisms (Krillin et. al. 2012, Tang et al. 2014, Dubovskaya et al. 2015) [**PC232**]. In addition, any impacts to krill are likely to be within natural mortalities rates thus not effecting the availability of krill available for foraging.

Impacts to the Bonney Coast Upwelling and its role it plays in ecosystem function and productivity is not predicted as:

- Impacts to phytoplankton are not predicted,
- Mortality or mortal injury effects to zooplankton are within natural mortality rates and zooplankton communities can begin to recover during the geophysical survey such that a continuous decline in zooplankton throughout the duration of the survey is not anticipated and parts of the survey area would be replenished as the survey progressed, and
- Mortality or mortal injury effects to zooplankton, including krill, does not impact on marine fauna being able to feed on them as they will still be available within the water column.

2. Marine Invertebrates

There has been a number of comprehensive reviews of seismic noise impacts to invertebrates such as Carroll et al. (2017) and Edmonds et al. (2016). Available literature suggests particle motion, rather than sound pressure, is a more important factor for crustacean and bivalve hearing. There are currently no defined noise effect criteria for invertebrates and hence the results from the Day et al. (2016) study on acoustic impacts from seismic exposure on southern rock lobsters (*Jasus edwardsii*) are typically used. The study found that sub-lethal effects, relating to impairment of reflexes, damage to the statocysts and reduction in numbers of haemocytes (possibly indicative of decreased immune response function), were observed after exposure to measured received sound levels of:

- Single-pulse SEL: 186–190 dB re 1 µPa2.s
- Accumulated SEL: 192–199 dB re 1 µPa2.s
- Peak-peak pressure: 209–212 dB re 1 µPa

Payne et al (2007) found no effects to the American lobster (Homarus americanus) in righting time or haemolymph biochemistry but a possible reduction in calcium after exposure to received noise levels of 202 dB re 1 µPa (PK-PK). Thus, the Payne et al (2007) level is applied as a no effect criteria. This assessment also used the no effect level proposed by McCauley and Duncan (2016) for rock lobsters of accumulated SEL 183 dB re 1 µPa2.s.

Table 6-25 details that the sound levels from the representative boomer and SBP do not reach any of the effect or no effect criteria for invertebrates at the seafloor. The VSP sound levels reached the no effect criteria within 470m of the source.

The VSP source is short term, being in the order of up to 24 hours duration per well. The drilling is not being undertaken in any relevant commercial fishery areas or sensitive habitats for invertebrates or benthic communities.

McCauley et al. (2000) assessed the effects of air gun noise on caged squid (*Sepioteuthis australis*). No sub-lethal injury or mortality as a result of exposures in this study was observed. Several squid showed alarm responses to the start-up of an airgun by firing their ink sacs and/or jetting away from the source, but this was not observed for similar or greater levels if the signal was ramped up. General habituation was observed with a decrease in alarm responses with subsequent exposures. During the trial the squid showed avoidance to the airgun by keeping close to the water surface at the end of the cage furthest from the airgun (within the sound shadow). McCauley suggests a threshold of 166 SPL would give an indication of the extent of disruption of a seismic survey by significant alteration in swimming patterns.

Table 6-25 details that the noise effect criteria at which a behavioural alteration of swimming patterns may occur is predicted within 3.9 km of the VSP, 90m of the boomer and not reached for the SBP.

This potential squid behavioural impact extent of 3.9 km for the VSP is short term, being in the order of up to 24 hours duration per well. The drilling is not being undertaken in any relevant commercial fishery areas or sensitive habitats for invertebrates or benthic communities.

Based on this, no mortality or injury effects to invertebrates including commercial squid, rock lobster and giant crab species are predicted with potential impacts limited to short term and localised behavioural affects with a Minor (1) consequence ranking assigned.

3. Fish

Noise effect criteria for fish are based on the presence of a swim bladder. Typically, site-attached, and demersal fish have a swim bladder, whereas pelagic fish do not. As noise effect criteria for sharks does not currently exist, they are assessed as fish without swim bladders. Noise effect criteria used in this assessment for fish are from the American National Standards Institute (ANSI) accredited report of sound exposure guidelines for fishes and sea turtles (Popper et al. 2014). These guidelines defined quantitative effect criteria for three types of immediate effects:

- Mortality, including injury leading to death
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma
- TTS

Table 6-25 details the noise effect criteria from Popper et al. (2014) and the distances at which modelling estimated they could be reached for fish with and without a swim bladder. In summary:

- The noise effect criteria for mortality/potential mortal injury from the boomer is predicted for fish with a swim bladder at a maximum distance of 4m and for fish without a swim bladder at 1.5m
- The noise effect criteria for recoverable injury is predicted for fish with a swim bladder and without a swim bladder at a maximum distance of 1.5m from the boomer
- The noise effect criteria for TTS for fish with and without a swim bladder was not reached
- No noise effect criteria for fish with or without a swim bladder was predicted to be reached from the VSP

Studies to date have not shown mortality in relation to potential impact to fish from impulsive noise, though prolonged or extreme exposure to high-intensity, low-frequency sound, may lead to physical damage such as threshold shifts in hearing or barotraumatic ruptures (Carroll et al. 2017). Based on the modelling and the fact that the geophysical surveys and VSP will not result in prolonged or extreme exposure to fish it is unlikely that injury impacts to fish would occur with a Minor (1) consequence ranking assigned.

Eels that have important cultural value to First Nations may also migrate through the Project or Planning Areas (Section 4.4.9.3). Eels that may migrate through the Otway shelf to deeper waters are not predicted to be impacted as a study by Koster et al. 2021 which tracked 16 short-finned eels found that the average speed was 30.8 ± 7.3 km/day while eels were on the continental shelf and 29.7 ± 11.1 km/day while in deep water. Thus, migrating eels are unlikely to be impacted based on the small distances to the sound exposure criteria (4 m) and the distance eels travel while migrating.

4. Marine Turtles

Noise effect criteria used in this assessment for injury to turtles are from the ANSI accredited report of sound exposure guidelines for fishes and sea turtles (Popper et al. 2014). Table 6-25 details the noise effect criteria from Popper et al. 2014 and the distances at which modelling estimated they could be reached. In summary:

- The noise effect criteria for injury to turtles was reached within only 4 m for the boomer and 0.8 m for the SBP for the peak sound pressure level (PK) and the noise effect criteria based on the sound exposure level (SEL) is not reached.
- There were no potential injury effects from the VSP.

Based on limited data regarding noise levels that illicit a behavioural response in turtles, the United States National Marine Fisheries Service criterion of 166 dB re 1 µPa (SPL) is typically applied (NFS 2011) and is detailed in the Recovery Plan for Marine Turtles in Australia (CoA 2017b).

This behavioural noise effect criteria is predicted at a maximum distance of 3.9 km from the VSP, 90m from the boomer but was not reached for the SBP.

Three marine turtle species are ‘known’ or ‘likely’ to occur within the Project Area based on the PMST search, however no BIAs or habitat critical to the survival of the species are present. The PMST presence for the Loggerhead Turtle is classified as ‘breeding likely to occur’. The presence of turtles in the Project Area and surrounds is considered unlikely, based on the following information provided in Section 4.4.9.5 [**PC229**]:

- Green Turtles are predominantly found in Australian waters off the Northern Territory, Queensland, and Western Australian coastlines, with limited numbers in New South Wales, Victoria, and South Australia. There are no known nesting or foraging grounds for Green Turtles offshore Victoria; they occur only rarely in these waters (DoE 2023m) (Section 4.4.9.5).
- This species (Leatherback Turtle) is an occasional visitor to the Otway shelf and has been sighted on a number of occasions during aerial surveys undertaken by the Blue Whale Study Group, particularly to the south-west of Cape Otway (Section 4.4.9.5).
- Loggerhead Turtles forage in all coastal states and the Northern Territory, but are uncommon in South Australia, Victoria, and Tasmania (CoA 2017a). Due to water depths, it is unlikely Loggerhead Turtle would be present in the Project Area but may be occasional visitors to the Planning Area (Section 4.4.9.5).’

Impacts to turtles are likely to be restricted to short term and highly localised behavioural avoidance from the VSP source. VSP is short term, being in the order of up to 24 hours duration per well, and this extent is within that of the potential for seabed disturbance around the MODU due to anchor footprint (2 km). Behavioural impacts to turtles would be temporary and unlikely to have a significant impact on individuals or at a population level with a Minor (1) consequence ranking assigned.

5. Marine Mammals

Noise effect criteria used in this assessment for impacts to marine mammals from impulsive noise activities are based on the following:

- The National Oceanic and Atmospheric Administration (NOAA 2019) acoustic threshold for behavioural effects in marine mammals of 160 dB re 1 µPa (SPL). Whilst the newly published Southall et al. (2021) provides recommendations and discusses the nuances of assessing behavioural response, the authors do not recommend new numerical thresholds for onset of behavioural responses for marine mammals.
- Southall et al. (2019) for the onset of PTS and TTS. These criteria are based on dual acoustic criteria for impulsive sounds that included peak pressure level thresholds and SEL_{24h} thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL.
- Secondary effects in marine mammals, such as masking, are poorly understood. Threshold levels cannot yet be applied in the same way as they can for direct sound effects, therefore a qualitative approach must be taken (Erbe et al. 2016). For the purpose of this evaluation, behavioural effect thresholds (as per NOAA 2019) are adopted as a conservative threshold for secondary effects i.e. masking (Hawkins and Popper 2017).

Table 6-25 details the noise effect criteria and the distances at which modelling estimated they could be reached.

a. Low Frequency Cetaceans

Several low frequency cetaceans may occur within the Project Area. Foraging behaviours were identified for the blue, fin, pygmy right and sei whales; no other important behaviours were identified. The following impulsive noise source EMBAs intersect the foraging BIAs for the pygmy blue whale (Figure 6-6) and the migration BIA for the southern right whale (Figure 6-7):

- Geophysical Sound Behaviour (360 m)
- VSP Sound Behaviour (2.6 km)
- VSP Sound Behaviour – shelf edge (6.5 km)

The reproduction BIA for the southern right whale does not overlap the Project area.

These EMBAs are based on the greatest distances from the activity where noise effect criteria are reached for impulsive noise sources, being for marine mammal behaviour (Table 6-25).

For low-frequency cetaceans the results showed the following:

- For low-frequency cetaceans the noise effect criteria for PTS is not reached and for TTS is only reached at 25 m for the 24-hour cumulative SEL.
- The acoustic threshold for behavioural effects is predicted at a maximum of 2 m from the SBP, 360 m from the boomer, 2.56 km for VSP operations and 6.5 km for VSP operations in shelf edge locations.

It is not feasible that a low-frequency cetacean, even if foraging, resting, or migrating would be within 25 m of a moving geophysical survey vessel for 24 hours.

Predicted impacts would, therefore, be limited to short term and localised behavioural responses such as avoidance of the area while the geophysical survey (360 m) or VSP (2.56 km on shelf and 6.5 km on shelf edge) is undertaken.

The consequence is assessed as Minor (1) for fin, pygmy right and sei whales as there are no biologically important behaviours or BIAs identified within the predicted ensonified area.

The fin and sei whale's conservation advice (TSSC 2015d, TSSC 2015e) has a consequence rating for anthropogenic noise and acoustic disturbance as minor with the extent over which the threat may operate as moderate-large. The pygmy right whale Species Profile and Threats Database (DotEE 2020a) in lieu of no conservation advice, does not identify anthropogenic noise and acoustic disturbance as a threat.

The consequence is assessed as Moderate (2) for southern right and pygmy blue whales as the activity area overlaps BIAs for these species.

Further detailed impact evaluation on Blue whales and Southern right whales, including the interaction with Conservation Management Plans relevant to both the impulsive and continuous noise sources of the Project, is addressed in Section 6.4.3.2.

b. High Frequency Cetaceans

High frequency cetaceans such as dolphins, sperm whales and beaked whales may occur in the Project Area, but no BIAs or biologically important behaviours were identified.

- The noise effect criteria for TTS and PTS for these species was not reached.
- The extent of the area of where high frequency cetaceans may be impacted behaviourally by noise is predicted to be 360 m for surveys and 2.56 km for VSP operations in shelf locations and 6.5 km on shelf edge locations.

Impacts to high-frequency cetaceans are likely to be limited to avoidance behavioural where they may move away from the vessel as it is undertaking the geophysical survey or MODU while undertaking VSP.

The area of impact is not within a BIA or habitat critical to the survival of a high frequency cetacean species and thus impacts are unlikely to have a significant impact on individuals or at a population level.

Based on this, the consequence ranking of potential impacts of impulsive noise to high frequency cetaceans is considered Minor (1).

c. Very High Frequency Cetaceans

Very high frequency cetaceans, such as pygmy and dwarf sperm whales, may occur in the Project Area but no BIAs or biologically important behaviours were identified.

- The maximum distance for the PTS noise effect criteria is 4.5 m and 22 m for TTS.
- The extent of the area of where very high frequency cetaceans may be impacted behaviourally by noise is predicted to be 360m for surveys and 2.56 km for VSP operations in shelf locations and 6.5 km for shelf edge locations.

Impacts to very high frequency cetaceans are likely to be limited to avoidance behavioural where they may move away from the vessel as it is undertaking the geophysical survey or VSP operations.

The area of impact is not within a BIA or habitat critical to the survival of a very high frequency cetacean species and thus impacts are unlikely to have a significant impact on individuals or at a population level.

Based on this, the consequence ranking of potential impacts of impulsive noise to very high frequency cetaceans is considered Minor (1).

d. Pinnipeds

The Australian and New Zealand fur-seals may occur in the Project Area but no BIAs or haul out areas were identified.

- The noise effect criteria for TTS and PTS for these species was not reached
- The extent of the area of where pinnipeds may be impacted behaviourally by noise is predicted to be 360m for surveys and 2.56 km for VSP operations in shelf locations and 6.5 km for shelf edge locations.

Impacts are likely to be limited to avoidance behavioural where they may move away from the vessel as it is undertaking the geophysical survey or VSP operations.

The area of impact is not within a BIA or habitat critical to the survival of pinniped species and thus impacts are unlikely to have a significant impact on individuals or at a population level.

Based on this, the consequence ranking of potential impacts of impulsive noise to pinnipeds is considered Minor (1).

6. Socio-economic Values

Where the functions, interests or activities of other marine users involve marine fauna, any effect to fauna presence or abundance may indirectly impact these users. The potential impact may occur for the duration of the sound emission; however, following cessation of the activity, long term changes in fauna abundance or distribution are not expected. Given the location of the Project Area and short-term nature of the more significant sound generating activities, changes to the functions, interests or activities of other users, such as commercial fisheries, from acoustic emissions are not expected.

7. Cultural Values and Sensitivities

The following First Nations values and sensitivities from Section 4.6.3 have been identified as potentially affected by sound and the potential impacts have been assessed within this section:

- Eels
- Fish
- Dolphins
- Blue whales
- Southern right whales
- Seals

The marine fauna listed above are connected to places associated with songlines or connected to individuals through ceremony (Section 4.6.3.5). The connection of marine fauna to places or individuals are considered cultural intangible values.

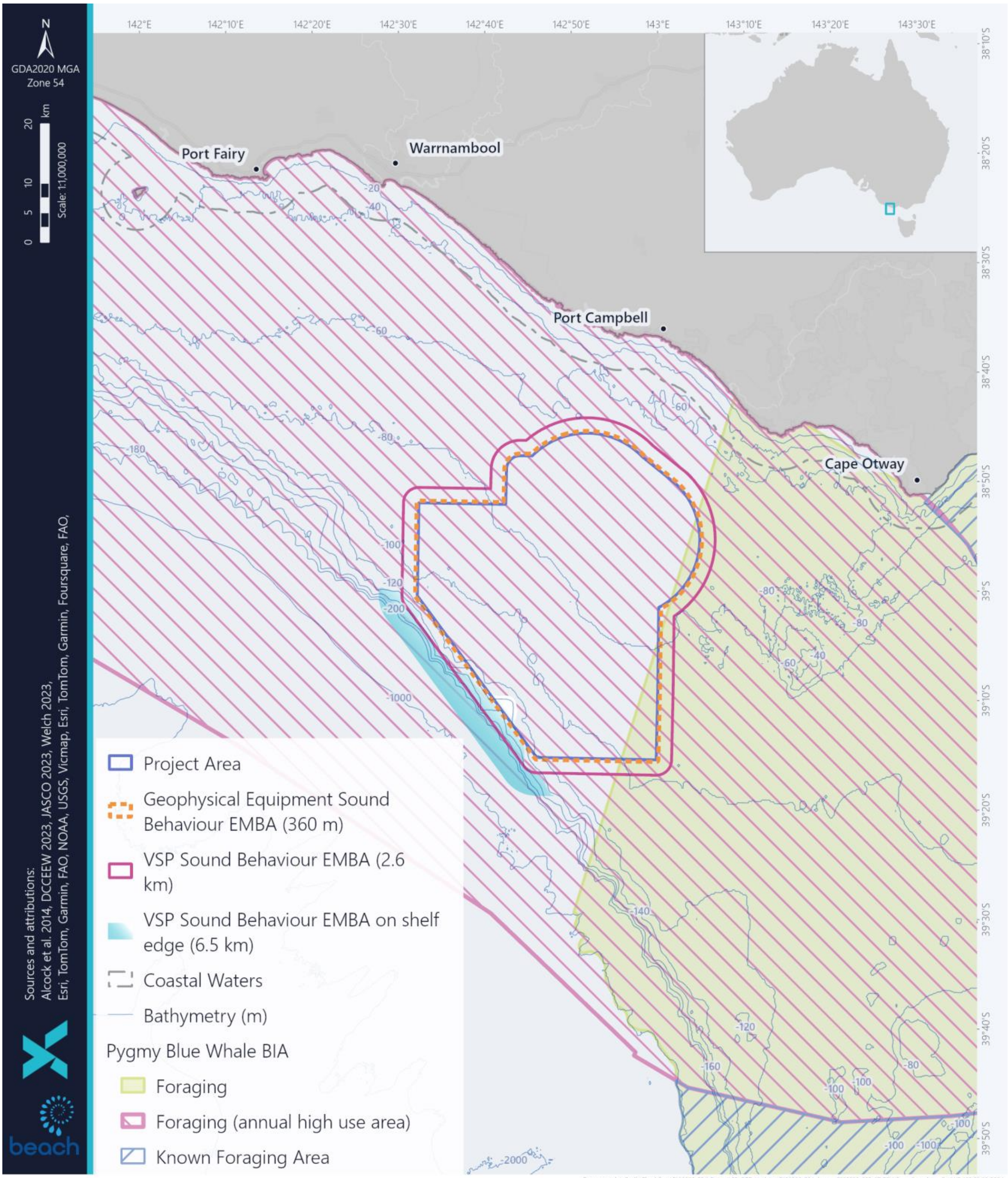
Underwater sound has the potential to impact marine fauna that have songlines, or spiritual connection to First Nations people. It is considered that impacts to species at a population level may prevent First Nations people’s obligations to maintain spiritual connections and care for culturally significant species and their habitats. As evaluated in Section 6.4.3.1, potential impacts to eels, fish, and marine mammals will not impact these species at a population level. Minor behavioural changes are expected from intermittent underwater sound emissions generated during the Project. As a result, underwater sound emissions from the Project are likely to result in Minor (1) consequences to cultural values and sensitivities.

Table 6-25: Noise Effect Criteria and Maximum Received Sound Levels for Impulsive Sources

Receptor	Noise Effect Criteria	Boomer Maximum Distance (m)	Boomer Maximum Distance – shelf edge (m)	SBP Maximum Distance (m)	SBP Maximum Distance – shelf edge (m)	VSP Maximum Distance (m)	VSP Maximum Distance – shelf edge (m)	Noise Effect Criteria Reference
Plankton: mortality/potential mortal injury	>207 dB PK or 210 dB SEL$_{24h}$	1.6 NR	4 NR	0.3 NR	0.8 NR	NR NR	NR NR	Popper et al. 2014
Invertebrates: effect at the seafloor	186–190 dB SEL 192–199 dB SEL$_{24h}$ 209–212 dB PK-PK	NR NR NR	NR NR NR	NR NR NR	NR NR NR	NR NR NR	NR NR NR	Day et al. 2016
Invertebrates: no effect at seafloor	202 dB PK-PK	NR	NR	NR	NR	185	470	Payne et al. 2008
Lobster: no effect at seafloor	183 dB SEL	NR	NR	NR	NR	NR	NR	McCauley and Duncan 2016
Squid: behavioural	166 dB SPL	36	90	NR	NR	1,550	3,900	McCauley et al. 2000
Fish (swim bladder): mortality/potential mortal injury	>207 dB PK or 207 dB SEL$_{24h}$	1.6 NR	4 NR	0.3 NR	0.8 NR	NR NR	NR NR	Popper et al. 2014
Fish (swim bladder): recoverable injury	>203 dB PK or >207 dB SEL$_{24h}$	0.6 NR	1.5 NR	0.1 NR	0.3 NR	NR NR	NR NR	Popper et al. 2014
Fish (no swim bladder): mortality/ potential mortal injury	>213 dB PK or >219 dB SEL$_{24h}$	0.6 NR	1.5 NR	0.1 NR	0.3 NR	NR NR	NR NR	Popper et al. 2014
Fish (no swim bladder): recoverable injury	>213 dB PK or >216 dB SEL$_{24h}$	0.6 NR	1.5 NR	0.1 NR	0.3 NR	NR NR	NR NR	Popper et al. 2014
Fish (swim bladder or no swim bladder): TTS	>186 dB SEL$_{24h}$	NR	NR	NR	NR	NR	NR	Popper et al. 2014
Turtle: behavioural	166 dB SPL	36	90	NR	NR	1,550	3,900	NSF 2011

Turtle: mortality/potential mortal injury	>207 dB PK or 210 dB SEL$_{24h}$	1.6 NR	4 NR	0.3 NR	0.8 NR	NR NR	NR NR	Popper et al. 2014
Marine mammals: Behavioural	160 dB SPL	145	360	2	5	2,560	6,500	NOAA 2019
Low-frequency cetaceans: PTS (humpback; pygmy blue whales)	219 dB PK 183 dB SEL$_{24h}$	NR NR	NR NR	NR NR	NR NR	NR NR	NR NR	Southall et al. 2019
Low-frequency cetaceans: TTS (humpback; pygmy blue whales)	213 dB PK 168 dB SEL$_{24h}$	NR 10	NR 25	NR 10	NR 25	NR NR	NR NR	Southall et al. 2019
High-frequency cetaceans: PTS (dolphins, beaked whales, sperm whales)	230 dB PK 185 dB SEL$_{24h}$	NR NR	NR NR	NR NR	NR NR	NR NR	NR NR	Southall et al. 2019
High-frequency cetaceans: TTS (dolphins, beaked whales, sperm whales)	224 dB PK 170 dB SEL$_{24h}$	NR NR	NR NR	NR NR	NR NR	NR NR	NR NR	Southall et al. 2019
Very-high-frequency cetaceans: PTS (pygmy; dwarf sperm whales)	202 dB PK 155 dB SEL$_{24h}$	4.5 NR	11 NR	0.6 NR	1.5 NR	NR NR	NR NR	Southall et al. 2019
Very-high-frequency cetaceans: TTS (pygmy; dwarf sperm whales)	196 dB PK 140 dB SEL$_{24h}$	8.9 NR	22 NR	1.2 NR	3 NR	NR NR	NR NR	Southall et al. 2019
Pinnipeds: PTS (sea lions; seals)	232 dB PK 203 dB SEL$_{24h}$	NR NR	NR NR	NR NR	NR NR	NR NR	NR NR	Southall et al. 2019
Pinnipeds: TTS (sea lions; seals)	226 dB PK 188 dB SEL$_{24h}$	NR NR	NR NR	NR NR	NR NR	NR NR	NR NR	Southall et al. 2019

NR: indicates the level is not reached



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_S04_A.aprx, P100383_S00_37_PBWSoundImpulsive, P-UWS-132,28/10/2024

Figure 6-6: Impulsive Sound Behaviour EMBAs and Pygmy Blue Whale BIAs

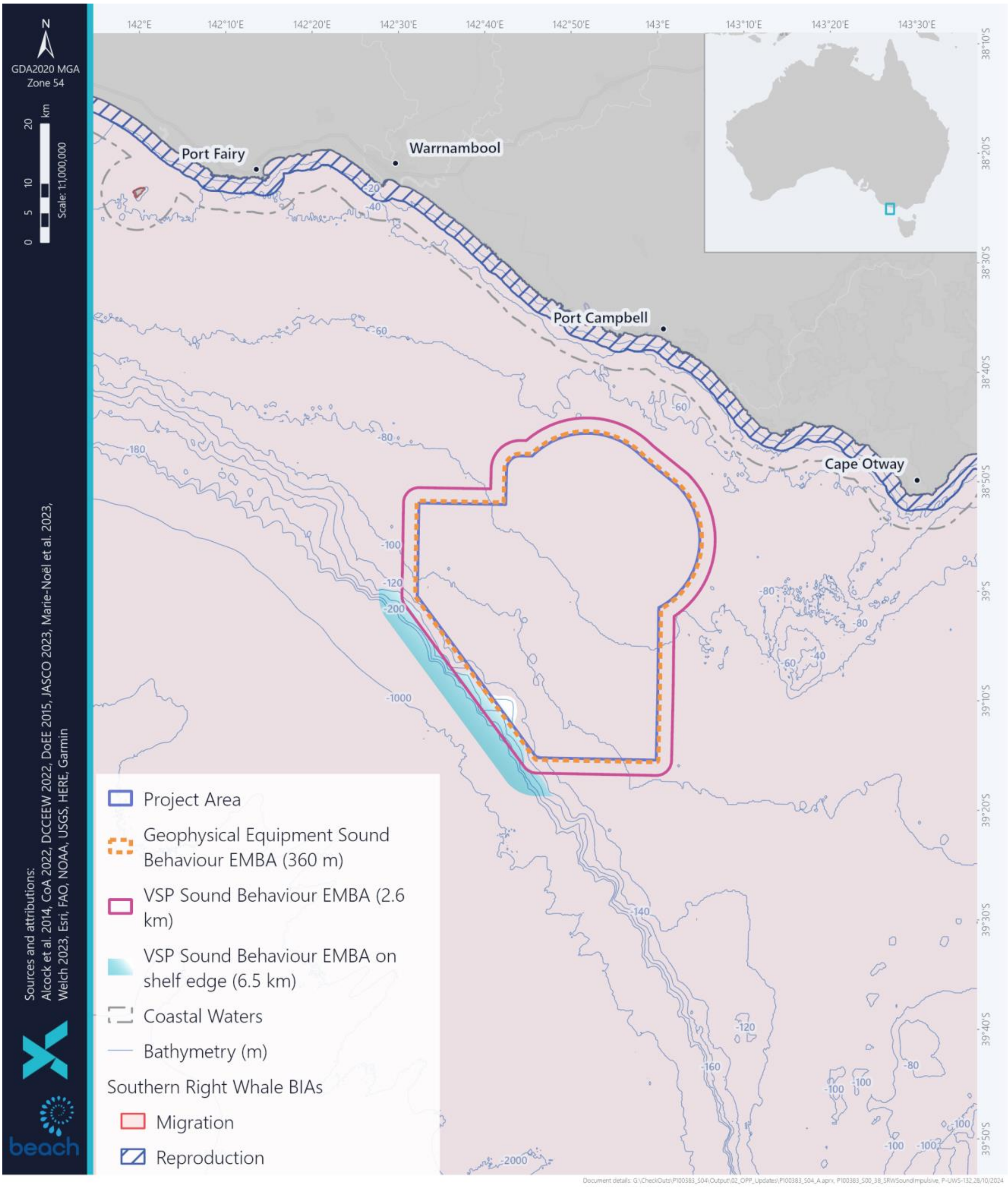


Figure 6-7: Impulsive Sound Behaviour EMBAs and Southern Right Whale BIAs

6.4.3.2 Continuous Sound

Receptors that may be impacted by continuous sound include:

- Fish
- Marine reptiles
- Marine Mammals
- Socio-economic receptors (i.e., commercial fisheries)
- Cultural values and sensitivities

The modelling studies assessed distances from activities where underwater sound levels reached exposure criteria corresponding to various levels of potential impact to marine fauna. The marine fauna considered was based on a review of receptors that may be impacted by continuous sound, these were marine mammals, turtles, and fish.

To assess the potential impacts to receptors from underwater continuous sound from the Project, acoustic modelling was used to identify the furthest underwater sound level to reach the defined noise effect exposure criteria for each receptor. The exposure criteria selected for the modelling and the impact assessment were selected as they have been accepted by regulatory agencies and because they represent current best available science (Koessler et al. 2020, Matthews et al. 2020).

The modelled received sound levels were compared to defined noise effect criteria detailed in Table 6-25 to Table 6-28 as determined by scientific research and academic papers.

1. Fish

Popper et al. (2014) details that there is no direct evidence of mortality or potential mortal injury to fish from ship sound emissions. Popper et al. (2014) details that risks of mortality and potential mortal injury, and recoverable injury impacts to fish with no swim bladder (sharks) or where the swim bladder is not involved in hearing is low and that TTS in hearing may be a moderate risk near (tens of metres) the vessel. For fish with a swim bladder involved in hearing risks of mortality and potential mortal injury impacts is low. However, some evidence suggests that fish sensitive to acoustic pressure show a recoverable loss in hearing sensitivity, or injury when exposed to high levels of sound and Popper et al. (2014) details SPL criteria for fish with a swim bladder involved in hearing.

Table 6-26 details the criteria and modelled distances to the effect criteria for fish as follows:

- The 48 hr recoverable injury threshold was reached within 50 m for drilling and not reached for the other activities
- The 12 hr TTS criteria was reached within 150 m for drilling, 40 m for Installation and IMR, and not reached for vessel resupply activities.

Surveys within the Project Area (Ramboll 2020, Appendix C) concluded that the seafloor in the surveyed area is unmodified marine sediment which supports a patchy complex of branchy epibiota and is typical of what is expected at shallow and middle shelf zones. Fauna associated with this type of habitat included amphipods, isopods, polychaete worms and molluscs. The survey also identified areas of rock outcrops. Based on available data, the presence of habitat which support site-attached fish within the Project Area cannot be ruled out.

The existing studies focus on the shallow and middle shelf zones of up to approximately 130m water depth. Beach commits to undertaking further seabed assessments of the deep shelf and upper slope zones (from approximately 130m to 180m water depth) located predominantly in the southern and western portions of the Project Area. These assessments will enable the seabed composition, benthic habitats and communities to be identified for locations where seabed disturbance activities such as drilling may take place, allowing final well location selection to avoid areas of high relief outcrops, reefs and sponge beds (CM#10).Based on this commitment, it is unlikely that fish species would be present within these distances from the activities for periods of over 12 or 48 hours and therefore injury and TTS impacts are not predicted.

Further seabed assessments will be undertaken of the deep shelf and upper slope zones (from approximately 130m to 200m water depth) located predominantly in the southern and western portions of the Project Area. These assessments will enable the seabed composition, benthic habitats and communities to be identified for locations where seabed disturbance activities such as drilling and infrastructure installation may take place

The West Tasmanian Canyons, where there are fish nurseries and the potential for site-attached fish was identified as being within the Project Area to a minor extent. The KEF is located on the continental slope where Project activities are not planned and is not within the potential area of impact for continuous noise.

Behavioural impacts are more likely such as moving away from the MODU or vessel. There are no habitats or features within the Project Area that would restrict fish and sharks from moving away from the activities.

The white shark is known to occur within the Project Area but there are no BIAs or critical habitats. The Recovery Plan for the White Shark (DSEWPaC 2013c) does not identify underwater acoustic emissions as a threat.

Impacts to fish, including sharks, would be limited to behavioural impacts such as startle response or avoidance behaviour near the MODU or vessel. Thus, behavioural impacts to fish would be temporary and unlikely to have a significant impact on individuals or at a population level.

Temporary avoidance behaviour may occur near the vessel for commercial fish species; however, recovery would occur once the activities have ceased after up to between 30-40 days each. Based on the small area of impact and that displaced fish would still be available to be caught, impacts to commercial fishing are not predicted.

Based on this, the consequence ranking of potential impacts to fish is considered Minor (1).

Eels that have important cultural value to First Nations may also migrate through the Project or Planning Areas (Section 4.4.9.3.2). Eels that may migrate through the Otway shelf to deeper waters are not predicted to be impacted as a study by Koster et al. 2021 tracked 16 short-finned eels found that the average speed was 30.8 ± 7.3 km/day while eels were on the continental shelf and 29.7 ± 11.1

km/day while in deep water. Thus, migrating eels are unlikely to be impacted based on the small distances to the sound exposure criteria (up to 150 m) and the distance eels travel while migrating.

2. Marine Turtles

The Recovery Plan for Marine Turtles in Australia (CoA 2017b) identifies noise interference as a threat to turtles. It details that exposure to chronic (continuous) loud noise in the marine environment may lead to avoidance of important habitat.

Popper et al. (2014) details that there is no direct evidence of mortality or potential mortal injury to sea turtles from ship sound emissions.

Popper et al. (2014) found that there was insufficient data available to propose a quantitative exposure guideline or criteria for marine turtles for continuous sound such as those generated by vessels and instead suggested general distances to assess potential impacts. Using semi-quantitative analysis, Popper et al. (2014) suggests that there is a low risk to marine turtles from shipping and continuous sound except for TTS near (10s of metres) to the sound source, and masking at near, intermediate (hundreds of metres) and far (thousands of metres) distances and behaviour at near and intermediate distances from the sound source.

Finneran et al. (2017) presented revised thresholds for turtle PTS and TTS for continuous sound. Table 59 details the criteria and modelled distances to them (Koessler and McPherson 2021. Appendix F) as follows:

- The 24hr PTS criteria was reached within 50m of drilling, 20m of installation and IMR, and not reached for OSV transit
- The 24hr TTS criteria was reached within 160m of drilling, 80m of installation and IMR, and 30m for OSV transit

Three marine turtle species may occur within the Project Area although no BIAs or habitat critical to the survival of the species were identified.

The Recovery Plan for Marine Turtles in Australia (CoA 2017b) details that exposure to chronic (continuous) loud noise in the marine environment may lead to avoidance of important habitat and no marine turtle important habits are located within the area that maybe impacted.

Low numbers of marine turtles are predicted in the Project Area and therefore impacts would be limited to a small number of individuals and over a temporary period of up to between 30-40 days for each activity and at a localised extent (160m).

Based on this, the consequence ranking of potential impacts to marine turtles is considered Minor (1).

3. Marine Mammals

Noise effect criteria used in this assessment for impacts to marine mammals are based on:

- NOAA (2019) acoustic threshold for behavioural effects in marine mammals of 120 dB re 1 µPa (SPL). Whilst the newly published Southall et al. (2021) provides recommendations and discusses the nuances of assessing behavioural response, the authors do not recommend new numerical thresholds for onset of behavioural responses for marine mammals

- NMFS (2018) exposure criterion for the onset of temporary hearing TTS and PTS for marine mammals based on their frequency hearing range. NMFS (2018) details that after sound exposure ceases or between successive sound exposures, the potential for recovery from hearing loss exists, with PTS resulting in incomplete recovery and TTS resulting in complete recovery. The NMFS (2018) exposure criteria are based on a cumulative SELs over a period of 24 hours
- Secondary effects in marine mammals, such as masking, are poorly understood. Threshold levels cannot yet be applied in the same way as they can for direct sound effects, therefore a qualitative approach must be taken (Erbe et al. 2016). For the purpose of this evaluation, behavioural effect thresholds (as per NOAA 2019) are adopted as a conservative threshold for secondary effects i.e. masking (Hawkins and Popper 2017).

Table 6-27 details the furthest modelled distance of each activity to the criteria for each marine mammal hearing group.

a. Low Frequency Cetaceans

Several low frequency cetaceans may occur within the Project Area. Foraging behaviours were identified for the blue, fin, pygmy right and sei whales; no other important behaviours were identified. The continuous noise source sound behaviour EMBAs for marine mammals of 7.98 km and for marine mammals on shelf edge of 19.6 km intersect the foraging BIAs for the pygmy blue whale (Figure 6-8) and the migration BIA for the southern right whale (Figure 6-9). These EMBAs are based on the greatest distances from the activity where noise effect criteria are reached for continuous noise sources.

For low-frequency cetaceans the modelling results showed the following:

- The 24hr PTS criteria is reached within 180m from drilling and 100m from drilling on shelf edge, 60m from installation/IMR and 150m for installation/IMR on shelf edge, and not reached for OSV standby/transit.
- The 24hr TTS criteria is reached within 1.31 km from drilling and 1.48 km from drilling on shelf edge, 660m from installation/IMR and 1.65 km for installation/IMR on shelf edge, not reached for OSV standby/transit and 10m for OSV standby/transit on shelf edge.
- The behavioural criteria is reached within 7.89 km from drilling and 19.6 km from drilling on shelf edge, 2.98 km from installation/IMR and 6.5 km from installation/IMR on shelf edge, 380m for OSV standby/transit and 410m from OSV standby/transit on shelf edge.

The consequence is assessed as Minor for fin, pygmy right and sei whales as there are no biologically important behaviours or BIAs identified within the sound EMBAs.

The fin and sei whale's conservation advice (TSSC 2015d, TSSC 2015e) has a consequence rating for anthropogenic noise and acoustic disturbance as minor with the extent over which the threat may operate as moderate-large. The pygmy right whale Species Profile and Threats Database (DotEE 2020a) in lieu of no conservation advice, does not identify anthropogenic noise and acoustic disturbance as a threat.

The consequence is assessed as Moderate (2) for southern right and pygmy blue whales as the activity area overlaps BIAs for these species.

Blue whales

Foraging behaviour for blue whales has been identified in the area where the PTS, TTS and behavioural criteria is reached for Project activities. On the advice of Gill (2020), all blue whales are assumed to be foraging.

The Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015c) requires that 'anthropogenic noise in BIAs will be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area'. The Guidance on Key Terms within the Blue Whale Conservation Management Plan (Commonwealth of Australia, 2021) defines the requirements of this action as "to ensure that any blue whale can continue to forage with a high degree of certainty in a Foraging Area, and that any blue whale is not displaced from a Foraging Area".

The Guidance on Key Terms within the Blue Whale Conservation Management Plan (Commonwealth of Australia, 2021) suggests a whale could be displaced from a foraging area if stopped or prevented from foraging, caused to move on when foraging, or stopped or prevented from entering a foraging area. A whale is considered to be displaced from a foraging area if foraging behaviour is disrupted, regardless of whether the whale can continue to forage elsewhere within that foraging area (Commonwealth of Australia, 2021).

A precautionary approach has been taken in the assessment of possible displacement from a foraging area BIA by using conservative assumptions so as to ensure that control measures will be implemented. The potential impacts of continuous underwater sound on blue whales is assessed as Moderate (2) consequence because:

- An assessment of Beach's MFO data collected between February 2021 and March 2022 for the ongoing drilling and installation campaign was undertaken (Section 4.4.9.7). Activities included drilling and construction at the Artisan well location and activities in the Geographe and Thylacine fields A summary of findings include:

- Of the 127 blue whales that were observed to enter the 3,000 m management zone, 70 (55%) were observed to move towards the MODU (following first detection) and 57 (45%) were observed to move away from the MODU. This indicates that blue whales are not being displaced.

- Published detection functions (Williams et al. 2016) and conservative assumptions were used to estimate blue whale densities in the management zones applied (0-500, 501-1,500, 1,501-2,000, 2,001-3,000, >3,000 m). If underwater noise was displacing blue whales, it would be expected less whales would be observed in the zones closest to the underwater noise. The expected densities of blue whales based on the detection function most closely matching the Lead MFOs advice indicated there was no difference in expected densities between any of the management zones (mean of 6.21 blue whales/ km^2).

- The expected densities of blue whales based on the conservative detection functions showed similar results for the 0-500 and 501-1,500 m zones (means of 7.27 and 7.73 blue whales/ km^2). However, they showed mean expected densities of 18.70 blue whales/ km2 and 22.91 blue whales/ km^2 for the 1,501-2,000 and 2,001-3,000 m zones. Even if the conservative functions are used there is still no detectable difference in expected densities of blue whales in the 0-500 and 501-1,500 m zones, which conservatively means that blue whales are not displaced within 1,500 m of the noise source.

- The Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015c) details that shipping and industrial noise are classed as a ‘minor’ consequence (defined as: individuals are affected but no affect at a population level).
- The activities will be of a short duration (up to 30-40 days per campaign)
- The area within the largest behavioural distance EMBA represents less than 4% of the BIA.
- Adopted controls for Project noise sources will prevent possible PTS, TTS and displacement impacts to pygmy blue whale that may be foraging.
- The largest sound EMBA is ~50 km from the Bonney coast upwelling KEF, which is a known feeding aggregation area (Gill et al. 2011; McCauley et al. 2018). The sound EMBAs are within an area where the occurrence of an upwelling event between 2002 and 2016 was assessed as very unlikely with an upwelling frequency of <10% (Huang and Wang 2019). Thus, blue whale foraging is likely to be opportunistic within the sound EMBAs
- Aerial surveys in the Otway region (2001 – 2007) recorded mean blue whale group size of 1.3±0.6 per sighting (Gill et al., 2011), meaning that pods do not have high numbers.
- Attard et al. (2017) showed that pygmy blue whales travel widely between the two known foraging areas (Bonney coast upwelling and Perth Canyon) and that records suggest that this population of blue whales may visit diverse, widespread areas for feeding during the austral summer, including perhaps the southern Indian Ocean and sub-Antarctic region, and travel to winter breeding grounds in the Indonesian region where they may also feed.
- The Commonwealth of Australia (2021) guidance regarding the definition of ’displaced from a foraging area’ states that mitigation measures must be implemented to reduce the risk of displacement occurring during operations where modelling indicates that behavioural disturbance within a foraging area may occur. The implementation of the control measures, including Whale Management Plans for each relevant Project activity, means that blue whale displacement from a foraging area is unlikely to occur. As such, the activity will be managed in a manner that is not inconsistent with the Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015c), specifically Action Area A.2.

Southern right whales

Migration behaviour for southern right whales has been identified in the area where the PTS, TTS and behavioural criteria is reached for Project activities.

The potential impacts from continuous underwater sound to southern right whales is assessed as Moderate (2) consequence due to the following:

- The activities will be of a short duration (up to 40 days per campaign).
- The area within the behavioural distance EMBA represents less than 1% of the BIA.

- The noise effect criteria thresholds are not reached at the southern right whale reproduction BIA and are ~10 km away at the closest point

- The activity is not being undertaken within the coastline areas of south-west Victoria in Gunditjmara Sea Country where southern right whale feed and birth or the Whale Birthing Dreaming Sites in coastal bay areas from Port Campbell to Portland, including Warrnambool (DCCEEW 2024o). Noise impacts to southern right whales in these sites are not predicted.

- Low numbers of SRW are predicted in and around the activity area based on aerial surveys in the Otway region (2002 – 2013), which recorded 12 groups of SRW consisting of 52 individuals (Gill et al., 2015). None were observed away from the coast, which Gill et al (2015) noted is consistent with winter habitat preferences.

- SRW are a highly mobile migratory species that travel thousands of kilometres between habitats used for essential life functions (DCCEEW 2024o; DSEWPaC 2012a). Along the Australian coast, individual SRW use widely separated coastal areas (200–1,500 km apart) within a season, indicating substantial coast-wide movement. The longest movements are undertaken by non-calving whales, though calving whales have also been recorded at locations up to 700 km apart within a single season (DCCEEW 2024o; DSEWPaC 2012a).

- The National Recovery Plan for the Southern Right Whale (DCCEEW 2024o) identifies industrial noise as a Moderate consequence and vessel noise as Minor consequence.

- Anthropogenic noise will be managed such that SRW are not deterred from calving nor displaced from the emerging aggregation area. The EPOs and control measures, including Whale Management Plans for each relevant Project activity, ensure that SRW will continue to utilise the emerging aggregation area; and movements are not deterred in and out of the migration area. The activity will be managed in a manner that is not inconsistent with National Recovery Plan for the Southern Right Whale (DCCEEW 2024o).

- The activity can be managed to ensure that it will not be inconsistent with the National Recovery Plan for the Southern Right Whale (DCCEEW 2024o) that details that actions within and adjacent to southern right whale BIAs and habitat critical to the survival of the species, should demonstrate that it does not prevent any southern right whale from utilising the area or cause injury (TTS and PTS) and/or disturbance. Adopted controls will prevent possible PTS, TTS and displacement impacts to southern right whales.

b. High Frequency Cetaceans

High frequency cetaceans such as dolphins, sperm whales and beaked whales may occur in the Sound behaviour EMBAs for continuous noise sources of 7.98 km and 19.6 km for shelf edge locations, but no BIAs or biologically important behaviours were identified.

For high frequency cetaceans the modelling results showed the following:

- The 24hr PTS criteria is reached within 50m from drilling and drilling on shelf edge, 20m for installation/IMR and 50m from installation/IMR on shelf edge, and not reached for OSV standby/transit

- The 24hr TTS criteria is reached within 160m from drilling and 80m from drilling on shelf edge, 90m for installation/IMR and 225m from installation/IMR on shelf edge, and not reached for OSV standby/transit
- The behavioural criteria is reached within 7.89 km from drilling and 19.6 km from drilling on shelf edge, 2.98 km from installation/IMR and 6.5 km from installation/IMR on shelf edge, 380m for OSV standby/transit and 410m from OSV standby/transit on shelf edge.

It is unlikely that a high frequency cetacean would be within the PTS and TTS extent distances of a MODU or vessel for in excess of 24 hours.

Predicted impacts would be limited to behavioural response such as avoidance of the area for a small number of individuals, not population level, while the activities are being undertaken for a temporary period of up to between 30-40 days.

Based on this, the consequence ranking of potential impacts of continuous noise to high frequency cetaceans is considered Minor (1).

c. Very High Frequency Cetaceans

Very high frequency cetaceans, such as pygmy and dwarf sperm whales, may occur in the Sound behaviour EMBAs for continuous noise sources of 7.98 km and 19.6 km for shelf edge locations, but no BIAs or biologically important behaviours were identified.

For very high frequency cetaceans the modelling results showed the following:

- The 24hr PTS criteria is reached within 260m from drilling and 170m from drilling on shelf edge, 120m for installation/IMR and 300m for installation/IMR from shelf edge, and not reached for OSV transit
- The 24hr TTS criteria is reached within 1.16 km from drilling and 1.53 km from drilling on shelf edge, 870m for installation/IMR and 2.18 km from installation/IMR on shelf edge, not reached for OSV transit and 10m from OSV standby/transit.
- The behavioural criteria is reached within 7.89 km from drilling and 19.6 km from drilling on shelf edge, 2.98 km from installation/IMR and 6.5 km from installation/IMR on shelf edge, 380m for OSV standby/transit and 410m from OSV standby/transit on shelf edge.

It is unlikely that a very high frequency cetacean would be within the PTS and TTS extent distances of a MODU or vessel for in excess of 24 hours.

Predicted impacts would be limited to behavioural response such as avoidance of the area for a small number of individuals, not population level, while the activities are being undertaken for a temporary period of up to between 30-40 days.

Based on this, the consequence ranking of potential impacts of continuous noise to very high frequency cetaceans is considered Minor (1).

d. Otariid Seals

Otariid seals, such as the Australian sea lion and Australian and New Zealand fur seals may occur within the Sound behaviour EMBAs for continuous noise sources of 7.98 km and 19.6 km for shelf edge locations, but no BIAs or biologically important behaviours were identified.

For otariid seals the modelling results showed the following:

- The 24hr PTS criteria is reached within 50m from drilling and 30m from drilling on shelf edge, 10m for installation/IMR and 25m from installation/IMR on shelf edge, and not reached for OSV transit
- The 24hr TTS criteria is reached within 90m from drilling and 50m from drilling on shelf edge, 20m for installation/IMR and 50m for installation/IMR on shelf edge, and not reached for OSV transit
- The behavioural criteria is reached within 7.89 km from drilling and 19.6 km from drilling on shelf edge, 2.98 km from installation/IMR and 6.5 km from installation/IMR on shelf edge, 380m for OSV standby/transit and 410m from OSV standby/transit on shelf edge.

It is unlikely that an otariid seal would be within the PTS and TTS extent distances of a MODU or vessel in excess of 24 hours.

Predicted impacts would be limited to behavioural response such as avoidance of the area for a small number of individuals, not population level, while the activities are being undertaken for a temporary period of up to between 30-40 days.

Based on this, the consequence ranking of potential impacts of continuous noise to otariid seals is considered Minor (1).

4. Socio-economic Values

Where the functions, interests or activities of other marine users involve marine fauna, any effect to fauna presence or abundance may indirectly impact these users. The potential impact may occur for the duration of the sound emission; however, following cessation of the activity, long term changes in fauna abundance or distribution are not expected. Given the location of the Project Area and short-term nature of the more significant sound generating activities, changes to the functions, interests or activities of other users, such as commercial fisheries, from acoustic emissions are not expected.

5. Cultural Values and Sensitivities

The following cultural values and sensitivities from Section 4.6.3 have been identified as potentially affected by sound and the potential impacts have been assessed within this Section 6.4.3:

- Eels
- Fish
- Dolphins
- Blue whales
- Southern right whales

- Seals

The marine fauna listed above are connected to places associated with songlines or connected to individuals through ceremony (Section 4.6.3.5). The connection of marine fauna to places or individuals are considered cultural intangible values.

Underwater sound has the potential to impact marine fauna that have songlines, or spiritual connection to First Nations people. It is considered that impacts to species at a population level may prevent First Nations people's obligations to maintain spiritual connections and care for culturally significant species and their habitats. As evaluated in Sections 6.4.3.2, potential impacts to eels, fish, and marine mammals will not impact these species at a population level. However, there is potential for possible injury to blue whales and southern right whales resulting in Moderate (2) consequences from continuous underwater sound emissions. As a result, continuous underwater sound emissions from the Project are likely to result in Moderate (2) consequences to cultural values and sensitivities. Underwater sound has not been identified as an impact to submerged cultural heritage.

Table 6-26: Noise Effect Criteria and Modelled Distances to the Criteria for Fish

Fish (swim bladder involved in hearing)	SPL (Lp; dB re 1 µPa)	Drilling + Resupply	Drilling + Resupply – shelf edge	Installation/IMR	Installation/IMR – shelf edge	OSV standby/transit	OSV standby/transit – shelf edge
		R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)
Recoverable injury	170 dB SPL (48h)	0.05	0.02	NR	NR	NR	NR
TTS	158 dB SPL (12h)	0.15	0.11	0.04	0.1	NR	NR

NR: indicates the level is not reached.

Table 6-27: Noise Effect Criteria and Modelled Distances to the Criteria for Marine Turtles

Marine Turtles	SEL24h threshold (dB re 1 µPa^2·s)	Drilling + Resupply	Drilling + Resupply – shelf edge	Installation/IMR	Installation/IMR – shelf edge	OSV standby/transit	OSV standby/transit – shelf edge
		R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)
PTS	220	0.05	0.05	0.02	0.05	NR	NR
TTS	200	0.16	0.08	0.08	0.2	NR	NR

NR: indicates that the level was not reached.

Table 6-28: Noise Effect Criteria and Modelled Distances to the Criteria for Marine Mammals

Marine Mammal	SEL24h threshold (dB re 1 µPa^2·s)	Drilling + Resupply	Drilling + Resupply – shelf edge	Installation/IMR	Installation/IMR – shelf edge	OSV standby/transit	OSV standby/transit – shelf edge
		R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)
PTS							

Marine Mammal	SEL24h threshold (dB re 1 µPa^2·s)	Drilling + Resupply	Drilling + Resupply – shelf edge	Installation/IMR	Installation/IMR – shelf edge	OSV standby/transit	OSV standby/transit – shelf edge
		R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)
Low-frequency cetaceans	199	0.18	0.1	0.06	0.15	NR	NR
High-frequency cetaceans	198	0.05	0.05	0.02	0.05	NR	NR
Very-high-frequency cetaceans	173	0.26	0.17	0.12	0.3	NR	NR
Otariid seals	219	0.05	0.03	0.01	0.025	NR	NR
TTS							
Low-frequency cetaceans	179	1.31	1.48	0.66	1.65	NR	0.010
High-frequency cetaceans	178	0.16	120m	0.09	0.225	NR	NR
Very-high-frequency cetaceans	153	1.16	1.53 km	870m	2.18	NR	0.01
Otariid seals	199	0.09	0.05	0.02	0.05	NR	NR
Behaviour							
Marine mammals	120 SPL	7.89	19.6	2.98	6.5	0.38	0.41

NR: indicates that the level was not reached.

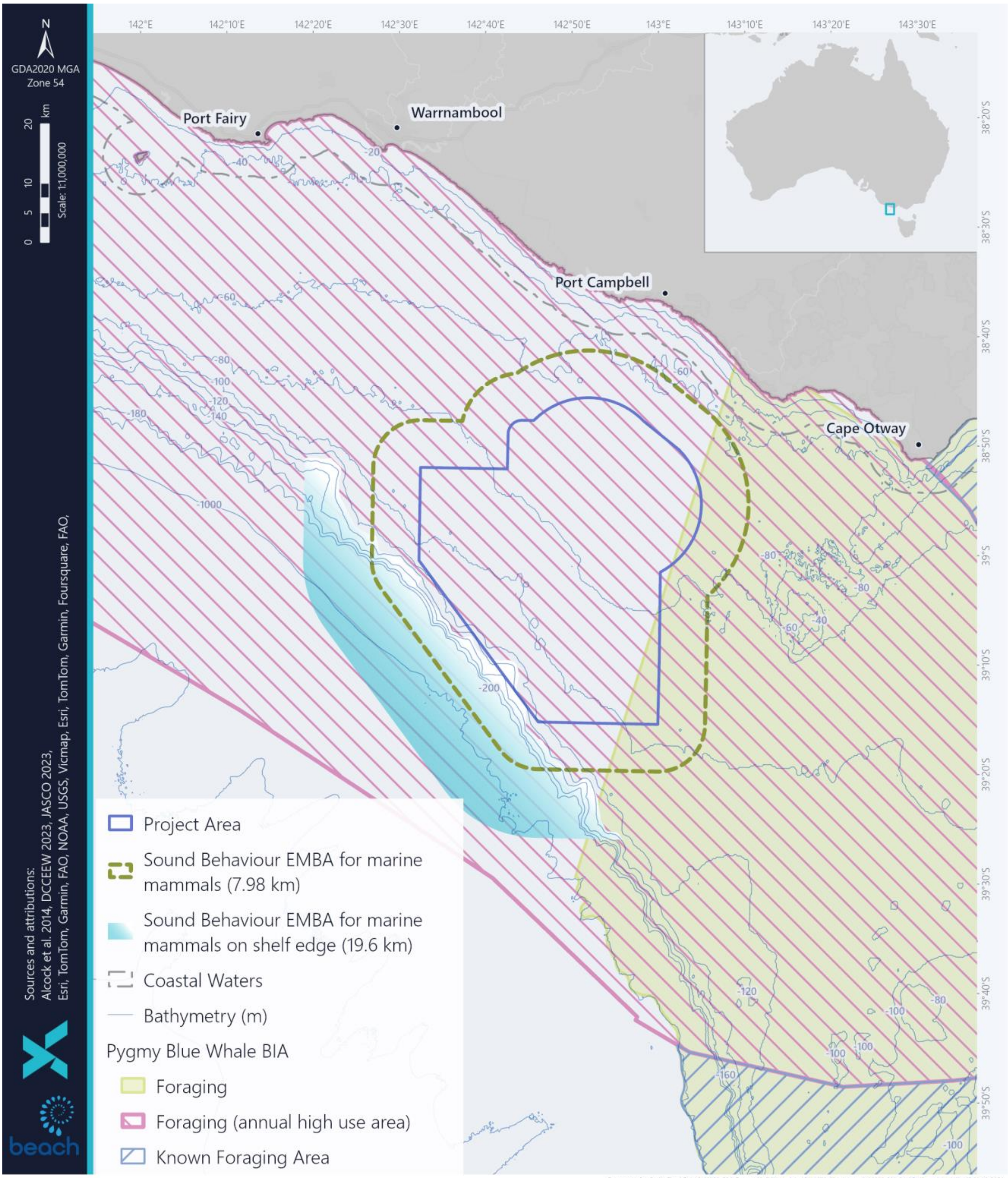
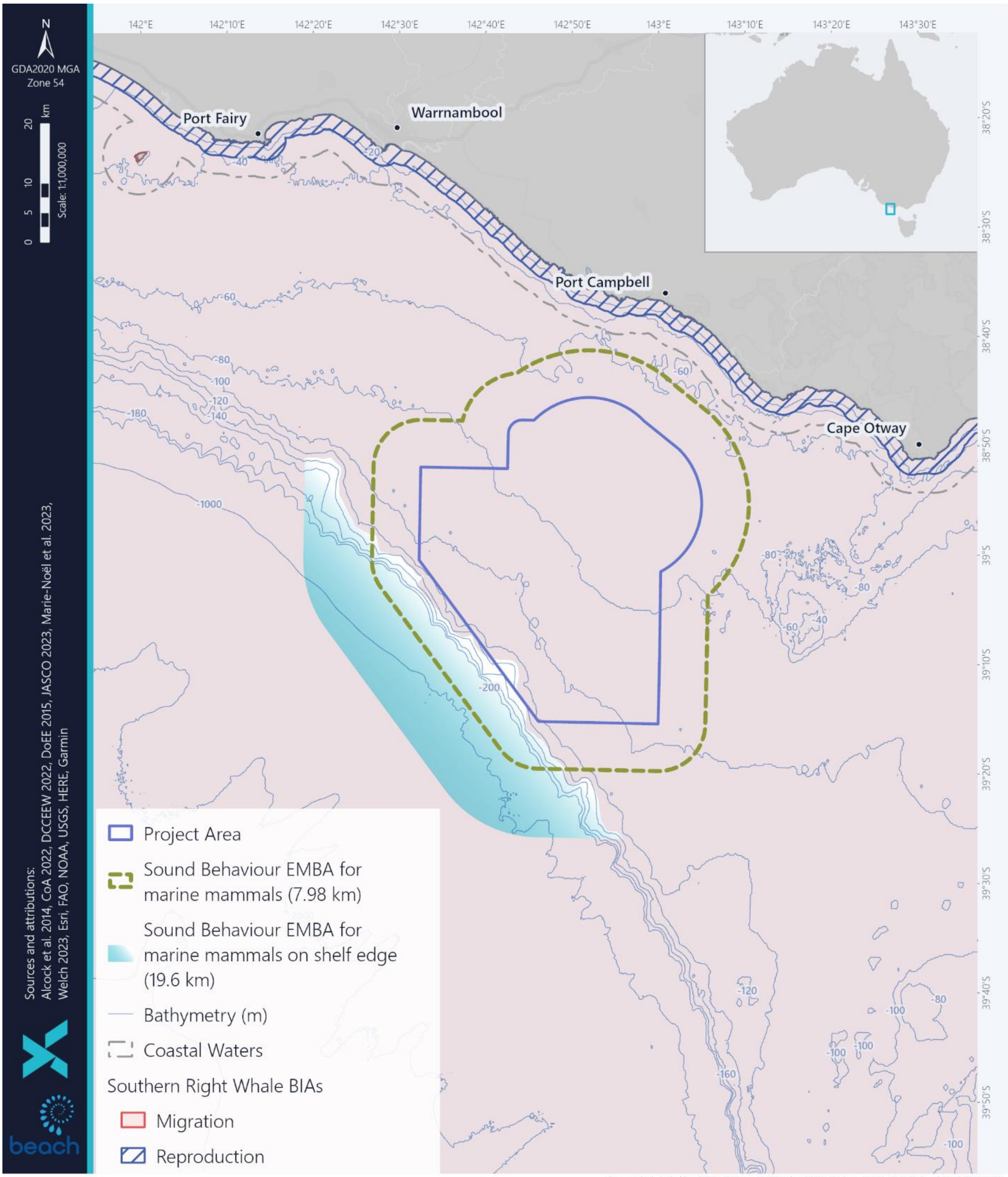


Figure 6-8: Pygmy Blue Whale BIAs and Continuous Sound Behaviour EMBAs



Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_S04_A.aprx, P100383_S00_35_SRWSound, P-UWS-132,28/10/2024

Figure 6-9: Southern Right Whale BIAs and Continuous Sound Behaviour EMBAs

6.4.4 Impact Evaluation Summary

The impact evaluation for underwater noise emissions is summarised in Table 6-29.

Table 6-29: Impact Evaluation Summary for Underwater Noise Emissions

Summary	
Summary of impact	Potential impacts from underwater noise emissions are expected to cause Minor (1) consequences of short term and highly localised changes in behaviour to marine fauna including fish, marine turtles, and most marine mammals. Injury and mortality is expected to be limited to plankton at rates well below natural mortality rates, however this is also considered a Minor (1) consequence. The potential for continuous underwater sound emissions to cause PTS, TTS and displacement impacts to blue whales and southern right whales results in a Moderate (2) consequence for these receptors. As a result, potential impacts to cultural values and sensitivities are also considered to be Moderate (2) consequences. With the adoption of controls to prevent the onset of injury and displacement to blue whales and southern right whales, these impacts will not have significant impacts on individuals or at impacts to population levels. With no potential impacts to the abundance or distribution of marine fauna including species of commercial value, impacts to socio-economic values are not expected.
Extent of impacts	Underwater noise that could potentially impact marine fauna will be generated during impulsive source activities (geophysical surveys, VSP operations) with a predicted maximum extent of impact (behavioural disturbance threshold for whales) of up to 2.56 km. Underwater noise that could potentially impact marine fauna will be generated during continuous source activities (drilling, installation and IMR and vessel transit) with a predicted maximum extent of impact (behavioural disturbance threshold for whales) of up to 7.89 km.
Duration of impacts	Continuous underwater sound emissions will be intermittent for the duration of Project activities based on the presence of vessels in the Project Area. Impulsive underwater sound emissions will be based on short-term activities including VSP operations (up to 24hrs per well), and geophysical surveys (up to 30-40 days per campaign).
Level of certainty of impacts	At the time of writing this OPP and at this preliminary stage of the Project, MODU and vessels contractors for the Project have not been confirmed. As a result, there is uncertainty with regards to specific sound source values for impulsive and continuous underwater sound. To ensure an acceptable level of certainty with regards to potential impacts from this aspect, analogue sound source values and acoustic modelling studies conducted for previous and relevant Beach operations in the region was used to inform the spatial extent of potential impact. This approach is considered appropriate to evaluate potential impacts from underwater sound until MODU and vessel contractors have been assigned for the Project. Previous underwater sound modelling studies commissioned by Beach for impulsive and continuous sound sources are considered suitable and representative analogues to define the spatial extent of the impact. The acoustic modelling studies have considered water depths covering continental shelf and shelf edge locations, and with an appropriate geoacoustic profile representative of the Project Area, and conservatively selected sound speed profiles and mean drilling sound levels. Overall, the impact evaluation was conducted on the basis that the broadband level predictions/propagation loss as a very similar type of seabed environment is expected within the continental shelf portion of the Otway Basin (Project Area) because it is supported by measurements of very similar operational activities (McPherson et al. 2021). MODU and vessel contractors are expected to be known during the development of future EPs under this OPP. As a result, future EPs under this OPP will use Project specific modelling if the analogue studies are not considered conservative, suitable and representative predictions.

Summary	
	Beach has a high level of certainty about the potential impacts from underwater sound emissions and has long-term experience in the area on the application of good industry practice to ensure impacts associated with underwater sound are acceptable.
Is the impact considered lower-order or higher-order?	Impacts from underwater sound emissions have been evaluated to result in consequences up to the Moderate (2) level. Moderate (2) consequences are considered lower-order impacts that are acceptable with the application of good industry practice.
Impact Consequence	
Moderate	

6.4.5 Demonstration of Acceptability

Table 6-30 demonstrates how and why predicted environmental impacts from sound emissions meets the defined acceptable levels (Table 5-4).

Table 6-30: Demonstration of Acceptability – Sound Emissions

Demonstration of Acceptability		
Impact and risk comparison with relevant defined acceptable levels	Acceptable levels relevant to sound emissions include acceptable levels 1, 2, and 3 (as detailed in Table 5-4). A **Moderate** impact consequence level was assigned for this aspect based on the impact analysis and evaluation. Moderate impact consequences from sound emissions will not result in: • interference with the recovery of EPBC Act listed threatened species • modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline • inconsistencies with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species As a result, the predicted environmental impact for sound emissions is better than the defined acceptable levels 1, 2, and 3.	
Principles of ESD	Integration principle	Section 6.4.3 identifies and evaluates environmental impacts associated with underwater sound emissions. As part of identifying the potential impacts, conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental impact. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks. For Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders on the Project and associated activities. No objections or claims were raised in Phase 1: Initial Project Consultation. For Phase 2: Project OPP Public Comment Period (Section 10.2.4), the public had the opportunity to provide further comment to this OPP during the period (18/3/2024 – 20/5/2024). Beach prepared the public comment report summarising all comments, an assessment of the merits of each comment, a statement of the response to each comment, and an outline of any changes made to the OPP as a result of the comment

Demonstration of Acceptability		
		(Appendix P). The impact assessment for this aspect has been updated to reflect the merit provided by public comment reference numbers PC190, PC229 and PC232. As a result, the impact assessment now integrates responses to public comments of merit and therefore is of an acceptable level. The potential environmental impact against this aspect was assessed as having a Moderate (2) impact consequence level which is considered a lower-order environmental impact. Lower-order environmental impacts are considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental impacts against this aspect were assessed as having a Moderate (2) impact consequence level which is considered a lower-order environmental impact. Lower-order environmental impacts cannot result in serious or irreversible environmental damage. There is high confidence in the impact assessment and effectiveness of controls against this aspect given the use of suitable analogue modelling, scientific literature and noise effect criteria. Beach has significant experience operating in the Otway and Bass based on their existing offshore developments and associated activities including the Beach Otway Drilling Campaign in 2021/2022.
	Intergenerational principle	The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts from underwater sound emissions is lower than the defined acceptable levels 1, 2, and 3, the health, diversity, and/ or productivity of the environment for future generations is expected to be maintained.
	Biodiversity principle	Section 6.4.3 identifies and evaluates environmental impacts associated with sound emissions. As part of identifying the potential impacts, conservation values and sensitivities including MNES in Section 4 were reviewed. Given predicted environmental impacts from sound emissions are lower than the defined acceptable levels 1, 2, and 3, there is no potential to affect biological diversity or ecological integrity is expected.
Internal context	Policy compliance	Beach Environmental Policy objectives are met through this environmental impact assessment.
	Management system compliance	Section 9 describes the implementation strategy employed for this activity.
External context	Stakeholder engagement is being carried out as part of this OPP process. Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable. During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect. During Phase 2: Project OPP Public Comment Period (Section 10.2.4), comments were raised against this aspect. The assessment of merit for these comments found this aspect to require updates. Changes to the OPP to address PC190, PC229 and PC232 have been integrated into the impact evaluation for this aspect. The science of underwater sound is continually evolving. Any new guidance or advice will be assessed and incorporated into adaptive management plans prepared for activity specific EPs.	

Demonstration of Acceptability		
Other requirements	**Requirement**	**Demonstration**
	Conservation Management Plan for the Blue Whale 2015-2025 (CoA, 2015b) Relevant management actions: • Assess and address anthropogenic noise. Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area. **National Recovery Plan for the Southern Right *Whale Eubalaena australis* (DCCEEW 2024o)** Relevant management actions: Assess, manage and mitigate impacts from anthropogenic noise **The following conservation advice or management plans identify underwater sound as a threat:** • Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC, 2015e) • Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale) (TSSC, 2015d) • Listing Advice *Megaptera novaeangliae* (Humpback Whale) (TSSC, 2022) • Recovery Plan for Marine Turtles in Australia, 2017-2027 (CoA, 2017) • Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA, 2008) • Conservation Listing Advice for the *Neophoca cinerea* (Australian sea lion) (TSSC, 2020) South-east Marine Region Profile (CoA, 2015c)	**CM14 EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans** All vessels will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans. Helicopters will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans **CM15 Geophysical Survey Whale Management Procedure** Development and implementation of a whale management procedure which outlines specific measures to minimise anthropogenic noise threats to relevant species, including the implementation of safe operating distances between vessels and whales, night-time and low visibility controls and pre-activity surveys for geophysical surveys using a boomer or SBP. This procedure provides a framework for minimising noise impacts to whales and details specific measures to be implemented that will ensure impacts and risks meet or are better than acceptable levels 1, 2 and 3. By meeting these acceptable levels, impacts will be consistent with Conservation Management Plan for the Blue Whale 2015-2025 (CoA, 2015b) and National Recovery Plan for the Southern Right Whale Eubalaena australis (DCCEEW 2024o). Specific measures in the procedure will include the following: • pre-start-up visual observations. Visual observations for the presence of whales carried out at least 30 minutes out to a distance of at least 300m from the source before startup of the boomer or SBP. • if during the prestart visual observation period, a whale is sighted within 300 m of the vessel the equipment activation will be delayed until the whale has moved outside of the 300 m zone or 30 minutes has lapsed since the last whale sighting within 300 m. • SBP equipment will not be started at night if there have been three or more delays to the start-up of the equipment due to whales in the previous 24 hours. • use of suitably trained Marine Mammal Observers (MMO) • once the survey has commenced CM#14 applies where the vessel is required to maintain a 300 m distance to all whales.

Demonstration of Acceptability

Adaptive management will be detailed the procedure to be included in future EPs under this OPP when scheduling of the activity is known in greater detail.

CM16 VSP Whale Management Procedure

Development and implementation of a whale management procedure which outlines specific measures to minimise anthropogenic noise threats to relevant species, including the implementation of safe operating distances, night-time and low visibility controls and pre-activity surveys for VSP activities that complies with 'Standard Management Procedures' set out in EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines (DEWHA 2008c) (or the contemporary requirements at the time of the activity). This procedure provides a framework for minimising noise impacts to whales and details specific measures to be implemented that will ensure impacts and risks meet or are better than acceptable levels 1, 2 and 3. By meeting these acceptable levels, impacts will be consistent with Conservation Management Plan for the Blue Whale 2015-2025 (CoA, 2015b) and National Recovery Plan for the Southern Right Whale Eubalaena australis (DCCEEW 2024o). Specific measures in the procedure will include the following:

- pre-start-up visual observations.
- start-up and normal operating procedures, including a process for delayed start-up/recommencement, should whales be sighted.
- night time and low visibility procedures
- use of suitably trained Marine Mammal Observers (MMO)

Adaptive management will be detailed the procedure to be included in future EPs under this OPP when scheduling of the activity is known in greater detail.

CM17 Drilling Whale Management Procedure

Development and implementation of a whale management procedure which outlines specific measures to minimise anthropogenic noise threats to relevant species, including the implementation of safe operating distances between vessels and whales, pre-activity surveys for specific activities, night-time and low visibility controls and establishment of safe points for operational activities in accordance with the Safety Case and Well Integrity requirements for drilling activities. This procedure provides a framework for minimising noise impacts to whales and details specific measures to be implemented that will ensure impacts and risks meet or are better than acceptable levels 1, 2 and 3. By meeting these acceptable levels, impacts will be consistent with

Demonstration of Acceptability

Conservation Management Plan for the Blue Whale 2015-2025 (CoA, 2015b) and National Recovery Plan for the Southern Right Whale Eubalaena australis (DCCEEW 2024o). Specific measures in the procedure will include the following:

- pre-start-up visual observations.
- start-up and normal operating procedures, including a process for delayed start-up/recommencement, should whales be sighted.
- night time and low visibility procedures
- use of suitably trained Marine Mammal Observers (MMO)
- weekly aerial surveys to detect and report the presence of whales within 20 km for anchor pre-lay, rig mooring and resupply activities in the shelf edge locations

Adaptive management will be detailed the procedure to be included in future EPs under this OPP when scheduling of the activity is known in greater detail.

CM18 Vessel Whale Management Procedure

Development and implementation of a whale management procedure which outlines specific measures to minimise anthropogenic noise threats to relevant species, including the implementation of safe operating distances between vessels and whales, night-time and low visibility controls and pre-activity surveys for installation, IMR and vessel transit/resupply activities. This procedure provides a framework for minimising noise impacts to whales and details specific measures to be implemented that will ensure impacts and risks meet or are better than acceptable levels 1, 2 and 3. By meeting these acceptable levels, impacts will be consistent with Conservation Management Plan for the Blue Whale 2015-2025 (CoA, 2015b) and National Recovery Plan for the Southern Right Whale Eubalaena australis (DCCEEW 2024o). Specific measures in the procedure will include the following:

- pre-start-up visual observations.
- start-up and normal operating procedures, including a process for delayed start-up/recommencement, should whales be sighted.
- night time and low visibility procedures
- use of suitably trained Marine Mammal Observers (MMO)

Adaptive management will be detailed the procedure to be included in future EPs under this OPP when scheduling of the activity is known in greater detail.

CM19 Noise Assessments

Acoustic noise assessments of significant noise generating activities associated with the Project will

Demonstration of Acceptability		
		be detailed in relevant activity specific Environment Plans prior to activities commencing. The EPs will detail the sound levels and distances to noise effect criteria, with the mitigations required to ensure the acceptable levels and Environmental Performance Outcomes of this OPP are met and ensure consistency against Conservation Management Plan for the Blue Whale 2015-2025 (CoA, 2015b) and National Recovery Plan for the Southern Right Whale Eubalaena australis (DCCEEW 2024o).

6.4.6 Environmental Performance

In accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 6-31) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 6-30 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 6-31 are met.

Table 6-31: Environmental Performance Outcomes – Emissions – Underwater Sound

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 1: No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetaceans species.	EPO7:	No death or injury[1] to listed threatened or migratory species from Project activities.
	EPO8:	Biologically important behaviours[2] can continue while Project Activities are being undertaken.
	EPO10:	Anthropogenic noise in biologically important areas and habitat critical to the survival of a species will be managed such that: - Any blue whale continues to utilise biologically important areas without injury[1], and is not displaced from a foraging area. It does not prevent any southern right whale from utilising biologically important areas or habitat critical to the survival of a species or cause auditory impairment (TTS and PTS).
	EPO11:	Implement CM15, CM16, CM17, CM18 Whale Management Procedures to ensure impacts and risks to whales from underwater sound are managed in accordance with relevant recovery plans.

Defined Acceptable Level	Environmental Performance Outcomes	
	EPO12:	Implement CM19 Noise Assessments to ensure impacts and risks to whales from underwater sound evaluated in relevant activity specific Environment Plans are based on the latest available scientific research on noise effect criteria.

---

[1] Injury to cetaceans as defined as auditory impairment from the onset of TTS and PTS, where DAWE (2021a) defines 'injury to blue whales' as:

> *For the purpose of interpreting and applying Action Area A.2 of the Blue Whale CMP, injury is both permanent and temporary hearing impairment (Permanent Threshold Shift and Temporary Threshold Shift) and any other form of physical harm arising from anthropogenic sources of underwater noise.*

[2] Biologically important behaviours such as reproduction, feeding, migration and resting (DCCEEW, 2023j).

6.5 **Emissions – Atmospheric Emissions**

6.5.1 Hazard Identification

Atmospheric emissions can be divided into greenhouse gas (GHG), and non-GHG emissions – also known as atmospheric pollutants. This section will only evaluate non-GHG emissions (atmospheric pollutants). GHG emissions are assessed in Section 6.6.

Atmospheric emissions refer to the release of atmospheric pollutants including gases, particles, and other substances into the air. These emissions have the potential to impact on air quality and human health. Atmospheric pollutants considered in this section include: Carbon monoxide (CO), Particulate Matter (PM) (i.e. dust in the air), typical pollutants for nitrogen oxides (NO_x), sulphur oxides (SO_x), and non-methane volatile organic compounds (NMVOCs), which includes aromatic (BTEX – benzene, toluene, ethylbenzene and xylene) and aliphatic (propane and long organic compound containing carbon and hydrogen joined together in straight chain).

Atmospheric emissions will be generated in the Project Area during the Project stages and associated activities identified in Table 6-32.

Table 6-32: Activities Undertaken During the Project that will Generate Atmospheric Emissions

Stage	Activity
Drilling and completions	Well Completion, Unload and Test
Support operations	MODU operations Vessel operations Helicopter operations

6.5.2 Hazard Description

6.5.2.1 Drilling and Completions

Well unloading and testing may generate atmospheric emissions if flaring is required.

Flaring associated with well flowback during the potential testing of the wells via the drilling rig may occur in the initial or future drilling campaigns if the base case of unloading the wells to the OGP is not feasible.

The duration of flaring for unloading a well of well construction fluid to the rig is in the order of one to two days per well and up to approximately 65 MMscf per day being flared.

During a well unload and test, when the gas volume and the rate of emission is typically significantly lower than which would be burnt at flare, it is necessary to bleed off formation fluids (gas) direct to atmosphere such that gas is cold vented rather than flared.

6.5.2.2 Support Operations

Atmospheric emissions will be generated from MODU, vessel and helicopter operations via the use of fuel for onboard generators and engine operation to generate power. Fuel will be marine diesel oil (MDO) or marine gas oil (MGO). Pollutants such as PM, CO, NO_x, SO2 and NMVOCs are released to the atmosphere during the combustion of these fuels.

Helicopters will be used during well construction and installation activities, primarily for crew change and medevac, and occasionally equipment and material transfers. Helicopter flights are expected to occur of 8 times a week during drilling and completions, installation, IMR, well intervention, and decommissioning, dependent on the progress of the drilling program, subsea installation, and logistical constraints. Helicopters use aviation fuel.

6.5.3 Impact Analysis and Evaluation

Atmospheric emissions have the potential to result in the following impact:

- change in air quality.

Atmospheric emissions generated during the Project are unlikely to impact on human health or amenity due to the remote location and rapid dispersion and dilution offshore. NO_2 is the main emission that poses a threat to receptor health. NO_2 emissions from routine MODU power generation for an offshore project was previously modelled by BP (BP, 2013). The model demonstrated that atmospheric emissions generated by MODU operations may increase ambient NO_2 concentrations by 1 $\mu g/m^3$ (0.001 ppm) within 10 km of the source. The predicted change in NO_2 concentrations within 10 km, is well below the WHO air quality guideline for NO_2 of 40 $\mu g/m^3$ annual mean. Given the change in NO_2 concentrations is limited to offshore environment and does not overlap coastal settlements, adverse impact on local or regional biodiversity, ecological integrity, social amenity, or human health is not predicted.

The Project Area overlaps foraging BIAs for albatross, petrel, and shearwater species. No habitat critical to the survival of birds occur within the Project Area. As it is unlikely that seabirds would remain close to the emission source for an extended period interaction between change in air quality and marine fauna are not predicted. Rapid dispersion and dilution will also ensure that seabirds and other fauna are not chronically exposed to concentrated plumes from vessel exhaust points. The impact associated with atmospheric emissions is therefore limited to change in air quality.

6.5.3.1 Air Quality

Intermittent atmospheric emissions during the Project from fuel combustion, flaring or venting will temporarily change the air quality within the immediate surrounds of the discharge location.

Air quality within the project area is expected to be high and typical to that of an unpolluted offshore environment. Emissions generated during activities will be similar to that generated during other activities undertaken in the region and result in a localised decrease in air quality at the point of release. The open ocean environment and prevailing winds of the Otway means that atmospheric emissions will rapidly disperse to background levels close to the emission source.. Concentrations of air emissions are not expected to be above the National Environment Protection (Ambient Air Quality) Measure levels at any point throughout the Project.

Atmospheric emissions from flaring and venting are not predicted to result in a substantial change to air quality within the local air shed given the dry gas is expected to readily combust via the flare package high-efficiency burner head or rapidly disperse in the wind.

Given the limited duration and intermittent nature of support operations, flaring and venting activities during the Project, and the rapid dispersion of atmospheric emissions close to the source, no substantial or cumulative impacts to air quality within the local airshed are predicted.

Temporary and localised changes to air quality from atmospheric emissions have been evaluated as a Minor (1) consequence.

6.5.4 Impact Evaluation Summary

The impact evaluation for atmospheric emissions is summarised in Table 6-33.

Table 6-33: Impact Evaluation Summary for Atmospheric Emissions

Summary	
Summary of impact	Atmospheric emissions generated during fuel combustion, flaring or venting operations in the Project Area are expected to temporarily change the air quality within the immediate surrounds of the discharge location. The Minor (I) consequences to air quality from atmospheric emissions is considered acceptable, given the controls are in place to ensure potential impacts are better than the defined acceptable level 1.
Extent and duration of impact	Localised - the open ocean environment and prevailing winds of the Otway Basin will rapidly disperse atmospheric emissions generated by the Project. Rapid dispersion allows for air quality to return to background levels within the immediate surrounds of the discharge location. Temporary - the intermittent short-term nature of support operations, flaring and venting activities prevents on-going generation of atmospheric emissions, as a result change to air quality will be infrequent and temporary.

Level of certainty	Impacts from atmospheric emissions are well understood and there is nothing new or unusual. Good practice is defined through the implementation of the following controls which ensures uncertainty is minimal: • Beach is committed to MARPOL Annex VI prevention of air pollution from ships • Beach is committed to measure, monitor or estimate facility fuel and flare emissions (in accordance with the National Pollutant Inventory) Beach has long-term experience in the area on the application of good industry practice to ensure impacts associated with atmospheric emissions are acceptable.
Is the impact considered lower-order or higher-order?	Potential impacts from atmospheric emissions have been evaluated to result in Minor (I) consequences. Minor consequences are considered lower-order impacts that is acceptable with the application of good industry practice.
Impact consequence	
Minor	

6.5.5 Demonstration of Acceptability

Table 6-34 demonstrates how and why predicted environmental impacts from atmospheric emissions meet the defined acceptable levels (Table 5-4).

Table 6-34: Demonstration of Acceptability – Atmospheric Emissions

Demonstration of Acceptability		
Impact and risk comparison with relevant defined acceptable levels	Potential localised impacts from atmospheric emissions in the Project Area is expected to result in minor consequences to air quality. The acceptable level relevant to atmospheric emissions is acceptable level 8 (as detailed in Table 5-4). A Minor (1) impact consequence level was assigned for this aspect based on the impact analysis and evaluation. Minor (1) consequences from atmospheric emissions: • will ensure temporary change in air quality from atmospheric pollutants emitted during Project activities (as defined in the OPP) will comply with MARPOL Annex VI (Prevention of Air Pollution from Ships) enacted in the *Navigation Act 2012*. As a result, the predicted environmental impact for atmospheric emissions is below the defined acceptable level 9.	
Principles of ESD	Integration principle	Section 6.5.3 identifies and evaluates environmental impacts associated with atmospheric emissions. Conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental impact. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks. For Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders on the Project

Demonstration of Acceptability		
		and associated activities. No objections or claims were raised in Phase 1: Initial Project Consultation. For Phase 2: Project OPP Public Comment Period (Section 10.2.4), the public had the opportunity to provide further comment to this OPP during the period (18/3/2024 – 20/5/2024). Beach prepared the public comment report summarising all comments, an assessment of the merits of each comment, a statement of the response to each comment, and an outline of any changes made to the OPP as a result of the comment (Appendix P). The assessment of merit for comments against this aspect found the response provided in the public comment report to be sufficient to address the comments against this aspect. Therefore, no further updates were required for this aspect. Given the thorough assessment and responses outlined in the public comment report, the impact evaluation for this aspect remains acceptable as is, demonstrating that public comments have been adequately addressed. The potential environmental impact against this aspect was assessed as having a Minor (1) impact consequence level which is considered a lower-order environmental impact. Lower-order environmental impacts are considered 'broadly acceptable' and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental impacts against this aspect were assessed as having a Minor (1) impact consequence level which is considered a lower-order environmental impact and below the defined acceptable level 8. Lower-order environmental impacts cannot result in serious or irreversible environmental damage. There is high confidence in the potential environmental impacts and effectiveness of controls against this aspect. Beach has significant experience operating in the Otway and Bass based on their existing offshore developments and associated activities including the Beach Otway Drilling Campaign in 2021/2022.
	Intergenerational principle	The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts for atmospheric emissions is lower than the defined acceptable level 8; the health, diversity, or productivity of the environment for future generations is expected to be maintained.
	Biodiversity principle	Section 6.5.3 identifies and evaluates environmental impacts associated with atmospheric emissions. Air quality is a component of the Commonwealth Marine Area, which is a MNES. Given predicted environmental impacts from atmospheric emissions are lower than the defined acceptable level 8; there is no potential to affect biological diversity or ecological integrity.

<table>
<tr><th colspan="3">Demonstration of Acceptability</th></tr>
<tr><td>Internal context</td><td>Beach Policy compliance</td><td>The defined acceptable levels, EPOs and controls proposed for this aspect are consistent with Beach Environmental Policy objectives. As a result, potential environmental impacts and risks from Project can be managed to align with Beach Environmental Policy objectives.</td></tr>
<tr><td>External context</td><td colspan="2">Stakeholder engagement is being carried out as part of this OPP process.
Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable.
During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect.
During Phase 2: Project OPP Public Comment Period (Section 10.2.4), comments were raised against this aspect. The assessment of merit for comments against this aspect found the responses provided in the public comment report to be sufficient to address the comments against this aspect. Given the thorough assessment and responses outlined in the public comment report, the impact evaluation for this aspect remains acceptable as is, demonstrating that public comments have been adequately addressed.</td></tr>
<tr><td>Other requirements</td><td colspan="2">Other requirements associated with this aspect includes compliance with Australian legislative requirements.
Management of this aspect is aligned with the legislative requirements below.
<table>
<tr><th>Requirement</th><th>Demonstration</th></tr>
<tr><td>Navigation Act 2012 (Cth)
Section 4 – Prevention of pollution
MO 97: Marine pollution prevention – air pollution</td><td rowspan="4">This requirement is addressed through the adoption of the following control measures:
CM20 MARPOL Annex VI (Prevention of Air Pollution from Ships)
Vessels and MODU will comply with MARPOL Annex VI (Prevention of Air Pollution from Ships), the Navigation Act 2012, the Protection of the Sea (Prevention of Pollution from Ships) Act 1983 and Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution (appropriate to vessel class) for emissions from combustion of fuel including:
• valid International Air Pollution Prevention (IAPP) certificate and a current international energy efficiency certificate
• Ship Energy Efficiency Management Plan (SEEMP) as per MARPOL 73/78 Annex VI
• engine NO_x emission levels will comply with Regulation 13 of MARPOL 73/78 Annex VI
• use low sulphur content fuel oil/diesel (≤0.5% m/m S) or an approved measure that achieves an equivalent air quality outcome
CM21 Emissions Monitoring</td></tr>
<tr><td>Protection of the Sea (Prevention of Pollution by Ships) Act 1983 (Cth)
Part IIID – Prevention of air pollution
MO Part 97 (Air Pollution), enacting MARPOL Annex VI (especially Regulations 6, 14, 16).</td></tr>
<tr><td>Ozone Protection and Synthetic Greenhouse Gas Management Act 1989
Aims to reduce the impact of ozone depleting substances and synthetic greenhouse gases.</td></tr>
<tr><td>NEPM Ambient Air Quality Standards
Standards for ambient air quality that allows for the adequate</td></tr>
</table></td></tr>
</table>

	Demonstration of Acceptability	
	protection of human health and well-being.	Measure, monitor or estimate facility fuel and flare emissions (in accordance with the National Pollutant Inventory) to inform and optimise management practices and minimise environmental impact of emissions. **CM22 Emission Abatement Opportunities Register** Per the requirements of the OEMS Sustainability Standard, Beach will maintain a register of opportunities for emissions reduction across its asset portfolio to reduce emissions.

6.5.6 Environmental Performance

In accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 6-) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 6-34 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 6- are met.

Table 6-35: Environmental Performance Outcomes – Atmospheric Emissions

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 8: Temporary change in air quality from atmospheric pollutants emitted during Project activities (as defined in the OPP) will comply with MARPOL Annex VI (Prevention of Air Pollution from Ships) enacted in the *Navigation Act 2012*.	EPO13:	Manage atmospheric emissions from the combustion of fuel during vessel and MODU operations in accordance with MARPOL Annex VI (Prevention of Air Pollution from Ships) enacted in the *Navigation Act 2012*.
	EPO14:	Implement CM22 Emissions Abatement Opportunities Register to maintain a register of opportunities for emissions reduction across its asset portfolio to reduce emissions.

6.6 Emissions – Greenhouse Gases

6.6.1 Hazard Identification

Greenhouse gas (GHG) emissions are associated with global warming and climate change. GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6) and specified types of hydrofluorocarbons and perfluorocarbons. GHGs trap heat in the Earth's atmosphere, leading to an increase in the planet's average temperature. This can lead to a variety of negative effects, including more extreme weather events, sea level rise, ocean acidification and changes in the distribution of plant and animal species. These changes can cause harm to human populations and ecosystems and could potentially have severe economic and social consequences.

6.6.2 Hazard Description

The activities listed in Table 6-36 may generate GHG emissions.

Table 6-36: Activities Undertaken During the Project which will Generate GHG Emissions

Stage	Activity
Drilling and completion	Well unload and production testing (flaring)
Production	Gas processing (fuel use, reservoir CO_2, fugitive emissions) Well intervention
Support Activities (all stages)	MODU operations, Vessel operations
Decommissioning	Plug and abandonment of wells

6.6.2.1 Drilling and Completions

Drilling will be carried out using a MODU. During well unload and production testing activities, the well is flowed to remove contaminants, including drilling or completions fluids and debris from the formation. These contaminants are flowed back via the OGPP to the onshore production separator, and the reservoir gas is flared. Unloading and production testing the well to the MODU for the Project is not intended, however, is provided for in this OPP as a contingency in the event it is required for technical and feasibility reasons. This may result in up to approximately 65MMscf of gas per day being flared for between one and two days per well.

During drilling fugitive emissions will result from releases from process vents, system upsets and accidents.

6.6.2.2 Production

During production, reservoir fluids will be extracted, transported via the OGPP to the OGP for processing. The OGP supplies gas to the domestic market in south-east Australia. GHG emissions will be produced during processing, transport and end use of sold products.

Well intervention and workovers may be required during Production. Flaring may be required as part of well intervention, similar to drilling. If well intervention is required, it will be infrequent, and if flaring is required, the estimated duration is one to two days per well. During well intervention, unloading and testing the well to the MODU is not intended however is provided for in this OPP as a contingency in the event it is required for technical and feasibility reasons. This may result in up to approximately 65MMscf of gas per day being flared for between one and two days per well. During well intervention, small volumes of gas may need to be transferred back to the OGP. The frequency of well intervention and workover activities depends on well performance, objective criticality, MODU/vessel availability and regulatory requirements with one well every 7 years being estimated based on historical interventions.

During production, fugitive emissions may occur from Project and existing infrastructure.

GHG emissions will also be generated from the processing of Project hydrocarbons, and from the transportation and use of sold products.

6.6.2.3 Support Activities

GHG emissions will be produced from combustion of fuel for power generation and propulsion on the MODU and support vessels during all phases.

6.6.2.4 Decommissioning

During well P&A, GHG emissions may occur due to unloading the well to the MODU is not intended however is provided for in this OPP as a contingency in the event it is required for technical and feasibility reasons. This may result in up to approximately 65 MMscf of gas per day being flared for between one and two days per well.

6.6.3 Impact Analysis and Evaluation

6.6.3.1 Greenhouse Gas Emissions Assessment

Beach commissioned Xodus to undertake a Greenhouse Gas emissions quantification assessment for the Project (Xodus 2025, Appendix K).

All emissions factors and energy content figures used to predict emissions were sourced from the NGER (Measurement) Determination 2008 and the API Compendium of GHG Emissions Methodologies (API 2009).

Emissions estimates are based on current Project definition and assumptions, current control measures, with inputs from the nature of the feed gas, and the efficiency and processes of the existing facilities.

Emissions are categorised based on the type of emissions:

- Scope 1 greenhouse gas emissions are emissions released into the atmosphere as a direct result of the activities at an organisation's facility. To align with the boundary of this OPP Scope 1 has been further categorised as:
  - Emitted within Project Boundary. Scope of OPP
  - Emitted outside Project Boundary (denoted Scope 1*)
- Scope 2 emissions for a facility represent the emissions that were released outside of an organisation's facility boundary to produce the electricity that is imported into the facility and used.
- Scope 3 emissions are indirect emissions other than scope 2 emissions. They occur outside of the boundary of an organisation as a result of the organisation's actions.

The activities and sources that emit GHG emissions over the lifecycle of the Project are outlined Table 6-36.

Table 6-37: Activities and Sources that Contribute to GHG Emissions from the Project

GHG Scope	Phase	Sub-Category	Source / Activities
1 (Emitted within Project Boundary. Scope of OPP)	Drilling and Completions; Production	Flaring & Venting	Well unload, well testing. Well intervention
	Production	Fugitive Emissions	Fugitive emissions from wells and flowlines
1* (Emitted outside Project Boundary)	Production	Reservoir CO_2	Reservoir CO_2 from Artisan, La Bella and future prospects emitted at OGP.
	Production	Onshore gas processing	Estimated fuel use apportioned to the processing of well fluids from Artisan, La Bella and prospects.
	Production	Onshore gas processing (fugitive emissions)	Fugitive emissions from OGP apportioned to throughput from Artisan, La Bella and prospects.
3	Support Activities (all stages)	Vessels	Variations of fleet including MODU and support vessels and helicopters required for: • Drilling • Installation • Inspection, Maintenance and Repair (IMR) • Well workover, • Decommissioning
	Production	Transmission and distribution losses	Transmission and distribution losses related to sales gas, assuming all sales gas are sold into the Victorian market.
		Sales Product	Use of sales gas, condensate from Artisan, La Bella and future prospects.
	Drilling and Completions, Installation, Decommissioning	Materials	Wells, flowlines, subsea equipment, cement, drilling mud.
	Production	Onshore gas processing	Estimated fuel use apportioned to the processing of well fluids from Artisan, La Bella and future prospects at OGP, including fugitive emissions.

GHG Scope	Phase	Sub-Category	Source / Activities

There are no scope 2 emissions from the Project.

The key inputs for the inventory assessment cover the full scope of the Project, including potential future development, as follows:

- Drilling of up to 8 wells between 2025 and 2026 (Note Artisan has been drilled, making a total of 9 wells in scope of the Project).
- Completions of up to 9 wells in 2027.
- Installation of associated infrastructure and flowlines for up to 9 wells in 2028.
- Production from existing wells and new wells from the Project to year 2045. The wells from the Project is forecasted to produce hydrocarbons from 2028 to 2038.
- Operations, and decommissioning of up to 9 wells and associated infrastructure from the Project by 2049.

The characteristics of the hydrocarbons, including CO_2 content, from the La Bella and Artisan fields are based on samples from these fields. Compositions from nearby fields targeting similar geological formations (Artisan and Thylacine) were used as conservative and representative proxies for the future prospects for this inventory assessment (refer to Section 3.6).

The input values used in the emissions estimates are considered “credible high” values, this accounts for a range of uncertainties including extended contingencies beyond a typical schedule of an activity. Up to 9 wells, with associated infrastructure, were considered in the emissions estimates, including at Artisan, La Bella, and future prospects.

The emissions created as a result of the Project at OGP have been determined. For fuel gas usage/processing feed gas and fugitive emissions, the emissions were calculated by determining the proportion of feed gas to be supplied by the Project to OGP compared to existing supply sources, on an annual basis. This annual proportion was used to apportion the fuel gas usage at OGP (based on historical data) required to process the Project feed gas, which was in turn used to calculate the predicted emissions. The calculated annual proportion of feed gas was also used to apportion the fugitive emissions at OGP (based on historical data) to the Project. Reservoir CO_2 venting at OGP was determined based on the flow rate of Project feed gas and the percentage of reservoir CO_2 in the Project feed gas.

Additional details related to the methodology and assumptions used in the emissions estimates are provided in Appendix K.

Table 6-38 provides a summary of the emissions inventory results. The emissions a forecasted based on scope 1 (Inside Project Boundary), and scope 1* (Outside Project Boundary) and scope 3, which comprises reservoir CO_2, embodied carbon, onshore processing at OGP and sale products.

Table 6-38: Emissions related to the Project Summary

Emissions t CO_2-e	**Scope 1 (Inside Project Boundary)**			**Scope 1* (Outside Project Boundary)**			**Scope 3**					**Total**
	Flaring	Venting	Fugitive (wells)	Processing	Fugitives (processing)	Reservoir CO2	Vessels	Helios	Embodied Carbon	Transmission and Distribution Losses	Product	
	103,505	1,507	14,560	751,162	20,235	318,645	393,296	1,287	124,322	366,203	10,954,872	13,049,595

Annualised emissions related to the Project are provided in Section 3.3 of Appendix K.

The emissions estimates do not account for ongoing emissions reduction that may be realised at OGP or by users of sold products.

The Project equates to a very small fraction of global emissions. In isolation, they will have no discernible impact on GHG concentrations in the atmosphere. Project gas is backfill for, and a replacement for, the depleting Thylacine and Geographe fields – the sales gas production is constrained by the existing facility, and no modifications to the gas plant is made. Thus, the emissions would be consistent on a per annum basis at the same sales gas production rate.

The United Nations International Panel on Climate Change in its Sixth Assessment Report forecast the remaining carbon budgets (from 1 January 2020) for a 50% likelihood to limit global warming to a specified range of temperature increase based on pre-industrialised levels (i.e. since 1850-1900) (IPCC, 2021). These carbon budgets and the percentage of carbon budget used due to the Project are shown in Table 6-39.

Table 6-39: Comparison of emissions related to the Project to the Global Carbon Budget

Global surface temperature change	**Estimated carbon budgets (50th percentile)**	**Percentage of Global Carbon Budget used due to the Project** **(Scope 1 (Inside Project Boundary), scope 1* (Outside Project Boundary) and scope 3)**
1.5°C	500 $GtCO_2$	0.0025%
2.0°C	1350 $GtCO_2$	0.0009%

In 2022, Australia revised its National Determined Contribution (NDC) under the Paris Agreement to reduce GHG emissions to 43% below 2005 levels by 2030 and reaffirmed the net zero emissions by 2050 target. These targets are legislated under the Commonwealth *Climate Change Act 2022*.

The Commonwealth Government has modelled a range of annual carbon reduction scenarios. The scenario modelled that is most relevant to this assessment is the ‘with additional measures’, which includes policies and measures in place at the time of publication. The ‘with additional measures’ scenario includes the 82% renewable energy target in Australia’s electricity grid by 2030 and further measures under the National Electric Vehicle Strategy (DCCEEW 2024r). Noting that the Safeguard Mechanism imposes a binding requirement on large emitters to net emissions reduction and net zero by 2050, consistent with Australia’s NDC under the Paris Agreement) [**PC218**].

An Australian carbon budget over the period of the Project (2025 to 2049) was calculated by:

- Using the DCCEEW Emissions Projections 2024 under the ‘with additional measures’ scenario to determine the Australian annual emissions (DCCEEW 2024r). Summing these annual projected emissions for the years where the Project activities and the DCCEEW forecast overlap (2025 to 2040). This provides a carbon budget for this period, and:

- for the period of 2041 to 2049, assuming a linear decline from the 2035 budget to zero emissions by 2050. The annual emissions budgets were summed to create an annual budget for this period.
- Both of these carbon budgets are summed together.

This creates an Australian carbon budget of 6729 Mt CO_2-e. The total scope 1 (Inside Project Boundary), scope 1* (Outside Project Boundary) and scope 3 GHG emissions from the Project are estimated to be approximately 0.19% of the Australian carbon budget [**PC218, PC326**].

6.6.3.2 Potential Impact

GHG emissions generated during the Project can contribute to the overall concentration of GHG emissions in the Earth's atmosphere. This consequence evaluation considers the contribution of emissions attributed to the Project (i.e. scope 1 [Inside Project Boundary], scope 1* [Outside Project Boundary] and scope 3) to global emissions and the potential impacts of climate change on sensitive receptors, including MNES within Australian jurisdictions.

It is important to acknowledge that climate change impacts cannot be directly attributed to any one activity, as they are the result of global GHG emissions, minus global GHG sinks, that have accumulated in the atmosphere since the industrial revolution began. Therefore, there is no direct link between GHG emissions from the Project and climate change impacts to specific ecological receptors.

Changes to production capacity, reservoir composition or process design are managed under Beach's Management of Change and Project Management Systems (depending on the complexity), both of which require an assessment of the change in safety, environment and financial risk profile brought about by the proposed change, and if material, each require revisions to the relevant EP, Safety Case and/or WOMP as a necessary step to achieve completion.

1. Climate Systems

The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) Working Group I was released in August 2021. The IPCC states with high confidence that many extreme heat events and global surface temperature rise would not have occurred without human influence and could be irreversible for several decades to millennia (IPCC 2021).

This is reiterated in the AR6 Synthesis Report released in March 2023, "Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850-1900 in 2011-2020. Global greenhouse gas emissions have continued to increase over 2010-2019, with unequal historical and ongoing contributions arising from unsustainable energy use, land use and land-use change, lifestyles and patterns of consumption and production across regions, between and within countries, and between individuals (high confidence). Human-caused climate change is already affecting many weather and climate extremes in every region across the globe" (IPCC 2023).

According the AR6 Synthesis Report, heat extremes (including heatwaves) have become more frequent and more intense across most land regions since the 1950s while cold extremes have become less frequent and less severe. Marine heatwaves have approximately doubled in frequency since the 1980s. The frequency and intensity of heavy precipitation events have increased since the 1950s over most land areas for which observational data are sufficient for trend analysis. It is likely that the global proportion of major (Category 3–5) tropical cyclone occurrence has increased over the last four decades (IPCC 2023).

The State of the Climate 2024 (BoM and CSIRO 2024) reported that:

- Australia's climate has warmed by an average of 1.51 ± 0.23 °C since national records began in 1910.
- Sea surface temperatures have increased by an average of 1.08 °C since 1900.

Considering scope 1 (Inside Project Boundary), scope 1* (Outside Project Boundary) and scope 3 from the Project, the contribution to national and global carbon budgets over the duration of the Project will be:

- 0.19% of the Australian carbon budget
- 0.0025% of the global carbon budget under a modelled 1.5°C temperature increase scenario
- 0.0009% of the global carbon budget under a modelled 2°C temperature increase scenario.

2. Ecosystems

Ecosystems that are particularly susceptible to adverse effects of climate change include alpine habitats, coral reefs, wetlands and coastal ecosystems, polar communities, tropical forests, temperate forests and arid and semi-arid environments (DoEE 2019). In Australia, this includes coral reefs, alpine regions, rainforests, arid and semi-arid environments, mangroves, grasslands, temperate forests and sclerophyll forests. Future climate change (increased temperature and decreased, but more variable, rainfall) has the potential to have a range of impacts on ecological factors and threaten biodiversity in the Australian Mediterranean ecosystem (CSIRO 2017a).

Redistribution and reorganisation of natural systems, driven by climate-change, is a major threat to biodiversity (Chapman et al. 2020). A report by Australia's Biodiversity and Climate Change Advisory Group summarises the potential impacts of climate change to marine and terrestrial species, habitats, and ecosystems across Australia (Steffen et al. 2009). The impacts to taxa are outlined in Table 6-40 and the impacts to ecosystems in Table 6-41.

Extensive modelling and monitoring studies over the last twenty years provide considerable evidence that global climate change is already affecting and will continue to affect species (Hoegh-Guldberg et al. 2018) however, these impacts are likely to be highly species-dependent and spatially variable. The most frequently observed and cited ecological responses to climate-change include species distributions shifting towards the poles, upwards in elevation and shifts in phenology (earlier and later autumn life history events) (Dunlop et al. 2012). Climate change may not only change species distribution patterns but also life-history traits such as migration patterns, reproductive seasonality, and sex-ratios.

Impacts of climate change such as altering temperature, rainfall patterns and fire regimes, are likely to lead to changes in vegetation structure across terrestrial ecosystems within Australia (Table 6-41, Dunlop et al. 2012). Increases in fire regimes will impact Australian ecosystems altering composition structure, habitat heterogeneity and ecosystem processes. It has been found that is already been an increase in extreme fire weather in Australia, with a longer fire season, across large parts of the country since the 1950s (BoM and CSIRO 2024). Changes in climate variability, as well as averages, could also be important drivers of altered species interactions, both native and invasive species (Dunlop et al. 2012). Climate change could result in significant ecosystem shifts, as well as alterations to species ranges and abundances within those ecosystems (Hoegh-Guldberg et al. 2018).

The IPCC Special Report describes impacts of warming above pre-industrial levels to key receptor groups including terrestrial ecosystems, mangroves, warm-water corals, unique and threatened systems, and arctic regions (Hoegh-Guldberg et. al. 2018). These receptor groups show varying sensitivity to warming conditions, with a range of responses shown at 1°C warming; from corals suffering moderate impacts, to mangroves not showing any impacts that are detectable and attributable to climate change (Hoegh-Guldberg et al. 2018). As warming reaches 1.5°C, which has already experienced in Australia (BoM and CSIRO 2024), all receptor groups show impacts attributable to climate change with severity ranging from moderate impacts that are detectable and attributable to climate change (mangroves), to impacts that are severe and widespread (warm-water corals) (Hoegh-Guldberg et al. 2018). At the point where global temperature rise, due to climate change, reaches 2°C, increasing numbers of receptor groups suffer impacts which are high to very high, and likely to be irreversible (terrestrial ecosystems, warm-water corals, unique and threatened systems, and arctic regions) (Hoegh-Guldberg et al. 2018).

The State of the Environment (SoE) report is produced every five years by the Australian Government as a comprehensive review on the state of the Australian environment. The most recent report was released in July 2022. The SoE concluded that climate change and extreme weather events was impacting the Australian environment and especially impacting various taxa (DCCEEW 2021). In many cases, the impacts of climate change on biodiversity are exacerbated by other pressures such as land clearing and invasive species, but in some cases impacts can be unequivocally attributed to climate change. A summary of the SoE impacts from climate change is provided in Table 6-43.

3. Terrestrial Ecosystems

All terrestrial ecosystems are likely to be impacted by a changing climate (Table 6-41, Steffen et al 2009, Hughes 2011, Dunlop et al. 2012, Hoegh-Guldberg et. al. 2018). The predicted impact of climate change on these ecosystems is highly variable, both between ecosystems and within individual ecosystems (Dunlop et al. 2012). Below is a summary of potential climate change impacts to two key terrestrial ecosystems – tropical rainforests and alpine/montane areas, other terrestrial ecosystems are summarised in Table 6-41.

a. Tropical Rainforests

Projections of future climate changes in the wet tropics of Australia under different scenarios are outlined by McInnes (2015). It is likely that temperatures in the wet tropics will become hotter and potentially fires and cyclones will be more intense. Consequently, there is an increased probability of fires penetrating into rainforest vegetation resulting in a shift from fire-sensitive vegetation to communities dominated by fire-tolerant species; and changing rainforest disturbance regime as cyclones become more intense) (Hughes 2011, Steffen et al. 2009). Changes in the timing of seasons (e.g., extended summer) could cause change in the seasonal response of plants, and alterations to species ranges and abundances (Hoegh-Guldberg et al. 2018).

b. Alpine/Montane Areas

Alpine systems are generally considered to be among the most vulnerable to future climate change (Hughes 2003). The extent of true alpine habitat in Australia is very small (0.15% of the Australian land surface) with limited high-altitude refuge (Hughes 2003). Australian alpine regions are home to a variety of alpine vertebrates who rely on snow cover for their survival. Maximum snow depth, snow cover and number of snow days have all decreased in Australian alpine regions since the late 1950s (BoM and CSIRO 2024). There is evidence of a reduction in populations of dusky antechinus, broad-toothed rats, and the mountain pygmy possum. The first two species are active under the snow throughout winter and are therefore subject to increased predation by foxes when snow is reduced (Hughes 2003). The pygmy possum depends upon snow cover for stable, low temperatures during hibernation (Hughes 2003).

4. Marine Ecosystems

Average sea surface temperature in the Australian region has warmed by 1.08°C since 1900, with nine of the 10 warmest years on record occurring since 2010 (BoM and CSIRO 2024). A warming ocean affects the global ocean and atmospheric circulation, the cryosphere, global and regional sea levels, and causes losses in dissolved oxygen, impacts on marine ecosystems (BoM and CSIRO 2024), including changes to species abundance, community structure and increased frequency and intensity of thermally induced coral bleaching events (CSIRO 2017a).

Oceanic warming has also served to alter ocean currents around Australia. In response to both ocean warming and stratospheric ozone depletion, the East Australian Current has increased in strength by about 20% between 1978 and 2005 (Cai and Cowan 2006) and extended further south, creating an area of more rapid warming in the Tasman Sea, where the warming rate is now twice the global average (BoM and CSIRO 2024). Sea-surface temperatures are projected to continue to increase, with estimates of warming in the Southern Tasman Sea of between 0.6 to 0.9°C and between 0.3 to 0.6°C elsewhere along the Australian coast by 2030 (Church et al. 2006).

Global mean sea level increased by 0.22 m since 1900 (BoM and CSIRO 2024). Global mean sea level rise is accelerating. Tide gauge and satellite altimetry observations show that the rate of global mean sea level rise increased from 1.5 cm (± 0.2 cm) per decade from 1901 to 2000, and is now approaching 4 cm (± 0.4 cm) per decade from 1993 to 2023. The dominant cause of global mean sea level rise since 1970 is anthropogenic climate change (BoM and CSIRO 2024).

Global mean sea level is predicted to rise between 0.308 m and 0.448 m by 2050, and between 0.438 m and 1.168 m by 2100, relative to 1900 levels (IPCC 2023). This global mean sea level rise is primarily caused by thermal expansion and mass loss from glaciers and ice sheets, with minor contributions from changes in land-water storage. Global mean sea level will continue to increase for centuries to millennia due to continuing deep ocean warming and ice sheet melt, and sea levels will remain elevated for thousands of years, at rates dependent on future emissions (IPCC 2023). This will lead to some coastal inundation affecting mangroves, salt marshes and coastal freshwater wetlands. Furthermore, as CO_2 is gradually absorbed by oceans and fresh water, the water becomes more acidic, which increases the solubility of calcium carbonate, the principal component of the skeletal material in aquatic organisms (Steffen et al. 2009).

Below is a summary of potential climate change impacts to two key marine ecosystems - mangroves and coral reefs, other marine ecosystems are summarised in Table 6-41.

a. Mangroves

Mangrove ecosystems in Australia will face higher temperatures, increased evaporation rates and warmer oceans (McInnes 2015) as well as an associated sea-level rise (Hoegh-Guldberg et al. 2018). Modelling indicates an increased likelihood of future severe and extended droughts across parts of Northern Australia (Dai 2013). Consequently, mangrove ecosystems may increase their southern range as a result of warmer temperatures. However, higher temperatures and evaporation rates, and extended droughts could lead to die-offs in northern Australia and a change in mangrove distribution and abundance (Duke et al. 2017). Mangrove systems should cope with rising sea-level by accumulating more peat or mud which will give them the opportunity to adjust to a rising sea level (Field 1995).

b. Coral Reefs

Climate change has emerged as a threat to coral reefs, with temperatures of just 1°C above the long-term summer maximum for an area over 4–6 weeks being enough to cause mass coral bleaching and mortality (Baker et al. 2008, Hoegh-Guldberg 1999, Hughes et al. 2017, Spalding and Brown 2015). Coral mortality or die off following coral bleaching events can stretch across thousands of square kilometres of ocean (Gilmour et al. 2016, Hoegh-Guldberg 1999, Hughes et al. 2017). The impacts associated with a warming ocean, coupled with increasing acidification (which is occurring faster than in recent decades [BoM and CSIRO 2024], are expected to undermine the ability of tropical coral reefs to provide habitat for fish and invertebrates, which together provide a range of ecosystem services (e.g., food, livelihoods, coastal protection) (Hoegh-Guldberg et al. 2018). Coral reefs are projected to decline by 70–90% as a result of 1.5°C of global warming (IPCC 2023).

Table 6-40: Potential Climate Change Impacts to Taxa

Taxa	Potential Vulnerability
Mammals	Narrow-ranged endemics susceptible to rapid climate change in-situ; changes in competition between grazing macropods in tropical savannas mediated by changes in fire regimes and water availability; herbivores affected by decreasing nutritional quality of foliage as a result of CO_2 fertilisation.
Birds	Changes in phenology of migration and egg-laying; increased competition of resident species; breeding of waterbirds susceptible to reduction; top predators vulnerable to changes in food supply; rising sea levels affecting birds that nest on sandy and muddy shores, saltmarshes, intertidal zones, coastal wetlands, and low-lying islands; saltwater intrusion into freshwater wetlands affecting breeding habitat.
Reptiles	Warming temperatures may alter sex ratios of species with environmental sex determination to cope with warming in-situ.
Amphibians	Frogs may be the most at-risk terrestrial taxa. Amphibians may experience altered interactions between; pathogens, predators, and fires.
Fish	Freshwater species vulnerable to reduction in water flows and water quality; limited capacity for freshwater species to migrate to new waterways; all species susceptible to flow-on effects of warming on the phytoplankton base of food webs. Significant decreases in streamflow are concentrated in southern Australia, while the increases are almost all in the north (BoM and CSIRO 2024).
Invertebrates	Expected to be more responsive than vertebrates due to short generation times, high reproduction rates and sensitivity to climatic variables.

Taxa	Potential Vulnerability
	No invertebrate species including limpets are listed as threatened under the EPBC Act or under the Victorian Flora and Fauna Guarantee Act 1988 Threatened List [**PC205**].
Plants	Climate change may impact various functional dynamics of plants due to changes in; increasing CO_2, fires, plant phenology and specific environmental characteristics.

Table 6-41: Potential Climate Change Impacts to Ecosystems

Key Component of Environmental Change	Projected Impacts on Ecosystems
Coral reef	
CO_2 increases leading to increased ocean acidity	Reduction in ability of calcifying organisms, such as corals, to build and maintain skeletons.
Sea surface temperature increases, leading to coral bleaching	If frequency of bleaching events exceeds recovery time, reefs will be maintained in an early successional state or be replaced by communities dominated by microalgae.
Oceanic systems (including planktonic systems, fisheries, sea mounts and offshore islands)	
Ocean warming	Many marine organisms are highly sensitive to small changes in average temperature (1-2 degrees), leading to effects on growth rates, survival, dispersal, reproduction, and susceptibility to disease.
Changed circulation patterns, including increase in temperature stratification and decrease in mixing depth and strengthening of the East Australian Current	Distribution and productivity of marine ecosystems is heavily influenced by the timing and location of ocean currents; currents transfer the reproductive phase of many organisms. Climate change may suppress upwelling in some areas and increase it in others, leading to shifts in location and extent of productivity zones.
Changes in ocean chemistry	Increasing CO_2 in the atmosphere is leading to increased ocean acidity and a concomitant decrease in the availability of carbonate ions.
Estuaries and coastal fringe (including benthic, mangrove, saltmarsh, rocky shore, and seagrass communities)	
Sea level rise	Landward movement of some species as inundation provides suitable habitat, changes to upstream freshwater habitats will have flow-on effects to species.
Increase in water temperature	Impacts on phytoplankton production will affect secondary production in benthic communities.
Savannas and grasslands	
Elevated CO_2	Shifts in competitive relationships between woody and grass species due to differential responses.
Increased rainfall in north and north-west regions	Increased plant growth will lead to higher fuel loads, in turn leading to fires that are more intense, frequent and occur over large areas.
Tropical rainforests	
Warming and changes in rainfall patterns	Increased probability of fires penetrating into rainforest vegetation resulting in shift from fire-sensitive vegetation to communities dominated by fire-tolerant species.
Changes in length of dry seasons	Altered patterns of flowering, fruiting and leaf flush will affect resources for animals.

Key Component of Environmental Change	Projected Impacts on Ecosystems
Rising atmospheric CO_2	Differential response of different growth forms to enhanced CO_2 may alter structure vegetation
Temperate forests	
Potential increases in frequency and intensity of fires	Changes in structure and species composition of communities with obligate seeders may be disadvantaged compared with vegetative resprouters.
Warming and changes in rainfall patterns	Potential increases in productivity in areas where rainfall is not limiting; reduced forest cover associated with soil drying projected for some Australian forests.
Inland waterways and wetlands	
Reductions in precipitation, increased frequency and intensity of drought	Reduced river flows and changes in seasonality of flows.
Changes in water quality, including changes in nutrient flows, sediment, oxygen and CO_2 concentration	May affect eutrophication levels, incidence of blue-green algal outbreaks.
Sea level rise	Saltwater intrusion into low-lying floodplains, freshwater swamps and groundwater; replacement of existing riparian vegetation by mangroves.
Arid and semi-arid regions	
Increasing CO_2 coupled with drying in some regions	Interaction between CO_2 and water supply critical, as 90% of the variance in primary production can be accounted for by annual precipitation.
Shifts in seasonality or intensity of rainfall events	Any enhanced runoff redistribution will intensify vegetation patterning and erosion cell mosaic structure in degraded areas. Changes in rainfall variability and amount will also impacts on fire frequency. Dryland salinity could be affected by changes in the timing and intensity of rainfall.
Warming and drying, leading to increased frequency and intensity of fires	Reduction in patches of fire-sensitive mulga in spinifex grasslands potentially leading to landscape-wide dominance of spinifex.
Alpine/Montane areas	
Reduction in snow cover depth and duration	Potential loss of species dependent on adequate snow cover for hibernation and protection from predators; increased establishment of plant species at higher elevations as snowpack is reduced.

Table 6-42: Potential Climate Change Impacts on BIAs

Receptor	Biologically Important Behaviour
Mammals	Terrestrial mammals are subject to ongoing population declines due to climate change and changes within habitats.
Birds	There is strong evidence of population declines in threatened bird species, waterbirds and migratory birds. Various extensive and persistent impacts contribute to declines, including climate change (particularly drought) and extreme events, habitat degradation, and invasive predators.

Reptiles	Reptile species in all areas of Australia have an increasing risk of extinction. Risk of extinction was recognised as primarily related to ongoing pressure from invasive predators, but compounded by pressure from habitat modification, climate change (particularly drought) and disease.
	Half of Australian freshwater turtle species are in drastic population decline due to climate change.
Amphibians	Droughts and fires are increasing pressures within habitats that impact amphibian species.
	The number of known threatened amphibian species, including those that are Critically Endangered in Australia, is increasing. Drought and fire are recognised as increasing pressures contributing to this decline.
Fish	Freshwater fish throughout Australia have more than a 50% risk of extinction in the next 20 years due to climate change and changes within freshwater habitats.
Invertebrates	Most threatened invertebrates are suffering from largescale habitat degradation and loss of biodiversity. Changes in regional temperature, humidity and rainfall impact their distribution, development and reproduction.
Plants	Habitat destruction is the leading cause of vulnerability within plant species. However, changes in temperature, rainfall and fire regimes are contributing threats to plant species.
	Alpine ecosystems and biodiversity in Australia are particularly vulnerable to climate change that affects snow depth and the spatial and temporal extent of snow, which have all declined since the late 1950s.

5. Socio-economic Values

Changes to climate can result in impact to social receptors that have values which include the ecological receptors previously discussed. This includes KEFs and AMPs.

Climate change also impacts on the functions, interests or activities of other users which rely on ecological values, including commercial and recreational fisheries and tourism. A temperature change of between 0.9°C to 2.0°C is forecast to reduce fisheries yield as the maximum catch potential around Australia by between 3% and 10% (IPCC 2023).

Rising sea levels pose a significant threat to coastal communities by amplifying the risks of coastal inundation, storm surge, erosion and saltwater intrusion into groundwater systems. Coastal communities in Australia are already experiencing some of these changes (BoM and CSIRO 2024).

6. Cultural Values and Sensitivities

Impacts to cultural heritage sites and places of spiritual importance in coastal locations may also be experienced due to rising sea levels. Global mean sea level is predicted to rise between 0.308 m and 0.448 m by 2050, and between 0.438 m and 1.168 m by 2100, relative to 1900 levels (IPCC 2023).

6.6.3.3 National and International Agreements and Frameworks Relevant to GHG Management

This section describes the relevant key national and international agreements and frameworks relevant to GHG management, including how these environmental requirements are relevant to the activity.

1. Paris Agreement **[PC211]**

The Paris Agreement is a global pact to respond to the challenge of climate change, signed by 196 countries. It is a landmark agreement that aims to strengthen the global response to the threat of climate change. Alignment with the intent of the Paris Agreement is considered a yardstick measure for climate ambition.

Article 2 of the Paris Agreement states that the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, includes "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change".

Australia's commitment to the Paris Agreement is reflected in the *Climate Change Act 2022*, which among other functions, sets out Australia's greenhouse gas emission reduction targets, which "contribute to the global goals of:

- (i) holding the increase in the global average temperature to well below 2°C above pre-industrial levels; and
- (ii) pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels;"

This is consistent with the Paris Agreement.

Beach reports our Australian scope 1 and scope 2 emissions under the *National Greenhouse and Energy Reporting Act 2007* (NGER). This includes the *National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015* made under section 22XS of the Act. The Safeguard Mechanism is an instrument used by the Australian Government to ensure that operators of large facilities manage their emissions in line with Government commitments to the global community, as described in Australia's Nationally Determined Contribution (NDC), and in alignment with the *Climate Change Act 2022*.

As part of the commitment to the Paris Agreement, Australia has an emissions budget for the 2021-2030 decade of 4353 $MtCO_2e$. The emissions related to the Project (including all scopes) during this period is ~ 0.1% of this carbon budget.

Safeguard Mechanism covered facilities ("safeguard facilities") are responsible for ~28% of Australia's greenhouse gas emissions; they have legislated emissions caps to ensure that Australia meets its emissions targets and stays within the 2030 emissions budget.

Three different emissions caps are set out in the Safeguard Mechanism rules and described in the *Safeguard Mechanism (Crediting) Amendment Act 2023*.

- Net emissions cap, drawn from the proportionate coverage of the safeguard facilities of ~28% of Australian emissions, sets a carbon budget of 1233 $MtCO_{2}$-e between 2020 and 2030.
- Net emissions from safeguard facilities must be no more than 100 $MtCO_{2}$-e in 2030, and net zero in 2050, reflecting the Australian government emissions targets.
- A limit on gross emissions, so that from 2025 5-year rolling average emissions must go down.

After the Australian Government sets the Nationally Determined Contribution (NDC) targets for 2035 and beyond, adjustments to the emissions budget will likely flow through the Safeguard Mechanism.

2. National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015

One of the key statutory instruments for regulating Australia's GHG emissions in line with Australia's NDCs under the Paris Agreement, is the National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015 (Cth) (the Safeguard Mechanism) made under the NGERS Act and administered by the Clean Energy Regulator. The Safeguard Mechanism was developed to ensure that Australia's largest greenhouse gas emitters keep their net emissions below an emissions limit (a baseline). The Safeguard Mechanism currently applies to facilities that emit more than 0.1 $MtCO_2$-e per annum and requires annual emissions to be reported against a designated emissions 'baseline'.

Key elements of the mechanism include:

- Safeguard facilities must meet the reporting and record-keeping requirements of the NGER Act, including the Clean Energy Regulator's requirements for audits prior to baseline setting or to check compliance management.
- If a safeguard facility is likely to exceed its baseline, the responsible emitter must act, including by purchasing and/or surrendering Australian carbon credit units, to offset excess emissions.
- Penalties for non-compliance.

The Safeguard Mechanism is the Government's primary legislation for achieving industrial emissions reduction in line with Australia's Nationally Determined Contribution (NDC). The OGP is an existing covered facility regulated under the Safeguard Mechanism and will receive a production adjusted, emissions intensity baseline that will decline by 4.9% per annum, in line with the 2030 emissions reduction target. OGP currently receives unprocessed natural gas from three pipelines: one offshore from the combined Thylacine and Geographe facilities and two onshore pipelines from the Halladale, Black Watch & Speculant (HBWS) and Enterprise well sites. The Thylacine, Geographe, HBWS and Enterprise sites are individual NGER facilities which do not meet the legislated safeguard threshold of 100,000 tonnes per annum of CO_2-e to be covered by the Safeguard Mechanism. However, scope 1 emissions produced within the OGP facility that are created in support of the Thylacine and Geographe, HBWS and Enterprise facilities such as venting of reservoir CO_2 are reported under the OGP facility.

Scope 1 emissions associated with gas production from the Otway Offshore Project would be reported at the individual facility (NGER) level and are forecast to be below the Safeguard Mechanism threshold. However, emissions associated with processing the gas from the Otway Offshore Project (including reservoir CO_2) would be reported as part of the OGP facility. If the Otway Offshore Project was to increase the emissions intensity of the OGP, the facility baseline would ensure emissions are reduced in accordance with Australia's emissions targets and budgets.

Beach Energy have engaged with the Clean Energy Regulator to discuss the Safeguard Mechanism boundary. Beach will continue these discussions with the Clean Energy Regulator as the Project progresses.

Gas and condensate from OGP is supplied into the domestic Australian market. The scope 3 emissions associated with the transmission/transport and end use of the gas and condensation will occur within Australian Commonwealth jurisdiction. Therefore the scope 3 emissions will be managed in accordance with Australia's regulatory regime including NGER and the Safeguard Mechanism, which is designed "to deliver emissions reductions consistent with Australia's [NDC] under the Paris Agreement" (DCCEEW, 2023i) and the *Climate Change Act 2022*.

3. National Greenhouse and Energy Reporting Scheme

The NGER Scheme is a single national framework for reporting company information about GHG emissions, energy production, and energy consumption. Key NGER Scheme legislation includes the *National Greenhouse and Energy Reporting Act 2007*, the National Greenhouse and Energy Reporting Regulations 2008, and the National Greenhouse and Energy Reporting (Measurement) Determination 2008.

The NGER Act provides a single, national framework for the reporting and distribution of information related to GHG emissions, energy production, and energy consumption. Beach reports scope 1 (Inside Project Boundary), scope 1* (Outside Project Boundary) emissions associated with the Otway Offshore Operations and Otway Gas Plant under the NGER Act.

4. Intergovernmental Panel on Climate Change (IPCC) 6th Report

The IPCC released its sixth assessment consisting of four reports,

- Climate Change 2021: The Physical Science Basis, released in August 2021 (IPCC 2021)
- Climate Change 2022: Impacts, Adaptation and Vulnerability, released in February 2022 (IPCC 2022a)
- Climate Change 2022: Mitigation of Climate Change, released in April 2022 (IPCC 2022b)
- Climate Change 2023: Synthesis Report, released in March 2023 (IPCC 2023)

The four releases of the report relate climate change and anthropogenic influence as well as deduce the impact that climate change has had on ecosystems, biodiversity, humans, and cities, and inform the 2023 Global Stocktake under the United Nations Framework Convention on Climate Change. The Physical Science Basis IPCC Report, released in August 2021, was the first to unequivocally relate climate change to human influences and the use of hydrocarbon fuels. Surface temperatures have increased at a rapid rate since 1970 compared to any other 50-year period in the last 2,000 years. The rapid changes that have occurred since the industrial revolution are unprecedented, even with the research on ice boreholes and the subsequent calculations of historical CO_2 concentrations. The IPCC states with high confidence that in 2019, atmospheric CO_2 concentrations were higher than anytime in at least 2 million years, along with very high confidence that concentrations of CH_4 and N_2O far exceeding intensities from at least 800,000 years (IPCC 2021).

The sixth assessment report presents a number of scenarios to understand climate response to a range of GHG emissions levels. The best-case scenario, scenarios with very low and low GHG emissions and CO_2 emissions decreases to net zero around or after 2050 (IPCC 2021), aligns with Beach's aspiration to achieve net zero Scope 1 and Scope 2 GHG emissions by 2050 and its interim target to reduce Beach GHG emissions intensity.

The IPCC found that natural gas may remain part of energy systems through mid-century, both for electricity generation and use in industry and buildings, even if warming is limited to 2°C or lower (IPCC 2023b). The decline in natural gas use from 2020 to 2050 is forecast to be between 21–62% of 2020 levels (interquartile range) in scenarios limiting warming to 1.5°C (>50%) with no or limited overshoot. Natural gas use is forecast to decline by between 14% to 36% by 2050 from 2020 levels (interquartile range) in scenarios limiting warming to 2°C (>67%). Scenarios indicate that gas use in electricity will likely peak around 2035 and 2050 if warming is limited to 1.5°C (>50%) with limited or no overshoot or to 2°C (>67%) with action starting in 2020, respectively (IPCC 2023b). The development of the Project, which does not increase the rate of gas supply, is not inconsistent with these modelled scenarios.

5. International Energy Agency World Energy Outlook **[PC211]**

The International Energy Agency (IEA) World Energy Outlook considers three main scenarios which are possible pathways for the energy sector to 2050. They are not forecasts, but a tool to be used to inform robust strategic planning.

The World Energy Outlook is published annually, using the most recent available energy market and cost data; recent editions have included three scenarios:

- Stated Policies Scenario (STEPS).
- Announced Pledges Scenario (APS)
- Net Zero Emissions by 2050 (NZE) Scenario

As described by the IEA, "each scenario responds in different ways to the fundamental economic and demographic drivers of rising demand for energy services. These differences largely reflect the various policy choices assumed to be made by governments, which, in turn, shape investment decisions and the ways in which households and companies satisfy their energy needs".

The Net Zero Emissions by 2050 scenario prepared by the IEA is consistent with the goals of the Paris Agreement.

In April 2024, Beach released their inaugural Climate Transition Action Plan (CTAP). This plan outlines the important role that we expect to play as a provider of critical energy products, as the world addresses the significant challenge of climate change. It describes the processes we have in place to consider and respond to climate-related risks and opportunities, and the targets that we have set to guide our progress. Emissions reduction is at the heart of our CTAP. We are actively pursuing reductions in our Scope 1 and 2 emissions and improvements in measuring and reporting our scope 3 emissions.

Beach uses scenario analysis to test the resilience of our portfolio under different climate scenarios, as we consider the risks and opportunities associated with climate change and the energy transition. We use the three IEA scenarios as the basis for this analysis.

In the most recent World Energy Outlook 2024, the IEA outlined the uncertainty of global natural gas demand (IEA 2024). The IEA assessed natural gas demand within the APAC region by specifically considering 'Japan and Korea' and 'Developing Asia' across the STEPS and APS scenarios. Whilst APS shows an increase in demand in Developing Asia from 2023-2025, demand decreases in Japan and Korea over the same period, both regions see a decrease in demand during 2035-2050. Under the STEPS scenario, Japan and Korea see demand reductions from 2023-2050, where Developing Asia is indicates an increase in demand over the same period. No gas demand for the NZE scenario was presented in the World Energy Outlook. Australia was not modelled in the results presented (IEA 2024).

AEMO has conducted detailed analysis of the natural gas demand in Australia across a range of future scenarios. The 2024 Gas Statement of Opportunities forecasts the adequacy of gas supplies in central and eastern Australia, based on information from gas industry participants, to meet the changing energy needs of households and businesses from now to 2043 (AEMO 2024). To meet this demand, AEMO outlines a range of options the market is considering to address the forecast supply challenges. The options include additional southern supply such as from the Otway Basin, where the Project is located. This analysis indicates that the development of the Project is consistent with required supply in the East Coast Gas Market and the Project is unlikely to result in a stranded asset.

Production of gas from the Beach Otway Gas Plant is critical in ensuring Victoria's energy security as demand for gas is expected to continue in Victoria and the south-eastern states particularly as a result of the decline in consumption of more emission intensive coal associated with the closure of coal-fired power stations. As a result of its lower emissions intensity, coal-to-gas switching has avoided more than 500 $MtCO_2$-e emissions over the 2011-2018 period, or around 750 $MtCO_2$-e by 2020 (IEA 2019). It is estimated that approximately 1.2 Gt CO_2 could be avoided by switching from coal to existing gas-fired plants, assuming a supportive relative pricing and government policies (IEA 2019).

6. Beach Environmental Management System Relevant to GHG Emissions

Beach's climate change framework sits within their Operations Excellence Management System (OEMS). Table 6-43 provides a summary of the Beach OEMS components relevant to the management of GHG emissions.

Table 6-43: Summary of the Beach OEMS Components Relevant to the Management of GHG emissions

Beach OEMS Component	**Description**	**Contribution to Managing Climate Change**
Corporate Policies		
Beach Climate Change Policy	Beach's climate change policy commitments include: Measuring and reporting carbon emissions as required by regulatory requirements. Integration of climate risks into project decision-making. Evaluating investment decisions to potential changes in global climate policy and changes in climate. Setting targets to encourage innovation and drive reductions in our carbon.	This public published policy specifies that Beach's top management is expected to demonstrate leadership, commitment to, and accountability for climate change adaptation. It identifies that the Board Risk, Corporate Governance and Sustainability Committee is responsible for overseeing the effectiveness of the policy. It formally expresses specific commitments related to climate change mitigation and adaptation.

Beach OEMS Component	Description	Contribution to Managing Climate Change
		All Beach policies are approved by the Board.
Environmental Policy	The relevant commitments/aspects within Beach's Environment Policy are: Establish environmental objectives and targets and implement programs to achieve them that will support continuous improvement. Identify, assess, and control environmental impacts of our operations by proactive management of activities and mitigation of impacts. Efficiently use natural resources and energy and engage with stakeholders on environmental issues. Publicly report on our environmental performance.	Specifies that all environmental impacts will be proactively identified, assessed, and managed; and publicly reported against. All applicable legal and other requirements will be complied with and managed via Beach's OEMS. Commits to setting environmental objectives and targets, and a program of continuous improvement.
Sustainability Policy	The relevant commitments/aspects within Beach's Sustainability Policy are: Ensuring an appropriate governance system is in place to maintain a sustainable business. Assessing and addressing material social, environmental, climate and economic risks and the impact of our operations, and integrating these considerations into business planning. Conducting business activities in an ethical and transparent manner. Setting clearly defined targets, measuring, monitoring and reporting sustainability performance to support continuous improvement. Complying with relevant legislation, standards and procedures. Providing information and training, as required, and encouraging the adoption of sustainable principles and practices.	Specifies that Beach's top management is expected to demonstrate leadership, commitment to, and accountability for climate change adaptation; and formally expresses specific commitments related to climate change mitigation and adaptation. It identifies Beach Executives and managers are responsible for leading the adoption of this policy and the integration of sustainability practices.
Climate Transition Action Plan (CTAP) [**PC172, etc**]	The CTAP considers the physical and transition risks of climate change, and the potential impacts to Beach under different climate scenarios. It describes how climate change risk is governed at Beach, and targets that we are pursuing as we work within the changing context of the energy transition. Emissions reduction is at the heart of our CTAP, and we support the pursuit of Paris-aligned emissions reduction targets. We are actively pursuing reductions in our scope 1 and 2 emissions and improvements in measuring and reporting our scope 3 emissions. This is reflected in our short-term (annual) and medium-term (2030) equity emission reduction targets. We also have a long-term (2050) net zero ambition.	The CTAP is a publicly disclosed plan which is available on the company website. It describes the important role that we expect to play as a provider of critical energy products, as the world addresses the significant challenge of climate change.
OEMS – Key Relevant Standards		

Beach OEMS Component	Description	Contribution to Managing Climate Change
8.1 Risk Management Standard	Standard 8.1 defines Beach's requirements to mitigate and manage risk at all levels within the business. It defines the Risk Management Framework for identifying, understanding, managing and reporting risks. The framework defines the documents, training, tools and templates to be used, and the accountabilities to be applied in support of effective risk management. Risks to people, the environment, Beach's reputation, financial position and any legal risks are assessed through the framework. The methodology is consistent with the Australian and New Zealand Standard for Risk Management (AS/NZS ISO 31000:2018, Risk Management – Principles and Guidelines).	The potential impact of GHG emissions is assessed using Standard 8.1 and the risk assessment process described in Section 6 of this OPP.
10.1 Environment Management Standard	Beach has an Environmental Management Standard (EMS) that was issued for use in December 2020 with a review frequency of 3 years. The standard requirements that are included within the EMS include: General rules Land Disturbance, Reinstatement and Rehabilitation Biodiversity Contaminated Land Management Water Management Air Quality and Emissions Noise and Vibration Amenity (Dust, Odour, Visual, Lighting); and Waste	Within Beach's EMS, there are management standards that will directly manage climate change. Most notably under the standards for Biodiversity and Air Quality and Emissions. Where Beach can manage emissions and protection to biodiversity, they will ensure that as much as they can. Notable standards for mitigating climate change include: 10.1.3.5 – Decisions to proceed with exploration, development, operation and closure activities must consider the presence of, and impact on, legally designated protected areas and be recorded. 10.1.6.3 – When assessing and selecting new plant and equipment, low emissions technology must be prioritised. 10.1.6.6 – An inventory of sources of air emissions including point, fugitive and mobile related emissions must be developed and maintained.
11.1 – Sustainability Standard	Standard 11.1 operationalises the requirements established by the Company's Sustainability Policy and other associated Beach policies. The Standard includes the following requirements: Responsibility for steering the company's response on sustainability. Completion of a Sustainability Report. Monitoring market and societal trends and Beach's response to them. Risk assessments to consider social, environmental, governance and economic risks.	Beach's senior management is expected to demonstrate leadership, commitment to, and accountability for climate change adaptation. The Sustainability Report allows Beach to publicly report the impacts of their activities in a transparent structured way that is transparent to stakeholders and other interested parties, incorporating recommendations from the Task Force on Climate Related Disclosures.

Beach OEMS Component	Description	Contribution to Managing Climate Change
	Preparation of sustainability targets and initiatives. Linkage to Project and Risk Management Systems.	Monitoring of trends interfaces closely with risk management and setting of targets and initiatives. In alignment with BTSD 8.1 (Risk Management Standard), operational and project level risk assessments ensures the Company continues to pursue sustainable activities and projects. The Project Management System ensures that Sustainability in Design is considered during the design phase of a project life cycle.
Leadership and Accountability		
Risk, Corporate Governance and Sustainability Committee Sustainability Steering Committee	The Beach Energy Board has the Risk, Corporate Governance and Sustainability Committee (RiskCo) which provides oversight on sustainability at Beach. The Sustainability Steering Committee sits under this. It is made up of all company executives as well as the Chief Executive Officer; and oversees the management and execution of sustainability performance and risks in the business. Both committees meet on a quarterly basis to discuss sustainability risks, opportunities, projects as well as performance against the targets set out in the sustainability reports. In respect to climate change, RiskCo's purpose is to assist the Board in the following: Regularly reviewing material risks (including through detailed reviews, or deep dives) and management actions and consider that the residual risk is appropriate. Monitoring and reviewing the company's policies and performance in relation to health, safety, environment, community, climate change and other sustainability matters. Developing annual sustainability reporting, including public disclosures regarding material climate change risks. Ensuring the effectiveness of the Climate Change Policy.	Provides management review of the system and changing circumstances in order to inform decisions on actions needed for improvement.
Commitment to Emissions Reduction		
Net zero Scope 1 and 2 operated emissions	Beach has an aspiration to achieve net zero Scope 1 and 2 emissions by 2050. This aspiration was announced in Beach's Financial Year report 2021, the Full Year Results ASX release, as well as being stated on the company's website under "reducing emissions".	Beach is working towards this aspiration via the processes described in this document. Estimated actual operated FY22 emissions were 12% lower than FY18.

Beach OEMS Component	Description	Contribution to Managing Climate Change
Corporate emissions reduction target	Beach has a stated, publicly available, objective to reduce company net equity emissions intensity by 35 per cent by FY30 against FY18 levels/ targets https://www.beachenergy.com.au/reducing-emissions/.	Initiatives include: LDAR surveys completed at all assets remedial actions being taken through the maintenance management system. Equity stake in Moomba CCS Project. Multiple emission reduction projects completed at operated facilities.

6.6.4 Impact Evaluation Summary

The impact evaluation for GHG emissions is summarised in Table 6-44.

Table 6-44: Impact Evaluation Summary for GHG Emissions

Summary	
Summary of Impacts	Emissions related to the Project scope 1 [Inside Project Boundary, scope 1* [Outside Project Boundary] and scope 3) will be a minor contributor to global GHG emissions and climate change.
Extent of impacts	Impact solely from the emissions related to the Project will be minor.
Duration of impacts	Not applicable for the emissions related to the Project in isolation.
Level of certainty of impact	Beach has a high level of certainty about the impacts of GHG emissions from the Project.
Impact decision framework context	C – the precautionary approach has been applied for assessment and mitigation of impacts.
Impact Consequence	
Minor	

6.6.5 Demonstration of Acceptability

Table 6-45 demonstrates how and why predicted environmental impacts from GHG emissions meet the defined acceptable levels (Table 5-4).

Table 6-45: Demonstration of Acceptability – GHG Emissions

Demonstration of Acceptability	
Impact and risk comparison with relevant defined acceptable levels	Acceptable level 9 is relevant to GHG emissions (as detailed in Table 5-4). A Minor (1) impact consequence level was assigned for this aspect based on the impact analysis and evaluation. Minor (1) consequences due to GHG emissions will not: • interfere with Australia's GHG commitments under the Paris Agreement and enacted in the *Climate Change Act 2022* and managed by the safeguard mechanism As a result, the predicted environmental impact for GHG emissions is lower than the defined acceptable level 10.

		Demonstration of Acceptability
ESD principles	Integration principle	Section 6.6.3 identifies and evaluates environmental impacts associated with GHG emissions. As part of identifying the potential impacts; conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental impact. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks. For Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders on the Project and associated activities. No objections or claims were raised against this aspect during Phase 1: Initial Project Consultation. For Phase 2: Project OPP Public Comment Period (Section 10.2.4), the public had the opportunity to provide further comment to this OPP during the period (18/3/2024 – 20/5/2024). Beach prepared the public comment report summarising all comments, an assessment of the merits of each comment, a statement of the response to each comment, and an outline of any changes made to the OPP as a result of the comment (Appendix P). The impact assessment for this aspect has been updated to reflect the merit provided by public comment reference numbers PC172, PC205, PC206, PC211, PC218 and PC326. As a result, the impact assessment now integrates responses to public comments of merit and therefore is of an acceptable level. The potential environmental impact against this aspect was assessed as having a Minor (1) impact consequence level which is considered a lower-order environmental impact. Lower-order environmental impacts are considered ‘broadly acceptable’ and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental impacts against this aspect were assessed as having a Minor (1) impact consequence level which is considered a lower-order environmental impact. Lower-order environmental impacts cannot result in serious or irreversible environmental damage. There is high confidence in the potential environmental impacts and effectiveness of controls against this aspect. Beach commissioned a Greenhouse Gas emissions quantification assessment, with all emissions factors and energy content figures used to predict emissions sourced from the NGER (Measurement) Determination 2008 and the API Compendium of GHG Emissions Methodologies (API 2009). The Project is in line with the Australia’s commitments under the Paris Agreement and Climate Change Act 2022. As such there is no uncertainty associated with this aspect.
	Intergenerational principle	The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts from GHG emissions is lower than the defined acceptable level 9; the health, diversity, or productivity of the environment for future generations is expected to be maintained. Gas and condensate from OGP is supplied into the domestic Australian market. The scope 3 emissions associated with the transmission/transport and end use of the gas and condensation will occur within Australian Commonwealth jurisdiction. Therefore the scope

Demonstration of Acceptability		
		3 emissions will be managed in accordance with Australia's regulatory regime including NGER and the Safeguard Mechanism, which is designed "to deliver emissions reductions consistent with Australia's [NDC] under the Paris Agreement" (DCCEEW, 2023i) and the *Climate Change Act 2022*.
	Biodiversity principle	Section 6.6.3 identifies and evaluates environmental impacts associated with GHG emissions. As part of identifying the potential impacts; conservation values and sensitivities including MNES in Section 4 were reviewed. Given predicted environmental impacts from GHG emissions are lower than the defined acceptable level 9; no potential to affect biological diversity or ecological integrity is expected.
Internal context	Policy compliance	Beach Climate Change, Sustainability and Environmental Policy objectives are met through this environmental impact assessment with further detail provided in future environment plans.
	Beach GHG Emission Management Plan	Requirements in the Beach Corporate GHG Emission Management Plan are applicable to the Otway Project.
	Management system compliance	The OEMS system has been, and will be, applied to management of GHG emissions. For example: • The Standard 8.1 and the Risk Matrix framework has been used to assess the potential impact of GHG emissions. • The Environmental Management Standard (10.1) requires low emissions technology to be prioritised when assessing and selecting new plant and equipment and an inventory of sources of air emissions including point, fugitive and mobile related emissions be developed and maintained
External context	Stakeholder engagement is being carried out as part of this OPP process. Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable. During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect. During Phase 2: Project OPP Public Comment Period (Section 10.2.4), comments were raised against this aspect. The assessment of merit for these comments found this aspect to require updates. Changes to the OPP to address PC172, PC205, PC206, PC211, PC218 and PC326 have been integrated into the impact evaluation for this aspect. The science of impacts of greenhouse gas emissions is continually evolving. Any new guidance or advice will be assessed and incorporated into adaptive management plans prepared for activity specific EPs.	
Other requirements	**Requirement**	**Demonstration**
	Climate Change Act 2022 (Cwth) Sets Australia's GHG emissions reduction targets consistent with the Paris Agreement.	**CM22 Emission Abatement Opportunities Register** Per the requirements of the OEMS Sustainability Standard, Beach will maintain a register of opportunities for emissions reduction across its asset portfolio to reduce emissions.

Demonstration of Acceptability		
	Climate Change Act 2017 (Vic) Victorian legislation to manage climate change risks. Establishes a long-term emissions reduction target of net-zero by 2050 with 5 yearly interim targets.	**CM23 GHG Management Plan** The intent of this plan is to guide activities needed to manage Beach Scope 1 and Scope 1* GHG emissions, including the Project, in line with relevant policy and legislative requirements such as the Safeguard Mechanism and NGER. Implementation of Beach GHG Emissions Management Plan incorporates: • the framework and specific techniques used to ensure that GHG emission related EPOs will be met over the life of the facility • emissions monitoring • emissions forecasting • an adaptive management approach to facilitate a continuous cycle of monitoring, evaluating and implementing improvements to minimise GHG emissions to ALARP and acceptable levels over the life of the Project. **CM24 GHG Emissions Monitoring** Beach reports scope 1 and scope 2 emissions under the National Greenhouse and Energy Reporting Act 2007 (NGER). This includes annual, mandatory reporting of emissions by 31 October for the prior financial year. We track our progress against emissions reduction targets according to the methods defined by NGER. Beach calculates scope 3 emissions based on the Greenhouse Gas Protocol's Corporate Value Chain (scope 3) Accounting and Reporting Standard and scope 3 guidance documents. Scope 3 emissions derived from the use of product will be reviewed against forecasts, with this focus reflecting the proportional contribution of final product use to overall Otway asset Scope 3 emissions. GHG emissions forecasts are prepared periodically using data such as production forecasts. This data informs the disclosures in our Sustainability Report and Climate Transition Action Plan [PC206]. **CM25 Fugitive Leak Detection and Repair Program** Beach undertakes periodic leak detection and repair (LDAR) fugitive emissions surveys at the Otway Gas Plant and Thylacine Platform. The scope, methodology, frequency, and repair guidance is detailed in the GHG Management Plan. **CM26 Preventative Maintenance System** Combustion equipment is inspected and maintained in accordance with the preventative maintenance system to ensure efficient operations. **CM27 Logistics Planning** Operations planning is undertaken for supply vessel and helicopter movements, thereby minimising unnecessary travel and minimising fuel combustion.
	National Greenhouse and Energy Reporting Act 2007 (NGER). National framework for reporting GHG emissions, energy production and energy consumption.	
	Safeguard Mechanism rule 2015 (Cwth) Regulates Australia's GHG emissions in line with Australia's targets under the Paris Agreement.	
	Marine Order 97: Marine Pollution Prevention – Air Pollution Vessels comply with marine order requirements including: • Hold a current international energy efficiency certificate. • Have a Ship Energy Efficiency Management Plan (SEEMP) as per MARPOL 73/78 Annex VI	
	The following plans or conservation advice identify climate change as a threat: • Wildlife Conservation Plan for Seabirds (CoA, 2020a) • Wildlife Conservation Plan for Migratory Shorebirds (CoA, 2015a) • National Recovery Plan for Albatrosses and Petrels 2022 (CoA, 2022) • National Recovery Plan for the Australian Fairy Tern (*Sternula nereis nereis*) (CoA, 2020) • Conservation Advice for *Limosa limosa* (black-tailed godwit) (DCCEEW, 2024f) • Conservation Advice for *Arenaria interpres* (ruddy turnstone) (DCCEEW, 2024d)	

Demonstration of Acceptability	
	- Approved Conservation Advice for *Calidris acuminata* (sharp-tailed sandpiper) (DCCEEW, 2024g) - Conservation Advice for *Calidris tenuirostris* (great knot) (DCCEEW, 2024l) - Conservation Advice for *Ardenna grisea* (sooty shearwater (DCCEEW, 2023d) - Conservation Advice for *Aphelocephala leucopsis* (southern whiteface) (DCCEEW, 2023g) - Conservation Advice for *Gallinago hardwickii* (Latham's snipe) (DCCEEW, 2024j) - Conservation Advice for *Neophema chrysostoma* (blue-winged parrot) (DCCEEW, 2024h). - Approved Conservation Advice for Pluvialis squatarola (grey plover) (DCCEEW, 2024k) - Conservation Advice for Stagonopleura guttata (diamond firetail) (DCCEEW, 2023e) - Approved Conservation Advice for Xenus cinereus (Terek sandpiper) (DCCEEW, 2024i) - Approved Conservation Advice for *Calidris canutus* (Red Knot) (DCCEEW, 2024m) - National Recovery Plan for the Australasian Bittern (*Botaurus poiciloptilus*) (DCCEEW, 2022x). - Approved Conservation Advice for *Botaurus poiciloptilus* (Australasian Bittern) (TSSC, 2019) - National Recovery Plan for the Orange-bellied Parrot (*Neophema chrysogaster*) (DELWP, 2016 - National Recovery Plan for the Swift Parrot (*Lathamus discolor*) (DCCEEW, 2024n)

Demonstration of Acceptability	
	- National Recovery Plan for the Australian Grayling (*Prototroctes maraena*) (Backhouse et al., 2008) - Conservation Advice *Prototroctes maraena* Australian Grayling (TSSC, 2021) - Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013c) - Recovery Plan for Marine Turtles in Australia, 2017-2027 (CoA, 2017) - Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA, 2008) - Conservation Management Plan for the Blue Whale, 2015-2025 (CoA, 2015b) - Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC, 2015d) - Listing Advice Megaptera novaeangliae (Humpback Whale) (TSSC, 2022) - Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale) (TSSC, 2015e) - Recovery Plan for the Australian sea -lion (*Neophoca cinerea*) (DSEWPaC, 2013d) - South-east Marine Parks Network Management Plan (DNP, 2025)

6.6.6 Environmental Performance

In accordance with NOPSEMA’s OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 6-) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 6-45 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 6- are met.

Table 6-46: Environmental Performance Outcomes – GHG Emissions

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 9: Project activities will not interfere with Australia's GHG commitments under the Paris Agreement and enacted in the *Climate Change Act 2022* and managed by the safeguard mechanism.	EPO15:	GHG emissions related to the Project, including (scope 1 [Inside Project Boundary], scope 1* [Outside Project Boundary] and scope 3) emissions are consistent with Australia's international GHG emissions commitments, as outlined in the *Climate Change Act 2022*. Emissions are to be determined based on the NGER scheme and managed by the Safeguard Mechanism.

6.7 **Planned Discharge – Drill Cuttings and Fluids**

6.7.1 Hazard Identification

Planned discharges including drill cuttings, fluids (such as completion, wellbore cleanout, well annular and suspension fluids) and swarf, herein termed 'drill cuttings and fluids', are to be discharged to the marine environment during the Project. Relevant stages and associated activities that results in planned discharges of drill cuttings and fluids are defined below in Table 6-47 and described in Section 6.7.2.

Table 6-47: Activities Undertaken During the Project Resulting in Planned Discharges - Drill Cuttings and Fluids

Stage	Activity
Drilling and completions	Drilling method Well completion, unload and test Well unload and testing
Operations	Well intervention and workover
Decommissioning	Plug and abandonment of wells

6.7.2 Hazard Description

6.7.2.1 Drilling and Completions

The Project plans to drill 8 wells across VIC/P43 and, VIC/P73 within the scope of this OPP. A MODU will be used to drill the wells. To drill a single well, the MODU will be present at the well location for 40 days. During drilling of the upper well sections, cuttings and drilling fluids will be released directly to the seabed in the vicinity of the well site (subsea). Following the installation of the riser within which the remainder of the well sections will be drilled through, the cuttings and associated drill fluids will be routed back to the MODU.

Cuttings are then processed within the solids control equipment (SCE), with drilling fluids separated from the cuttings and recirculated back for further use. Cuttings are processed further through shale shakers and centrifuges to remove course and fine material. Processed cuttings, coated in drilling fluids, are discharged overboard.

A description for each planned discharge is detailed as follows:

- **Drill cuttings:** are the rock and sediment brought to the surface during the process of drilling in offshore environments. These cuttings can include a mixture of clay, silt, sand, and rock, and can also contain small amounts of oil and other drilling fluids.

- **Drilling fluids:** also known as drilling mud, are used to lubricate the drill bit, cool the drill, maintain the stability of the well, transport the cuttings out of the hole and control the pressure in the well. Water Based Drilling Fluid (WBDF) with the use of Synthetic Based Drilling Fluid (SBDF) as a contingency will be used to drill and complete the wells associated with the Project. WBDF use seawater with pre-hydrated bentonite gel sweeps and will be discharged directly to the seabed with cuttings. The seawater may be treated with caustic soda (NaOH) and/or soda ash (Na2CO3) to increase pH and alkalinity. If required, SBDF will be used once the riser is installed and returned to the topsides of the MODU, treated through the mud systems and reused. SBDF has increased lubricity, greater cleaning abilities with less viscosity than water-based fluids plus can withstand greater heat without breaking down. Base fluid is typically a hydrocarbon, ether, ester, or acetal as a base. Additives include organophilic clays, barite, lime, aqueous chloride, rheology modifiers fluid loss control agents, and emulsifiers. Excess seawater with pre-hydrated bentonite gel sweeps and water-based fluids will be discharged to the marine environment, however no whole SBDF will be discharged into the marine environment. SBDF that is recovered from drill cuttings for re-use will be recycled or disposed of at a land-based facility or used in future drilling activities.

- **Completion fluids:** Completion fluids are usually brines (i.e. a mixture of seawater or formation water) with additives that can include chlorides (often sodium, potassium or calcium), bromides, hydrate inhibitor (MEG), biocide, oxygen scavenger, viscosifiers and surfactants. They are designed to have the proper density and flow characteristics to be compatible with the reservoir formation. Completion fluids are used to run well completions, and during wellbore clean-up, unloading and testing during drilling.

- **Wellbore cleanout fluid:** Wellbore and casing clean-up are required at various stages of the drilling operations to ensure the contents of the well are free of contaminants before the next stage of drilling. A chemical wellbore cleanout fluid train may be used to remove residual fluids (including SBDF, if used) from the wellbore. The wellbore cleanout fluid is usually brine (similar to completion fluid) that can include several chemicals, such as biocide and surfactant. During the clean-up process, fluids are circulated back to the MODU, and analysed before they are discharged overboard.

The expected volumes for the above drill cuttings and fluids to be discharged for each well is detailed in Table 6-48. Concurrent drilling campaigns are not a credible scenario given only one MODU will be used for the Project.

6.7.2.2 Operations

Well intervention activities may be undertaken, consisting of well workovers, wireline, logging, testing and flowback. Discharges from these activities may include:

- **Completion fluids:** associated with well testing, as detailed above in Section 6.7.2.1, where the total discharge volume of completion fluids would be up to approximately 300 m^3 per well, containing up to 16 m^3 of formation water, and

- **Well annular fluids:** fluids that remain in the wellbore, or annular spaces between the casing and typically of any remaining drill fluids and may include small amounts of hydrocarbon may be discharged from the seabed up to a volume of 10 m^3.

6.7.2.3 Decommissioning

During well P&A, discharge of suspension fluids may occur during the operation. Suspension fluids are fluids suspended in wells that are estimated to consist of corrosion inhibitor (soluble oil) and of suspension fluid (treated with dilute oxygen scavenger, preservative (Glutaraldehyde) and caustic soda) for each well. It is expected that up to approximately 100 m^3 of well suspension fluid per well will be discharged during the wellhead removal operation

Section milling may be required to re-establish permanent wellbore barriers, which would generate swarf. This is lifted to surface via a circulated water-based fluid system and separated for onshore disposal.

Following P&A the wellhead is cut with the use of either a mechanical cutting tool or an abrasive cutter using water and inert abrasives and removed below the mudline (~2 m). Should a mechanical cutting tool be used, the process produces <0.002 m^3 per well of metal shavings (swarf) which will remain on the seabed.

WBDF used during riserless drilling and well annular fluids will be released to the marine environment when the well head is removed during abandonment. Upon wellhead removal, small volumes (up to 10 m^3) of fluid exchange between the annular spaces and the ocean may occur. The exchange will not be instantaneous as the annular spaces are small and the fluids are typically heavier than seawater. The non-instantaneous nature of the release of the well annular fluids is expected to result in rapid dilution within meters of the release.

6.7.2.4 Volumes of Planned Discharges – Drill Cuttings and Fluids

Table 6-48 summarises the expected volumes of drill cuttings and fluids to be discharged for each well. This is conservatively based on a directional well up to approximately 4,500 m deep that is not currently planned but may be required for future wells. The Project plans to drill 8 wells vertically to depths of approximately between 2,000 m and 3,500 m. As a result, the planned wells will have lower associated cuttings and fluids discharge volumes.

Table 6-48: Total Expected Volumes of Planned Discharges – Drill Cutting and Fluids

Project Stage	**Discharge type**	**Discharge location**	**Indicative volume (per well)**
Drilling	Drill cuttings	Seabed	400 m^3
		Surface	200 m^3
	Drilling fluids *Seawater & pre-hydrated gel sweeps*	Seabed	2,500 m^3
	WBDF	Surface	1,500 m^3
	SBDF (contingency)	Surface	100 m^3

	Wellbore cleanout fluids	Surface	100 m^3
	Completion fluids	Surface	300 m^3 *(including 16 m^3 of formation water)*
Operations (well workovers and interventions)	Completion fluids	Surface	300 m^3 *(including 16 m^3 of formation water)*
	Well annular fluid	Seabed	10 m^3
Decommissioning	Suspension fluids	Seabed	100 m^3
	Metal shavings (swarf)	Seabed	<0.002 m^3

6.7.3 Impact Analysis and Evaluation

Planned discharges of drill cuttings and fluids to the marine environment have the potential to result in the following impacts:

- change in water quality
- change in sediment quality
- change in habitats and communities.

As a result of a change in water and sediment quality, further impacts may occur, which include:

- injury/mortality to fauna.

The potential impacts of injury/mortality to fauna will be limited to the Project Area, as such receptors potentially affected are:

- plankton
- fish, marine mammals, and marine reptiles.

Changes to benthic habitats and communities also has the potential to result in indirect changes to the functions, interests, or activities of the following receptors:

- Commonwealth and state commercial fisheries
- cultural values and sensitivities.

6.7.3.1 Water Quality

Periodic discharges of drill cuttings and fluids will temporarily change the water quality within the immediate surrounds of the discharge location. Changes in water quality include increased turbidity within the water column. Discharge of drill cuttings and fluids to sea have been well-studied, where in-field observations and predictive studies have all found these discharges to cause temporary water quality changes, mainly due to increased turbidity that dissipates quickly (Sanzone et al., 2016).

Drilling fluids will be discharged intermittently in batches ranging from around 1 m^3 to 400 m^3 and, depending on volume, may be discharged over a matter of minutes or over several hours.

During drilling of the top-hole section, discharges of drill cuttings and fluids will occur at the seabed, resulting in a localised increase in turbidity immediately around the well. The drill cuttings and fluids will settle rapidly within proximity to the wellhead, with finer particles (approx. 10% of the discharge volume) dispersing further within ocean currents (Hinwood et al. 1994).

For drill cuttings and fluids discharged below the sea surface, Hinwood et al. (1994) indicates that larger particles of cuttings and adhered muds (90-95%) discharged from the surface fall to the seabed within close proximity to the release point. Larger particles, representing approximately 90% of the mass of mud solids discharged to the marine environment will form a plume which settles swiftly on the seafloor (or until the plume entrains enough seawater to reach neutral buoyancy). The remaining 10% of the mass forms another plume in the upper water column which drifts with prevailing currents away from the source and is diluted rapidly in the water column (Neff 2005, 2010). In well-mixed oceans, drilling cuttings and fluid plume is diluted by more than 100-fold within 10 m of the discharge (Neff 2005), with drilling fluid concentration falling to below acute toxicity threshold of 10,000 ppm within 100 m of the discharge source (Neff 2010).

Dispersion of the cuttings plume is influenced by two factors: fluid type (i.e. particle size) and ocean current speed. The case studies described in Neff (2005) used WBMs and uses lower surface current speeds as a conservative estimate of 0.15–0.3 m/s. The Project will also use WBMs to drill the wells in ocean currents in excess of 1 m/s (Section 4.3.2.4), as a result, the dispersion extents and dilution rates in Neff (2005) are considered highly conservative.

WBDF is a water-based drilling fluid where water or brine is the primary liquid component. The potential use of oil-based Synthetic Based Drilling Fluids (SBDF) is considered as a contingency activity for the Project. SBDFs, though generally less toxic than traditional oil-based muds, can introduce low concentrations of hydrocarbons to the marine environment. The potential use of SBDF would be subject to Beach's chemical selection process to ensure chemicals used are environmentally acceptable whilst also meeting technical requirements. WBM includes additives that are either:

- Inert in marine environments
- Naturally occurring, benign minerals
- Readily biodegradable organic polymers
- Low-concentration substances with minimal environmental impact.

Bentonite sweeps or barite, commonly used as weighting agents, are classified internationally as posing little or no risk to the environment (PLONOR). Ambient water quality in the Project Area is expected to be high and typical of the offshore marine environment. In the high-energy shelf waters, any changes in water quality will be quickly dispersed where dilution rates are expected to be more than 100-fold within 10 m of the discharge (Neff 2005). The increase in turbidity is expected to be intermittent and temporary where drill cuttings and fluids will settle rapidly within proximity to the wellhead resulting in localised impacts to water quality. Planned discharges of drill cuttings and fluids will occur at both the surface and seabed, but will occur in short periods, with no long-term or continuous discharges planned. This will allow water quality to quickly recover, with no long-term changes to ambient water quality expected. Temporary and localised changes to water quality have been evaluated as a Minor (1) consequence.

6.7.3.2 Sediment Quality

Periodic discharges of drill cuttings and fluids will temporarily change sediment quality within the immediate surrounds of the discharge location. Changes in sediment quality includes the introduction and accumulation of contaminants and change in physical characteristics of seafloor sediments from both subsea and surface discharges of drill cuttings and fluids. Contaminants may accumulate within benthic sediment because of chemical additives within drilling fluids. Increased sedimentation because of cuttings material deposition may alter the physical characteristics of the seabed sediment profile through changes in minerology, sediment structure, particle distribution, particle flow and chemical composition. The area of thickness for seabed deposition is dependent on a range of factors including:

- fluid type adhered to cuttings (WBDF or SBDF)
- amount of fluid retained on cuttings
- particle size distribution of cuttings
- water depth
- current speed and direction at varying depths

Drill cuttings and fluids discharged during drilling operations are expected to result in the greatest change in sediment quality, as cuttings tend to clump together and settle rapidly, with thicker cuttings piles generally located downstream from the discharge. This is especially evident for SBDF. Deposition of sediments is expected to be highly localised around the well site (Neff 2005).

Field studies summarised by International Association of Oil & Gas Producers (IAOGP) (2016), found that cuttings and adhered WBDF could be detected either visually or through increases in barium concentrations within 10 – 150 m of the source. Maximum height of the cuttings pile was usually <50 cm. When cuttings were discharged from the rig (i.e. at the surface), the increased depth allows small particles to disperse over greater distances, leaving thinner layers of cuttings near the well site – for example, WBDF cuttings discharged from a single well in >300 m water may disperse so widely they may not be detectable in sediments at any distance from the well.

Metals present in drilling fluids generally resemble that of marine sediments, albeit with concentrations of some metals higher than clean marine sediments (Neff 2005). Metals associated with WBDF drill cuttings have been shown to have a low bioavailability as they tend to remain in a non-ionic form, remaining bound to other compounds, presenting a low toxicity risk to marine fauna (Neff 2005). Other metals present in drilling wastes, mainly as salts, may originate from formation cuttings or from impurities in barite and other mud components. Barite used during the Drilling and P&A activities will have very low concentrations of mercury (Hg) and cadmium (Cd) (less than 1 mg/kg and 3 mg/kg respectively). A study investigating barite solubility and the release of trace metal compounds recorded that <1% of the mercury and 15% of the cadmium dissolved from the barite after one-week exposure to the marine environment (Crecelius et al. 2007). Further, these do not contribute to sediment toxicity due to their low bioavailability (Schaanning et al. 2002). The field studies summarised by IAOGP at three continental slope drilling locations in water depths between 37 and 119 m found that within a year, concentrations of barium and chemicals from WBDF and SBDF discharges reduced by 2.4 to 80% for barium and 65 to 99% for chemicals within 100 m of the discharge source (IAOGP 2016). The IAOGP studies (IAOGP 2016) also found the following regarding the extent of cuttings deposition and potential impact:

Cuttings and adhered fluids typically disperse slower and cover a wider area when WBDF are used rather than SBDF.

Surface discharges of SBDF are generally deposited within approximately 100–200 m downstream of the discharge source for shallower water (<400 m) and up to a maximum of 1 km downstream for deeper waters with concentrations decreasing with distance from the discharge site

WBDF cuttings discharged near to the sea surface tend to accumulate on the seafloor down current from the discharge at distances of about 100m to up to a maximum of 1.4 km.

The Minerva exploration well study in the Bass Strait identified that cuttings were visually detected to 100 m from wellhead at 1 week post-drilling and no cuttings detected 11 months post drilling.

For both SBDF and WBDF discharges at the seafloor; cuttings could be detected visually, or as elevated barium concentrations in benthic sediments within 10 – 150 m of the discharge, with a greater spread down-current.

Based on these studies, a conservative exposure radius of up to 2 km is assumed for drill cuttings and fluids on the seabed to result in change to sediment quality for up to 11 months before returning to pre-drilling conditions.

In summary, change in sediment quality is expected to localised and temporary such that changes are limited to 2 km from the discharge location for each well and pre-drilling conditions will return within 11 months of the discharge. Temporary and localised changes to sediment quality have been evaluated as Minor (1) consequence.

6.7.3.3 Benthic Habitats and Communities

Periodic drill cuttings and fluid discharges will alter benthic habitats and communities within the immediate surrounds of the discharge location. Drill cuttings are expected to physically smother seabed habitats and communities, whereas fluid adhered to cuttings discharges will expose localised benthic habitats and communities to bio accumulative chemicals such as hydrocarbons and metals such as lead and zinc..

As discussed in Section 4.3.3, several studies (Boreen et al. 1993, BBG 2003, CEE Consultants Pty Ltd 2003 and Ramboll 2020) have been undertaken within the Project Area within the shallow and middle shelf zones. These studies have identified the seabed is similar across these areas, consisting of carbonate rich coarse to medium sands with areas of exposed limestone substrate. This type of seabed is highly mobile making it difficult for filter feeders and soft body invertebrates to survive and establish in significant populations. Epifauna is dominated by low density, patchy assemblages of branching bryozoans, gorgonian cnidarians and sponges.

Seabed discharges of drill cuttings and fluids will create a cuttings pile surrounding the well location. The size of the cuttings pile generally extends tens of metres from the well location. The cuttings pile will directly bury and smother the benthic habitats and communities surrounding the immediate well location, resulting in the localised loss of low density sessile benthic fauna and alteration of carbonate rich coarse to medium sand habitats. The presence of the hydrocarbon component in the cuttings pile is SBDF is used will prevent recolonisation of benthic communities in the area. Recolonisation of the cuttings pile (SBDF mud-cuttings piles in cold-water marine environments) is expected within one to two years of ceasing discharges once the hydrocarbon component of the cutting piles biodegraded (Neff 2010). As a result, the localised loss of benthic habitats and communities is expected to be temporary.

Surface water discharges of drill cuttings and fluids will generally deposit on the seabed up to a maximum of 1 km from the discharge site. However, effects to benthic habitats and communities from surface discharges is expected to be within 200 m of the discharge location given cuttings concentrations decreases with distance from the discharge site (Terrens et al. 1998; Jones et al. 2021). The loss of low density sessile benthic fauna and alteration of carbonate rich coarse to medium sand habitats is expected within 200 m of the well location based on smothering effects of drill cuttings and fluid discharges. Impacts to mobile benthic fauna (e.g. crabs, shrimps, demersal fish) are not expected given their ability to avoid effected areas (IOGP, 2016).

In a contingency event where SBDF is used for lower well sections, the discharge of SBDF adhered to cuttings will deposit of the seabed resulting in an increase in SBDF in benthic sediments that may lead to depletion of oxygen in surface layers and cause a change in or decrease in diversity of the benthic community (IOGP, 2016). SBDF also contains hydrocarbons that may bioaccumulate. However, Melton et al. (2000) suggests that given the ability for organisms to oxidise and expel aromatics, hydrocarbons are not expected to bioconcentrate given the reactivity and biodegradation rate of drilling materials in high energy environments.

A study on the impacts of drilling in Bass Strait, where the Drilling and P&A activities will be conducted, by Terrens et al. (1998) observed biological effects within 100 m of the drilling site shortly after drilling; recovery of seabed communities across the area were reported within four months. This study found that after 11 months SBDF was not detectable in sediments, indicating that recovery of the seabed is through a combination of dispersion and biodegradation. Neff (2010) found that recolonisation of SBDF mud-cuttings piles in cold-water marine environments began within one to two years of ceasing discharges once the hydrocarbon component of the cutting piles biodegraded. Thus, for WBDF recolonisation would be faster as there is no hydrocarbon component.

A recent study on the Northwest Shelf (Jones et al. 2021), where in-situ surveys were undertaken during a drilling campaign, suggest a zone of high impact surrounding the drill centre up to 50–75 m in all directions which would have been caused by cuttings and fluid discharges from the drill rig. Outside this zone was an area of medium impact up to approximately 200 m where there were clear losses of epifauna, but nevertheless sponges and soft corals were still observed. Pre- and post-drilling ROV surveys which documented physical smothering effects from WBDF cuttings within 100 m of the well were compared and found that outside the area of smothering, fine sediment was visible on the seabed up to 250 m from the well (Jones et al. 2006, 2021). After three years, there was significant removal of cuttings particularly in the areas with relatively low initial deposition (Jones et al. 2021). The area impacted by complete cuttings cover had reduced from 90 m to 40 m from the drilling location, and faunal density within 100 m of the well had increased considerably and was no longer significantly different from conditions further away.

Marine fauna that are exposed in the laboratory or field to cuttings in sediments do not bioaccumulate significant quantities of metals (Hartley et al. 2003). There is some evidence of a limited bioavailability of a few metals, such as lead and zinc, which are present in cuttings piles; however, doubt remains that metal bioaccumulation in marine fauna from cuttings piles is sufficient to cause harmful effects in marine fauna living on or near cuttings piles (OSPAR 2019). Neff (2010) concludes that, due to a lack of toxicity and low bioaccumulation potential of drilling fluids, the effects of drilling discharges are highly localised and are not expected to spread through the food web.

Hinwood et al. (1994) explain that the main environmental disturbance from discharging drilling cuttings and fluids is associated with the smothering and burial of sessile benthic and epibenthic fauna. Many studies have shown that the effects on seabed fauna and flora from the discharge of drilling cuttings with water-based muds are minimal (e.g. Cranmer 1988, Neff et al. 1989, Hyland et al. 1994, Daan & Mulder 1996, Currie and Isaacs 2005, OSPAR 2009, Bakke et al. 2013).

The above-mentioned studies have concluded that impacts to benthic habitats and communities from drill cuttings and fluid discharges are limited to localised burial and smothering of low density sessile benthic fauna and carbonate rich coarse to medium sand habitats. Impacts are expected to be within 200 m of the well location, where recovery of benthic habitats is expected to be within 11 months and recolonisation of cuttings piles is expected to be within one to two years of ceasing discharges. The biodegradation rate of drilling materials in high energy environments ensures low bioaccumulation potential to benthic fauna communities.

The localised and temporary change in benthic habitats and communities from periodic planned discharges of drill cuttings and fluids is expected from direct burial and smothering. Given that epifaunal communities are likely well represented in the region and that the footprint of the potential impact of drilling 8 wells is small in comparison with the spatial extent of these communities in the region, there is a high level of confidence that drill cuttings and fluids will not destroy, fragment or isolate these communities nor modify or disturb substantial areas of habitat. Temporary and localised changes to benthic habitats and communities highly represented in the region have been evaluated as a Minor (1) consequence.

6.7.3.4 Plankton

A reduction in water quality through increased turbidity and increased toxicity, caused by the discharge of drill cuttings and fluids within the Project Area, will have a negligible effect on plankton populations at a measurable level. Jenkins and McKinnon (2006) identified suspended sediment concentrations greater than 500 mg/L will likely result in a measurable impact to larvae species of most fish species, with concentrations of 100 mg/L effecting larvae species of most fish if exposed to for longer than 96 hours. Previous studies (Neff, 2010) showed discharges of cuttings and fluids could reach 100 mg/L within 100 m of the MODU within approximately 16 minutes, assuming a conservative 0.1 m/s current speed. Changes in water quality associated with increased turbidity are therefore restricted to within proximity of the discharge source.

Plankton have a patchy distribution linked to localised and seasonal productivity that produces sporadic bursts in populations (CoA, 2015c). Plankton distribution in the project area is expected to be highly variable both spatially and temporally and are likely to comprise characteristics of tropical, southern Australian, central Bass Strait and Tasman Sea distributions. A change in water quality at levels that may illicit acute toxicity to plankton as a result of drill cuttings and fluids is likely to be limited to within 100 m of the MODU (limited to within the project area) and therefore unlikely to lead to injury or mortality of plankton at a measurable level and will not result in a change in the viability of the population or ecosystem dynamics during regional upwelling events or otherwise. Therefore, no impacts to plankton populations from drill cuttings or fluids discharges are expected. Not all zooplankton are alive in the natural environment, non-consumptive mortality of zooplankton in marine habitats have been recorded from naturally occurring changes to oxygen layers, thermoclines, upwelling, and salinity gradients (Daase & Soreide 2021). As a result, zooplankton carcasses may play an important role in marine food webs as they may serve as nutritious food for benthic organisms (Daase & Soreide 2021). Consequently, the temporary and localised loss of plankton from planned discharge of drilling cuttings and fluids will not significantly contribute to existing non-consumptive mortality of zooplankton naturally occurring in the marine habitats and therefore has been evaluated as a Minor (1) consequence.

6.7.3.5 Fish, Marine Mammals and Marine Reptiles

A reduction in water quality through increased turbidity and increased toxicity, caused by the discharge of drill cuttings and fluids in the Project Area, will have negligible effects on fish, marine mammals, and marine reptiles. Neff et al. (2000) states that drill cuttings are of little risk to water column biota due to Water Based Drilling Fluid having low toxicity levels and will be rapidly diluted near the source. Based on the low toxicity levels and short duration of the drill cuttings and fluids plume in the Project Area, there is no potential for acute or chronic exposure of fish, marine mammals, and marine reptiles from the low toxicity levels contained within a highly temporary drill cuttings and fluids plume. With no potential for acute or chronic exposure, the potential for injury or mortality to occur to these species is not credible.

Marine fauna found in the water column, such as fish, marine mammals and marine reptiles, are expected to actively avoid discharge plumes and associated turbidity within the water column. If marine fauna does not actively avoid the discharge plume, exposure to low toxicity levels in the plume is expected to be temporary given the Project Area is habitat to transient fish, marine mammals, and marine reptiles based on the absence of site attached habitats for these species.

The intermittent and temporary drill cuttings and fluids plumes are expected to be restricted within the Project Area (Section 6.7.3.1) and therefore will only overlap fish, marine mammal, and marine reptile BIAs relating to distribution (white shark), foraging (blue whale), and migration (southern right whale). These BIAs and the open offshore waters of the Project Area does not foster site fidelity or attachment for these species.

The Project Area overlaps the BIA distribution area for the white shark. No habitat critical to the survival of the white shark or behaviours were identified. The Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013c) does not identify waste discharges as a threat. As a result, the white shark is expected to be a highly mobile and transient species within the Project Area. The temporary exposure of low toxicity levels from the drill cuttings and fluids plume in the Project Area prevents acute or chronic exposure to transient white sharks, therefore, no injury or mortality is expected.

Three species of marine mammal listed as Vulnerable (sei whale, fin whale, humpback whale) and two species listed as Endangered (blue whale, southern right whale) are known or likely occur within the Project Area. The Project Area overlaps foraging and distribution BIAs for the pygmy blue whale and migration BIA for the southern right whale. The Conservation Management Plans for the Blue Whale (CoA, 2015b) and Southern Right Whale (DSEWPaC, 2012a) identifies acute and chronic chemical discharges as a threat mainly in relation to hydrocarbon spills and bioaccumulation of pollutants. Pollution (persistent toxic pollutions) is identified as a minor threat for the sei whale (Approved Conservation Advice for Balaenoptera borealis (Sei Whale) (TSSC, 2015e) and fin whale (Approved Conservation Advice for Balaenoptera physalus (Fin Whale) (TSSC, 2015d). Based on the low toxicity levels contained within highly temporary and intermittent drill cuttings and fluids plumes in the Project Area, , there is no potential for acute or chronic exposure of pollutants to marine mammals and therefore no injury or mortality is expected. There are three marine turtle species with potential to be present, however no BIAs or habitat critical to the survival of the marine turtle species occur within the Project Area. The Recovery Plan for Marine Turtles in Australia, (CoA, 2017) identifies chemical and terrestrial discharge as a threat, although this is mostly in relation to pollution from agricultural, terrestrial industrial and domestic sources. Based on the low toxicity levels contained within highly temporary and intermittent drill cuttings and fluids plumes in the Project Area, there is no potential for acute or chronic exposure of pollutants to marine reptiles and therefore no injury or mortality is expected.

6.7.3.6 Commonwealth and State Commercial Fisheries

a Discharges of drill cuttings and fluids has the potential to result in a change to benthic habitats and communities. This change is indirectly associated with commercially valued benthic species. Potential changes to commercially valued benthic species in the Project Area may then result in indirect changes to the functions, interests, or activities of Commonwealth and state commercial fisheries. There are two commercially fished marine benthic invertebrate species which are present within the Project Area which could be indirectly susceptible to discharges of drill cuttings and fluids: the giant crab and the southern rock lobster (Section 4.4.7.1).

Southern rock lobster live in rocky reefs (VFA 2023b) a habitat unlikely to be disturbed by Project activities as rocky reefs are not an appropriate substrate for anchoring or drilling of a well. Giant crab have recorded movements up and down the continental shelf depending on food availability (Levings et al. 2001), where change to benthic habitats and communities in potential giant crab habitats in the Project Area potentially leading to emigration of the mobile biota to other areas along the continental shelf.

The extent of the impact is expected to be within 200 m of the discharge location and recovery from change in benthic habitats and communities is anticipated to be within 11 months (Section 6.7.3.3). Therefore, the impact from discharges of drill cuttings and fluids is likely to result in Minor (I) consequences to the functions, interests, or activities of Commonwealth and State commercial fisheries based on:

- Giant crab and southern rock lobster are mobile species and are generally less vulnerable than sessile taxa to sedimentation, as they are able to move to areas with less sediment accumulation or by more efficiently physically removing particles (Fraser et al. 2017).
- The Project Area intersects the following giant crab and southern rock lobster fisheries areas:
    - Southern rock lobster
        - 14 of the 200 Victorian southern rock lobster reporting blocks (up to 20 active vessels – Figure 4-82).

        - The Project Area does not overlap the Tasmanian southern rock lobster reporting blocks.
    - Giant crab
        - 9 of the 48 Victorian giant crab reporting blocks (up to 13 active vessels – Figure 4-78).
        - 1 of the 386 Tasmanian giant crab reporting blocks (confidential fishing effort due to less than 5 vessels being active within the fishery – Figure 4-85).

- The southern rock lobster fishery has a stock status listed as sustainable for Victoria, Tasmania and South Australia (FRDC 2020). The giant crab fishery has a stock status listed as sustainable for Victoria and South Australia and depleted for Tasmania (FRDC 2020; 2020a). The depleted stock status for the Tasmanian giant crab fishery is based on data obtain from 2013-2014, and there has been insufficient data for the fishery since 2013 to determine if the stock is recovering (FRDC 2020a).
- Based on the localised change in benthic habitats and communities (within 200 m of the discharge location) and recovery of benthic habitats is expected to be within 11 months, the disturbance footprint is considered negligible compared with the wider extent of available fishing grounds and the intermittent nature of drilling discharges, impacts to benthic species of commercial importance are predicted to be localised and insignificant at a population level.
- As rock lobster live in rocky reefs (VFA 2023b) it is unlikely that their habitat would be disturbed as rocky reefs are not an appropriate substrate for anchoring or drilling of a well.
- Seabed surveys will be undertaken to allow for the consideration of seabed habitat type in the final selection of well locations to avoid area of high relief outcrops, reefs or sponge beds.
- The area of impact is predicted to be small compared to the extent of available and utilised commercial fishing areas for both the Victorian and Tasmanian giant crab and southern rock lobster fisheries.

6.7.3.7 Cultural Values and Sensitivities

As detailed in Section 4.6 no First Nations underwater cultural heritage has been identified in the Project Area. However, First Nations people specifically Eastern Maar highlights that although the edge of the continental shelf is under sea, it was occupied for thousands of years and rising sea levels have not washed away the history, physical evidence, or connection to that part of Sea Country (Section 4.6.3.5). At present, oil and gas infrastructure exists across the Otway Basin and memories and songlines relating to the historical occupation of the present-day seabed are still acknowledged and recognised (Biosis 2023).

Periodic discharges of drill cuttings and fluids will result in localised and temporary change in benthic habitats and communities which may interact with unknown First Nations submerged cultural heritage and landscapes. To prevent potential interaction with First Nations submerged cultural heritage and landscapes in the Project Area, Beach has consulted with First Nations groups to define the management approach of intangible cultural heritage to prevent impacts and risks to environmental features that are associated with intangible cultural heritage (Australia ICOMOS Burra Charter, 2013). As per the draft Guidelines for Working in the Near and Offshore Environment to Protect Underwater

Cultural Heritage (DCCEEW 2023) Beach has consulted with First Nations groups and relevant underwater culture heritage researchers and organisations to understand what data could be obtained from the seabed survey that will be undertaken prior to planned drilling discharges and other seabed disturbing activities to identify First Nations submerged cultural heritage and submerged cultural landscapes. Data from seabed surveys will be provided to an appropriately qualified underwater archaeologist to identify submerged cultural heritage. Should any submerged cultural heritage be identified, Beach will consult with the relevant First Nations groups (see Section 4.6.2) and determine any exclusion areas or further cultural heritage management procedures that may be required. Thus, impacts to First Nations underwater cultural heritage are not predicted.

6.7.4 Impact Evaluation Summary

The impact evaluation for planned discharge of drill cuttings and fluids is summarised in Table 6-49.

Table 6-49: Impact Evaluation Summary for Planned Discharges of Drill Cuttings and Fluid

Summary	
Summary of impact	Intermittent discharges of drill cuttings and fluids in surface waters and at the seabed is expected to result in temporary and localised changes to water quality, sediment quality, and benthic habitats and communities. These changes act as impact pathways to the localised injury and mortality of plankton, emigration of commercially valued species from the Project Area and the potential interaction with First Nations submerged cultural heritage and landscapes in the Project Area. Data from seabed surveys will be provided to an appropriately qualified underwater archaeologist to identify submerged cultural heritage. Should any submerged cultural heritage be identified, Beach will consult with the relevant First Nations groups (see Section 4.6.2) and determine any exclusion areas or further cultural heritage management procedures that may be required to prevent interactions with First Nations submerged cultural heritage and landscapes. Together these impacts from intermittent discharges of drill cuttings and fluids will result in Minor (1) consequences with the application of adopted controls. The Minor (1) consequences are considered acceptable, given controls are in place to ensure potential impacts are better than the defined acceptable levels 1, 6, 14, 15, and 16.
Extent of impacts	The greatest extent of impact is from change in sediment quality where localised changes are limited to within 2 km from the discharge location.
Duration of impacts	The longest impact duration is from change in benthic habitats and communities where habitat recovery is expected within 11 months of the discharge and recolonisation of communities is expected within one to two years of ceasing discharges.
Level of certainty of impacts	Impacts from planned discharges of drill cuttings and fluids are well understood and there is nothing new or unusual. There is high level of certainty on the predicted impacts from drill cuttings and fluids, including: • Impact and fate in the environment • Toxicity of individual components within the drilling fluids • likely distribution of cuttings on the seabed. Good practice is defined through the implementation of the following controls which ensures uncertainty is minimal: • Beach is committed to undertake seabed surveys and commission an appropriately qualified underwater archaeologist to identify submerged cultural heritage to avoid impacts to cultural values and sensitivities. Beach has long-term experience in the area on the application of good industry practice to ensure impacts associated with planned discharge of drill cuttings and fluids are acceptable.

Is the impact considered lower-order or higher-order?	Potential impacts from planned discharges of drill cuttings and fluids have been evaluated to result in Minor (I) consequences. Minor consequences are considered lower-order impacts that is acceptable with the application of good industry practice.

Impact Consequence
Minor

6.7.5 Demonstration of Acceptability

Table 6-50 demonstrates how and why predicted environmental impacts from planned discharges of drill cuttings and fluids meet the defined acceptable levels (Table 5-4).

Table 6-50: Demonstration of Acceptability – Planned Discharge – Drill Cuttings and Fluids

Demonstration of Acceptability		
Impact and risk comparison with relevant defined acceptable levels	The acceptable level relevant to the planned discharge – drill cuttings and fluids includes acceptable levels 6, 7, 10, 11, 15, and 16 (as detailed in Table 5-4). A **Minor** impact consequence level was assigned for this aspect based on the impact analysis and evaluation. Minor (1) consequences resulting from planned discharge – drill cuttings and fluids: • will contain chemical additives subject to Beach’s chemical selection process • will result in a localised change in water quality (<2 km from discharge point located in the Project Area) which will return to baseline conditions following completion of planned discharges • will result in localised change in sediment quality (<2 km from the discharge point located in the Project Area) for sediments highly represented throughout the region from planned discharges • will not impact on unique seafloor habitats[2] to the south-east region, including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests • will only impact on benthic habitats and communities within the Project Area that are highly represented throughout the region and are not unique seafloor habitats • will not impact on underwater cultural heritage with values as conferred by the *Underwater Cultural Heritage Act 2018* (Cth) • will not impact on declared areas or objects of particular significance with values as conferred by the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth). As a result, the predicted environmental impact from planned discharge – drill cuttings and fluids is better than the defined acceptable levels 6, 7, 10, 11, 15, and 16.	
ESD principles	Integration principle	Section 6.7.3 identifies and evaluates environmental impacts associated with the discharge of drill cuttings and fluids. Conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental impact. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks. For Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders on the Project and associated activities. No objections or claims were raised against this aspect during Phase 1: Initial Project Consultation. For Phase 2: Project OPP Public Comment Period (Section 10.2.4), the public had the opportunity to provide further comment to this OPP during the period (18/3/2024 – 20/5/2024). Beach prepared the public comment report

		summarising all comments, an assessment of the merits of each comment, a statement of the response to each comment, and an outline of any changes made to the OPP as a result of the comment (Appendix P). The assessment of merit for comments against this aspect found the response provided in the public comment report to be sufficient to address the comments against this aspect. Therefore, no further updates were required for this aspect. Given the thorough assessment and responses outlined in the public comment report, the impact evaluation for this aspect remains acceptable as is, demonstrating that public comments have been adequately addressed. The potential environmental impacts against this aspect was assessed as having Minor (1) consequences which is considered a lower-order environmental impact. Lower-order environmental impacts are considered 'broadly acceptable' and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental impacts against this aspect were assessed as having Minor (1) consequences which is considered a lower-order environmental impact and below defined acceptable levels 6, 7, 10, 11, 15, and 16 . Lower-order environmental impacts cannot result in serious or irreversible environmental damage. There is high confidence in the potential environmental impacts and effectiveness of controls against this aspect. Beach has significant experience operating in the Otway and Bass based on their existing offshore developments and associated activities including the Beach Otway Drilling Campaign in 2021/2022.
	Intergenerational principle	The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts due to the discharge of drill cuttings and fluids is lower than the defined acceptable levels 6, 7, 10, 11, 15, and 16 ; the health, diversity, or productivity of the environment for future generations is expected to be maintained.
	Biodiversity principle	Section 6.7.3 identifies and evaluates environmental impacts associated with the discharge of drill cuttings and fluids. As part of identifying the potential impacts; conservation values and sensitivities including MNES in Section 4 were reviewed. Given predicted environmental impacts due to the discharge of cement is lower than the defined acceptable levels 6, 7, 10, 11, 15, and 16; no potential to affect biological diversity or ecological integrity is expected.
Internal context	Beach Policy compliance	The defined acceptable levels, EPOs and controls proposed for this aspect are consistent with Beach Environmental Policy objectives. As a result, potential environmental impacts and risks from Project can be managed to align with Beach Environmental Policy objectives.
External context	Stakeholder engagement is being carried out as part of this OPP process. Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable. During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect. During Phase 2: Project OPP Public Comment Period (Section 10.2.4), comments were raised against this aspect. The assessment of merit for comments against this aspect found the responses provided in the public comment report to be sufficient to address the comments against this aspect. Given the thorough assessment and responses outlined in the public comment	

	report, the impact evaluation for this aspect remains acceptable as is, demonstrating that public comments have been adequately addressed.
Other requirements	Other requirements associated with this aspect includes compliance with Australian legislative requirements. Management of this aspect is aligned with the legislative requirements below.

Requirement	Demonstration
OPGGS Act 2006 (Cth) Section 460(2) - a person carrying on activities in an offshore area under the permit must carry out those activities in a manner that does not interfere with the conservation of the resources of the sea and seabed to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.	This requirement is addressed through the adoption of the following control measures: **CM10 Seabed assessments** Seabed assessments undertaken of each well location and tie-back route prior to final selection to identify seabed composition, benthic habitats and communities and ensure areas of high relief outcrops, reefs, sponge beds, maritime archaeology, submerged cultural heritage and landscapes are avoided where practicable within technical and safety constraints. Seabed assessment data will be provided to the following appropriately qualified specialists to identify sensitive benthic receptors: • Marine benthic ecologist to identify seabed habitat types including areas of high relief outcrops, reefs or sponge beds that are likely to be associated with site-attached fish. • Underwater archaeologist to identify shipwrecks and other maritime archaeological heritage. • Geophysical data analyst to identify location of unexploded ordinances. • Underwater archaeologist to identify submerged cultural heritage and landscapes. Reports from each specialist evaluation of seabed assessment data will be provided to Beach. Beach will assess the reports and identify any areas of overlap, potential risks from Project activities, and determine any exclusion areas that may be required. **CM11 Cultural heritage assessments** Imagery and data from seabed surveys and assessments will be provided to appropriately qualified underwater archaeologists to identify any maritime archaeological and submerged cultural heritage and landscapes and inform protection priorities, management measures and reporting requirements. Should any maritime archaeological and submerged cultural heritage and landscapes be identified, Beach will report the findings in accordance with the *Underwater Cultural Heritage Act 2018*, and will consult with the relevant First Nations groups and determine any exclusion areas
The Minimata Convention Countries that have ratified the Convention are bound by international law to put controls in place to manage emissions, releases and disposal of mercury and mercury compounds. At present there are no specific guidelines regarding acceptable levels of mercury waste in drilling fluids.	
The following management plans or conservation advice identify pollution, habitat degradation or discharges as a threat: • Recovery Plan for Marine Turtles in Australia, 2017-2027 (CoA, 2017) • Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA, 2008) • Conservation Management Plan for the Blue Whale, 2015-2025 (CoA, 2015b) • National Recovery Plan for the Southern Right Whale *Eubalaena australis* (DCCEEW, 2024o) • Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC, 2015e) • Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale) (TSSC, 2015d)	

		or further cultural heritage management procedures that may be required. **CM28 Well design** All wells to be drilled with WBDF, with SBDF only to be used where technical requirements preclude the use of WBDF **CM29 Chemical selection process** A process for chemical selection will be implemented to ensure chemicals used are environmentally acceptable whilst also meeting technical requirements **CM30 Drilling fluid inventory** Drilling fluids inventory will be developed and tracked to reduce or avoid discharge of bulk materials including excess powders, brines, and drilling fluids **CM31 Solids control equipment** If SBDF is used, drill cuttings will be processed on the MODU to recover and reduce residual SBDF content prior to overboard discharge **CM32 Minamata convention** Drilling fluids will have concentrations of mercury and cadmium less than 1 mg/kg and 3 mg/kg respectively in stock barite (WBM and SBM)

6.7.6 Environmental Performance

In accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 6-) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 6-50 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 6- are met.

Table 6-51: Environmental Performance Outcomes – Planned Discharge – Drill Cuttings and Fluids

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 7: Localised change in water quality (<2 km from discharge point located in the Project Area) which will return to baseline conditions following completion of planned discharges (as defined in the OPP) containing chemical additives subject to Beach's chemical selection process is acceptable. **Acceptable level 8:** Localised change in sediment quality (between 1 km and 2 km from the discharge point located in the Project Area[1]) where physical characteristics of seafloor sediments will return to pre-drilling conditions within a year following completion of planned discharges (as defined in the OPP) containing chemical additives subject to Beach's chemical selection process is acceptable.	EPO16:	Implement CM28 Well design to ensure all wells to be drilled with WBDF, with SBDF only to be used where technical requirements preclude the use of WBDF.
	EPO17:	Implement CM29 Chemical selection process to ensure chemicals used are environmentally acceptable whilst also meeting technical requirements
	EPO18:	Implement CM30 Drilling fluid inventory to reduce or avoid discharge of bulk materials including excess powders, brines, and drilling fluids.
	EPO19:	Implement CM31 Solids control equipment to recover and reduce residual SBDF

Defined Acceptable Level	Environmental Performance Outcomes	
		content prior to overboard discharge, if SBDF is used.
	EPO20:	Implement CM32 Minamata convention to ensure drilling fluids will have concentrations of mercury and cadmium less than 1 mg/kg and 3 mg/kg respectively in stock barite (WBM and SBM)
Acceptable level 11: No impacts on unique seafloor habitats[2] to the south-east region, including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests. **Acceptable level 12**: Impacts on benthic habitats and communities within the Project Area that are highly represented throughout the region and are not unique seafloor habitats is acceptable.	EPO21:	Defined well locations and immediate surrounds (<2 km from well location) within the Project Area will not contain unique seafloor habitats[2].
	EPO4:	Implement CM 10 Seabed assessments to identify seabed composition, benthic habitats and communities and ensure areas of unique seafloor habitats[2], maritime archaeology, UXOs, submerged cultural heritage and landscapes are avoided where practicable within technical and safety constraints.
Acceptable level 16: No impacts on underwater cultural heritage with values as conferred by the *Underwater Cultural Heritage Act 2018* (Cth). **Acceptable level 17**: No impacts on declared areas or objects of particular significance with values as conferred by the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth).	EPO5	No impact on underwater cultural heritage.
	EPO6:	Implement CM11 Cultural heritage assessments to identify any maritime archaeological and submerged cultural heritage and landscapes to inform protection priorities, and develop and implement management measures and reporting requirements, where required, to prevent potential impacts.

---

[1] Seabed disturbance from upper well section drilling fluids and cuttings discharges is expected to be within 1 km of the well location (RPS 2023). This area of disturbance is included in the total project seabed disturbance footprint (Table 6-5) as long-term seabed disturbance, where relevant acceptable levels and EPOs for seabed disturbance are defined in Section 6.2.6.

[2] Unique seafloor habitats of the south-east region including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests (DNP, 2025).

6.8 **Planned Discharge – Cement**

6.8.1 Hazard Identification

Planned discharges including cement are to be discharged into the marine environment during the Project. The cement used in offshore drilling is typically a blend of Portland cement, water, and various additives that are designed to improve its performance under the high pressures and temperatures.

Relevant stages and associated activities that results in planned discharges of cement are defined below in Table 6-52and described in Section 6.8.2.

Table 6-52: Activities Undertaken During the Project Resulting in Planned Discharges - Cement

Stage	Activity
Drilling and completions	Drilling method
Operations	Well intervention and workovers
Decommissioning	Well plugging and abandonment

6.8.2 Hazard Description

6.8.2.1 Drilling and Completions

The Project plans to drill and develop 9 wells across VIC/P43 and, VIC/P73 within the scope of this OPP. These wells are planned to be drilled as exploration wells, and subject to success, will undergo completions to become development wells. Cementing fluids will be discharged during drilling of the 9 wells. Cement is used to form permanent barriers and fix casings in place during drilling operations. Cementing of the casings may result in the release of small amounts of cement (up to approximately 50 m^3 per well) to the seabed when the cement mixture is circulated to the seabed during grouting or when surplus fluids require disposal after cementing operations. During liner cement jobs, some excess cementing fluids will be circulated back to the surface and discharged to the sea. Cement discharged at the sea surface is expected to be a combination of cement slurry and wash water and will be a maximum of 70 m^3 per well, and an additional 25 m^3 at the final well location.

6.8.2.2 Operations

Well intervention and workovers may require the use of cement. If well intervention and workovers are required, cement discharges are not expected to exceed the volumes estimated for the drilling stage.

6.8.2.3 Decommissioning

During well plug and abandonment, cement and/or mechanical plugs may be set within the well to install a permanent reservoir and surface barrier.

During well plug and abandonment activities, cement discharges are not expected to exceed the volumes estimated for the drilling stage.

6.8.3 Impact Analysis and Evaluation

Planned discharges of cement to the marine environment have the potential to result in the following impacts:

- change in water quality
- change in sediment quality
- change in habitats and communities.

As a result of a change in water and sediment quality, further impacts may occur, which include:

- injury/mortality to fauna.

The potential impact of injury/mortality to fauna will be limited to the Project Area, as such receptors potentially affected are:

- plankton
- fish, marine mammals, and marine reptiles.

Changes to benthic habitats and communities also has the potential to result in indirect changes to the functions, interests, or activities of the following receptors:

- Commonwealth and state commercial fisheries
- cultural values and sensitivities.

6.8.3.1 Water quality

The surface discharge of cement can cause increased turbidity in the water column and result in a temporary change in surface water quality. However, cement particles are expected to disperse under the action of metocean conditions and eventually settle out of the water column. Cement slurry discharge from the rig is not expected to result in excessive turbidity as it will stick together and deposit rapidly to the seabed. BP (2013) modelled a large cement discharge of ~78m^3 over a one-hour period and found that, within two hours of discharge, suspended solid concentrations within the plume, which was 150 m horizontal and 10 m vertical, ranged between 5–50 mg/L. Four hours after discharge concentrations were <5 mg/L. The volume modelled is slightly greater than the maximum surface discharge volume predicted for the Drilling activities, therefore it is predicted that the concentration of suspended sediments would be lower within a localised area surrounding the discharge location.

The chief chemical components of Portland cement are calcium, silica, alumina and iron. Calcium is derived from limestone, marl or chalk, while silica, alumina and iron come from the sands, clays and iron ore sources. Other raw materials may include shale, shells and industrial by products such as mill scale. All these products are inert and will, therefore, pose little or no risk to the environment. Similarly, chemical additives used will be selected to ensure low risk to the environment.

Planned discharges of cement will occur at both the surface and seabed, but will occur in short periods, with no long-term or continuous discharges planned. This will allow water quality to quickly recover, with no long-term changes to ambient water quality expected. Temporary and localised changes to water quality have been evaluated as a Minor (1) consequence.

6.8.3.2 Sediment quality

Intermittent cement discharges will temporarily change sediment quality within the immediate surrounds of the discharge location. Changes in sediment quality includes the introduction and accumulation of contaminants and change in physical characteristics of seafloor sediments from subsea discharges of cement. Contaminants may accumulate within benthic sediment because of chemical additives within cement. However, cement is typically inert and is considered to pose little or no risk to the environment. CIN (2005) states that once cement has set it is essentially inert and not likely to have chronic toxicity effects.

The area of thickness for seabed deposition is dependent on a range of factors including:

- particle size distribution of cement

- water depth
- current speed and direction at varying depths

The environmental survey undertaken for the Otway Gas Development (Ramboll, 2020) concluded that sediments in the project area had a high ORP (oxidation-reduction potential) and low or undetectable levels of toxicants indicating an unmodified seabed environment. Cement discharged during the Project is expected to result in the greatest change in sediment quality. Deposition of sediments is expected to be highly localised around the well site (Neff 2005).

6.8.3.3 Benthic Habitats and Communities

It is estimated that approximately 50 m^3 of cement will be discharged to seabed per well which has the potential to smother and alter the benthic habitats and communities.

Cement discharged at the seabed is not expected to disperse as it is designed to set in a marine environment and will therefore set in-situ. BP (2013) modelled a 200 t (~83 m^3) cement discharge at the seabed and found changes to the benthic environment were limited to 10 m. Chevron (2018) indicated that planned cement discharges from overflow during drilling operations may affect the seabed around the well to a radius of ~10 – 50 m. This is an area of 0.007 km^2 for an individual well. For cement discharged in surface waters, modelling undertaken by de Campos et al. (2017) showed average deposition of 0.05 mg/m^2 of cement material on the seabed from a release of 18 m^3 of cement wash water. It is expected that benthic habitats and communities within 50 m of the discharge location has the potential to be smothered by deposition of cement from both surface and seabed cement discharges. Benthic habitats and communities within the Project Area are highly represented throughout the region. No species or ecological communities listed as threatened under the EPBC Act were observed. Therefore, the loss of 0.007 km^2 per well within the Project Area of benthic habitats and communities highly represented throughout the region is considered area very localised area of disturbance.

Given the change in benthic habitats and communities from cement discharges results in a very localised area of disturbance (within 50m of the well) in non-threatened benthic habitats highly represented throughout the region, the impact has been evaluated as a Minor (1) consequence.

6.8.3.4 Plankton

A reduction in water quality from increased turbidity caused by the discharge of cement slurry from surface waters within the Project Area will have a negligible effect on plankton populations at a measurable level.

Plankton have a patchy distribution linked to localised and seasonal productivity that produces sporadic bursts in populations (CoA, 2015c). Plankton distribution in the project area is expected to be highly variable both spatially and temporally and are likely to comprise characteristics of tropical, southern Australian, central Bass Strait and Tasman Sea distributions.

Jenkins and McKinnon (2006) reported that levels of suspended sediments greater than 500 mg/l are likely to produce a measurable impact upon zooplankton (larvae of most fish species and marine invertebrates) and levels of 100 mg/l where exposure occurs for greater than 96 hours may also affect the larvae of some species. Jenkins and McKinnon (2006) further indicate that levels of 100 mg/l may affect the larvae of several marine invertebrate species. It is understood that the zooplankton (such as egg and larval stages) are more vulnerable to suspended particles than other life stages. Modelling conducted by BP (2013) detailed that particulate concentrations within the cement discharge plume 2 hours after the start of discharge were in the 5-50 mg/l and 4 hours after the start of the discharge, the modelling indicates that the plume will have completely dispersed to particulate concentrations of less than 5 mg/l. Thus, impacts to plankton are not predicted.

A change in water quality as a result of cement discharges is unlikely to lead to injury or mortality of plankton at a measurable level and will not result in a change in the viability of the population or ecosystem dynamics during regional upwelling events or otherwise. Consequently, the temporary and localised loss of plankton, with no effects on plankton populations at a measurable level, from cement discharges has been evaluated as a Minor (1) consequence.

6.8.3.5 Fish, Marine Mammals and Marine Reptiles

A reduction in water quality through increased turbidity, caused by the cement discharges in the Project Area, will have negligible effects on fish, marine mammals, and marine reptiles. Cement is typically inert and is considered to pose little or no risk to the environment, and the cement plume from surface water discharge is expected to deposit rapidly to the seabed within four hours of discharge (BP 2013). Based on the low toxicity levels and short duration of the cement plume in the Project Area, there is no potential for acute or chronic exposure of fish, marine mammals, and marine reptiles from the low toxicity levels contained within a highly temporary cement plume. With no potential for acute or chronic exposure, the potential for injury or mortality to occur to these species is not credible.

6.8.3.6 Commonwealth and State Commercial Fisheries

Seabed discharges of cement have the potential to result in a change to benthic habitats and communities. This change is indirectly associated with commercially valued benthic species. Potential changes to commercially valued benthic species in the Project Area may then result in indirect changes to the functions, interests, or activities of Commonwealth and state commercial fisheries. There are two commercially fished marine benthic invertebrate species which are present within the Project Area which could be indirectly susceptible to discharges of cement: the giant crab, and the southern rock lobster (Section 4.5.11).

Southern rock lobster live in rocky reefs (VFA 2023b) a habitat unlikely to be disturbed by Project activities as rocky reefs are not an appropriate substrate for anchoring or drilling of a well. Giant crab have recorded movements up and down the continental shelf depending on food availability (Levings et al. 2001), where change to benthic habitats and communities in potential giant crab habitats in the Project Area potentially leading to emigration of the mobile biota to other areas along the continental shelf.

The extent of the impact is expected to be within 50 m of the discharge location (Section 6.8.3.3). Therefore, the impact from discharges of cement is likely to result in Minor (I) consequences to the functions, interests, or activities of Commonwealth and state commercial fisheries based on:

- Giant crab and southern rock lobster are mobile species and are generally less vulnerable than sessile taxa to sedimentation, as they are able to move to away from impacted benthic areas (Fraser et al. 2017).
- The Project Area intersects the following giant crab and southern rock lobster fisheries areas:

- Southern rock lobster
    - 14 of the 200 Victorian southern rock lobster reporting blocks (up to 20 active vessels – Figure 4-82).
    - The Project Area does not overlap the Tasmanian southern rock lobster reporting blocks.
- Giant crab
    - 9 of the 48 Victorian giant crab reporting blocks (up to 13 active vessels – Figure 4-78).
    - 1 of the 386 Tasmanian giant crab reporting blocks (confidential fishing effort due to less than 5 vessels being active within the fishery – Figure 4-85).

The southern rock lobster fishery has a stock status listed as sustainable for Victoria, Tasmania and South Australia (FRDC 2020). The giant crab fishery has a stock status listed as sustainable for Victoria and South Australia and depleted for Tasmania (FRDC 2020; 2020a). The depleted stock status for the Tasmanian giant crab fishery is based on data obtain from 2013-2014, and there has been insufficient data for the fishery since 2013 to determine if the stock is recovering (FRDC 2020a).

Based on the localised change in benthic habitats and communities (within 50 m of the discharge location), the disturbance footprint is considered negligible compared with the wider extent of available fishing grounds and the intermittent nature of drilling discharges, impacts to benthic species of commercial importance are predicted to be localised and insignificant at a population level.

As rock lobster live in rocky reefs (VFA 2023b) it is unlikely that their habitat would be disturbed as rocky reefs are not an appropriate substrate for anchoring or drilling of a well.

Seabed surveys will be undertaken to allow for the consideration of seabed habitat type in the final selection of well locations to avoid area of high relief outcrops, reefs or sponge beds.

The area of impact is predicted to be small compared to the extent of available and utilised commercial fishing areas for both the Victorian and Tasmanian giant crab and southern rock lobster fisheries.

6.8.3.7 Cultural values and Sensitivities

Impacts to First Nations values and sensitivities such as intangible spiritual connection or responsibility to whales, dolphins, seals, fish, and eels are not predicted as cement is inert and considered to pose little or no risk to the environment (OSPAR 2021) and the turbidity plume is temporary and suspended sediments are below levels where measurable impact upon plankton (larvae of most fish species) which are likely to be more sensitive than eels and whales, dolphins and seals may be present.

As detailed in Section 4.6, no First Nations underwater cultural heritage has been identified in the Project Area. However, First Nations people specifically Eastern Maar highlights that although the edge of the continental shelf is under sea, it was occupied for thousands of years and rising sea levels have not washed away the history, physical evidence, or connection to that part of Sea Country (Section 4.6.3.5). At present, oil and gas infrastructure exists across the Otway Basin and memories and songlines relating to the historical occupation of the present-day seabed are still acknowledged and recognised (Biosis 2023).

Intermittent cement discharges will result in localised change in benthic habitats and communities which may interact with unknown First Nations submerged cultural heritage and landscapes. To prevent potential interaction with First Nations submerged cultural heritage and landscapes in the Project Area, Beach has consulted with First Nations groups to define the management approach of intangible cultural heritage to prevent impacts and risks to environmental features that are associated with intangible cultural heritage (Australia ICOMOS Burra Charter, 2013). As per the draft Guidelines for Working in the Near and Offshore Environment to Protect Underwater Cultural Heritage (DCCEEW 2023) Beach has consulted with First Nations groups and relevant underwater culture heritage researchers and organisations to understand what data could be obtained from the seabed survey that will be undertaken prior to planned cement discharges and other seabed disturbing activities to identify First Nations submerged cultural heritage and submerged cultural landscapes. Data from seabed surveys will be provided to an appropriately qualified underwater archaeologist to identify submerged cultural heritage. Should any submerged cultural heritage be identified, Beach will consult with the relevant First Nations groups (see Section 4.6.2) and determine any exclusion areas or further cultural heritage management procedures that may be required. Thus, impacts to First Nations underwater cultural heritage are not predicted.

6.8.4 Impact Evaluation Summary

The impact evaluation for planned discharges of cement is summarised in Table 6-53.

Table 6-53: Impact Evaluation Summary for Planned Discharges - Cement

Summary	
Summary of impacts	Intermittent planned discharges of cement in surface waters and at the seabed is expected to result in temporary and localised changes to water quality, sediment quality, and benthic habitats and communities. These changes act as impact pathways to the localised injury and mortality of plankton and the potential interaction with First Nations submerged cultural heritage and landscapes in the Project Area. Data from seabed surveys will be provided to an appropriately qualified underwater archaeologist to identify submerged cultural heritage. Should any submerged cultural heritage be identified, Beach will consult with the relevant First Nations groups (see Section 4.6.2) and determine any exclusion areas or further cultural heritage management procedures that may be required to prevent interactions with First Nations submerged cultural heritage and landscapes. Together these impacts from intermittent discharges of cement will result in Minor (1) consequences with the application of adopted controls. The Minor (1) consequences are considered acceptable, given controls are in place to ensure potential impacts are better than the defined acceptable levels 1, 15, and 16.
Extent of impact	Localised – The greatest extent of impact is from change in sediment quality where localised changes are limited to within 50 m from the discharge location.
Duration of impact	Temporary - the longest impact duration is from change in benthic habitats and communities where the presence of the cement overflow is expected to exist until decommissioning.
Level of certainty	Impacts from planned discharges of cement are well understood and there is nothing new or unusual. There is high level of certainty on the predicted impacts from cement discharges, including: • Cement dispersion;

Summary	
	• toxicity of individual components within the cement; and • likely distribution of overspill on the seabed. Good practice is defined through the implementation of the following controls which ensures uncertainty is minimal: • Beach is committed to undertake seabed surveys and commission an appropriately qualified underwater archaeologist to identify submerged cultural heritage to avoid impacts to cultural values and sensitivities. Beach has long-term experience in the area on the application of good industry practice to ensure impacts associated with planned discharge of cement are acceptable.
Is the impact considered lower-order or higher-order?	Impacts from planned discharges of cement has been evaluated to result in Minor (1) consequences. Minor (1) consequences are considered lower-order impacts that is acceptable with the application of good industry practice.
Impact Consequence	
Minor	

6.8.5 Demonstration of Acceptability

Table 6-54 demonstrates how and why predicted environmental impacts from planned discharges of cement meets the defined acceptable levels (Table 5-4).

Table 6-54: Demonstration of Acceptability – Discharge of Cement

Demonstration of Acceptability		
Impact and risk comparison with relevant defined acceptable levels	Acceptable levels relevant to cement discharge includes acceptable levels 6, 7, 10, 11, 15, and 16 (as detailed in Table 5-4). A Minor (1) impact consequence level was assigned for this aspect based on the impact analysis and evaluation. Minor (1) consequences resulting from planned discharge – cement: • will contain chemical additives subject to Beach's chemical selection process • will result in a localised change in water quality (<2 km from discharge point located in the Project Area) which will return to baseline conditions following completion of planned discharges • will result in localised change in sediment quality (<2 km from the discharge point located in the Project Area) for sediments highly represented throughout the region from planned discharges • will not impact on unique seafloor habitats[2] to the south-east region, including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests • will only impact on benthic habitats and communities within the Project Area that are highly represented throughout the region and are not unique seafloor habitats • will not impact on underwater cultural heritage with values as conferred by the *Underwater Cultural Heritage Act 2018* (Cth) • will not impact on declared areas or objects of particular significance with values as conferred by the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth). As a result, the predicted environmental impact for cement discharge is lower than the defined acceptable levels 6, 7, 10, 11, 15, and 16.	
ESD Principles	Integration principle	Section 6.8.3 identifies and evaluates environmental impacts associated with the discharge of cement. Conservation values and sensitivities, physical environment, ecological environment, socio-

Demonstration of Acceptability		
		economic values, and First Nations values and sensitivities described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental impact. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks. For Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders on the Project and associated activities. No objections or claims were raised against this aspect during Phase 1: Initial Project Consultation. For Phase 2: Project OPP Public Comment Period (Section 10.2.4), the public had the opportunity to provide further comment to this OPP during the period (18/3/2024 – 20/5/2024). Beach prepared the public comment report summarising all comments, an assessment of the merits of each comment, a statement of the response to each comment, and an outline of any changes made to the OPP as a result of the comment (Appendix P). The assessment of merit for comments against this aspect found the response provided in the public comment report to be sufficient to address the comments against this aspect. Therefore, no further updates were required for this aspect. Given the thorough assessment and responses outlined in the public comment report, the impact evaluation for this aspect remains acceptable as is, demonstrating that public comments have been adequately addressed. The potential environmental impact against this aspect was assessed as having a Minor (1) consequences which is considered a lower-order environmental impact. Lower-order environmental impacts are considered 'broadly acceptable' and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental impacts against this aspect were assessed as having a Minor (1) consequences which is considered a lower-order environmental impact and below defined acceptable levels 6, 7, 10, 11, 15, and 16. Lower-order environmental impacts cannot result in serious or irreversible environmental damage. There is high confidence in the potential environmental impacts and effectiveness of controls against this aspect. Beach has significant experience operating in the Otway and Bass based on their existing offshore developments and associated activities including the Beach Otway Drilling Campaign in 2021/2022.
	Intergenerational principle	The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts due to the discharge of cement is lower than the acceptable levels 6, 7, 10, 11, 15, and 16; the health, diversity, or productivity of the environment for future generations is expected to be maintained.
	Biodiversity principle	Section 6.8.3 identifies and evaluates environmental impacts associated with the discharge of cement. As part of identifying the potential impacts, conservation values and sensitivities including MNES in Section 4 were reviewed.

<table>
<tr><th colspan="3">Demonstration of Acceptability</th></tr>
<tr><td></td><td></td><td>Given predicted environmental impacts due to the discharge of cement is lower than the defined acceptable levels 6, 7, 10, 11, 15, and 16 ; no potential to affect biological diversity or ecological integrity is expected.</td></tr>
<tr><td>Internal context</td><td>Beach Policy compliance</td><td>The defined acceptable levels, EPOs and controls proposed for this aspect are consistent with Beach Environmental Policy objectives. As a result, potential environmental impacts and risks from Project can be managed to align with Beach Environmental Policy objectives.</td></tr>
<tr><td>External context</td><td colspan="2">Stakeholder engagement is being carried out as part of this OPP process.
Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable.
During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect.
During Phase 2: Project OPP Public Comment Period (Section 10.2.4), comments were raised against this aspect. The assessment of merit for comments against this aspect found the responses provided in the public comment report to be sufficient to address the comments against this aspect. Given the thorough assessment and responses outlined in the public comment report, the impact evaluation for this aspect remains acceptable as is, demonstrating that public comments have been adequately addressed.</td></tr>
<tr><td>Other requirements</td><td colspan="2">Other requirements associated with this aspect includes compliance with Australian legislative requirements.
Management of this aspect is aligned with the legislative requirements below.
<table>
<tr><th>Requirement</th><th>Demonstration</th></tr>
<tr><td>OPGGS Act 2006 (Cth)
Section 460(2) - a person carrying on activities in an offshore area under the permit must carry out those activities in a manner that does not interfere with the conservation of the resources of the sea and seabed to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.</td><td rowspan="2">This requirement is addressed through the adoption of the following control measures:
CM10 Seabed assessments
Seabed assessments undertaken of each well location and tie-back route prior to final selection to identify seabed composition, benthic habitats and communities and ensure areas of high relief outcrops, reefs, sponge beds, maritime archaeology, submerged cultural heritage and landscapes are avoided where practicable within technical and safety constraints.
Seabed assessment data will be provided to the following appropriately qualified specialists to identify sensitive benthic receptors:
• Marine benthic ecologist to identify seabed habitat types including areas of high relief outcrops, reefs or sponge beds that are likely to be associated with site-attached fish.
• Underwater archaeologist to identify shipwrecks and other maritime archaeological heritage.
• Geophysical data analyst to identify location of unexploded ordinances.</td></tr>
<tr><td>The following management plans or conservation advice identify discharges, habitat degradation or pollution as a threat:
• Approved Conservation Advice for <i>Balaenoptera physalus</i> (Fin Whale) (TSSC, 2015d)
• National Recovery Plan for the Southern Right Whale <i>Eubalaena australis (</i>DCCEEW, 2024o)</td></tr>
</table></td></tr>
</table>

Demonstration of Acceptability		
	• Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC, 2015e) • Conservation Management Plan for the Blue Whale, 2015-2025 (CoA, 2015b) • Recovery Plan for Marine Turtles in Australia, 2017-2027 (CoA, 2017) • Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA, 2008)	• Underwater archaeologist to identify submerged cultural heritage and landscapes. Reports from each specialist evaluation of seabed assessment data will be provided to Beach. Beach will assess the reports and identify any areas of overlap, potential risks from Project activities, and determine any exclusion areas that may be required. **CM11 Cultural heritage assessments** Imagery and data from seabed surveys and assessments will be provided to appropriately qualified underwater archaeologists to identify any maritime archaeological and submerged cultural heritage and landscapes and inform protection priorities, management measures and reporting requirements. Should any maritime archaeological and submerged cultural heritage and landscapes be identified, Beach will report the findings in accordance with the *Underwater Cultural Heritage Act 2018*, and will consult with the relevant First Nations groups and determine any exclusion areas or further cultural heritage management procedures that may be required. **CM29 Chemical selection process** A process for chemical selection will be implemented to ensure chemicals used are environmentally acceptable whilst also meeting technical requirements. **CM33 Cementing program** Cementing programs shall be developed to reduce or avoid discharge of cement to the marine environment, including the reduction and avoidance of excess cement discharge upon completion of the drilling program.

6.8.6 Environmental Performance

In accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 6-) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 6-54 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 6- are met

Table 6-55: Environmental Performance Outcomes – Planned Discharge – Cement

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 7: Localised change in water quality (<2 km from discharge point located in the Project Area) which will return to baseline conditions following completion of planned discharges (as defined in the	EPO17:	Implement CM29 Chemical selection process to ensure chemicals used are environmentally acceptable whilst also meeting technical requirements

Defined Acceptable Level	Environmental Performance Outcomes	
OPP) containing chemical additives subject to Beach's chemical selection process is acceptable. **Acceptable level 8:** Localised change in sediment quality (between 1 km and 2 km from the discharge point located in the Project Area[1]) where physical characteristics of seafloor sediments will return to pre-drilling conditions within a year following completion of planned discharges (as defined in the OPP) containing chemical additives subject to Beach's chemical selection process is acceptable.	EPO22:	Implement CM33 Cementing program to reduce or avoid discharge of cement to the marine environment, including the reduction and avoidance of excess cement discharge upon completion of the drilling program.
Acceptable level 11: No impacts on unique seafloor habitats[2] to the south-east region, including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests. **Acceptable level 12**: Impacts on benthic habitats and communities within the Project Area that are highly represented throughout the region and are not unique seafloor habitats is acceptable.	EPO21:	Defined well locations and immediate surrounds (<2 km from well location) within the Project Area will not contain unique seafloor habitats[2].
	EPO4:	Implement CM 10 Seabed assessments to identify seabed composition, benthic habitats and communities and ensure areas of unique seafloor habitats[2], maritime archaeology, UXOs, submerged cultural heritage and landscapes are avoided where practicable within technical and safety constraints.
Acceptable level 16: No impacts on underwater cultural heritage with values as conferred by the *Underwater Cultural Heritage Act 2018* (Cth). **Acceptable level 17**: No impacts on declared areas or objects of particular significance with values as conferred by the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth).	EPO5	No impact on underwater cultural heritage.
	EPO6:	Implement CM11 Cultural heritage assessments to identify any maritime archaeological and submerged cultural heritage and landscapes to inform protection priorities, and develop and implement management measures and reporting requirements, where required, to prevent potential impacts.

---

[1] Seabed disturbance from upper well section drilling fluids and cuttings discharges is expected to be within 1 km of the well location (RPS 2023). This area of disturbance is included in the total project seabed disturbance footprint (Table 6-5) as long-term seabed disturbance, where relevant acceptable levels and EPOs for seabed disturbance are defined in Section 6.2.6.

[2] Unique seafloor habitats of the south-east region including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests (DNP, 2025).

6.9 **Planned Discharge – Commissioning and Operational Fluids**

6.9.1 Hazard Identification

Commissioning and operational fluids associated with drilling, commissioning, operations and decommissioning activities will be released to the marine environment. All planned discharges from commissioning and operational fluids will occur in the Project area.

Planned discharges from drilling activities including drilling muds and cements are discussed in Section 6.7 and Section 6.8 respectively. Operational waste discharges are discussed in Section 6.10.

Table summarises activities within the relevant activities that can result in commissioning and operational fluid discharges.

Table : Activities Undertaken During the Project which will Result in the Discharge of Subsea Equipment Discharges

Stage	Activity
Drilling	Blow-out preventer installation and function testing
Installation	Commissioning and Hydrotest
Operations	Valve actuation
Decommissioning	Plug and abandonment of wells

6.9.2 Hazard Description

6.9.2.1 Drilling and Decommissioning

During drilling (and well P&A), hydraulic control fluids will be released during BOP functioning and pressure testing. Function tests are generally undertaken every 7 days and will release ~ 2,200 L of potable water with 1 – 3% water-soluble control fluid. Pressure tests are generally undertaken every 21 days and may release small volumes of water-soluble fluids. In addition to this, BOP fluids are released whenever the riser is unlatched resulting in an additional release of fluids to the environment.

Hydraulic control fluids are water-based, low toxicity and readily biodegradable. On discharge they dilute rapidly in the open water environment to concentrations below which could possibly cause environmental harm. This means that their discharge into the marine environment will inherently have a minor impact to receptors, as any exposure will be short-lived and non-toxic, and chemicals will disperse quickly in the marine environment meaning that the potential timeframe for exposure will be short [**PC265**]. The extent of the impact is predicted to be within tens of metres from the MODU with a duration of hours whilst the BOP is being tested. The severity is assessed as less than Minor (1) and not discussed further, based on:

- BOP hydraulic fluid is of low toxicity, readily biodegradable and low potential for bioaccumulation.
- discharges will rapidly disperse in the marine environment.
- no sensitive resident receptors were identified within the area that may be affected.

6.9.2.2 Installation

Flowlines are filled with inhibited seawater and subjected to test pressures that will meet design code requirements, typically above any pressures seen during operation. Hydrotesting activities of flowlines will result in the release of treated seawater being released to the marine environment. Based conservatively on the maximum flowline diameter (12 inches), this would result in a discharge of approximately 5,700 m^3 of hydrotest fluid.

The chemicals added to the treated seawater will result in the discharge of residual chemicals to the marine environment. These chemicals may include biocides, dyes, corrosion inhibitors and scale inhibitors; these residual chemicals may result in a temporary decrease in water quality in the water column affected by the discharge. This decrease in water quality may result in impacts to marine biota, benthic habitats and sediments.

6.9.2.3 Operations

During the operations stage planned discharges from the actuation of subsea valves or maintenance and repair of hydraulic leads will result in the discharge of hydraulic fluid (~2 L). Based on the existing Otway Development it is estimate that the volume discharged from the additional Development valves would be ~ 4 m^3 per year. These fluids are typically low toxicity and biodegradable and would dissipate rapidly within the water column. Thus, impacts to water quality will be negligible and have not been discussed further.

6.9.2.4 Hydrotest discharge modelling

Beach commissioned a modelling study (RPS, 2023a) to better understand the potential fate of discharged hydrotest water in the environment; the report is provided as Appendix L. The modelling considered a 6,000 m^3 discharge of treated seawater over a period of 42.9 hours (140 m^3/hr), from a discharge outfall 2 m above the seafloor. The modelling study conservatively assumed a discharge volume of 120% of the longest potential flowline of 65 km between the prospect in the southern portion of the T/30P permit and Thylacine platform, being in the order of 6,000 m^3.

The discharge location was selected as the prospect in the southern portion of the T/30P permit as it is considered “worst-case” due to the higher sensitivity of the receiving environment, including the proximity to the Zeehan AMP. T/30P has since been removed from the scope of this OPP, however fate predictions of this modelling study are still considered a suitable and representative analogue for hydrotest discharges within the Project Area based on the conservative estimate provided by the parameters of the modelled location and the larger discharge volume.

The biocide concentration was the parameter modelled, as this component of the treated seawater has the greatest potential for environmental impacts. The modelling was based on the concentration of biocide at the time of discharge assumed to be 550 ppm; this is a conservative assumption as the actual concentration is expected to be significantly lower than this. The modelling also assumed the biocide is not consumed in the environment (i.e. it does not get consumed as it reacts with material); which is an additional conservative assumption upon which the modelling results are based.

An impact threshold of 1 ppm of biocide was defined; it was assumed that concentrations below this threshold would not result in significant environmental impacts. This threshold is consistent with published acute toxicity test data for aquatic species for typical biocides that may be used. For example, the Wheatstone Project Offshore Facilities and Produced Formation Water Discharge Management Plan: Stage 1 (Chevron, 2015) identified an acute toxicity threshold of 1 ppm for Hydrosure, a representative biocide product. The Safety Data Sheet for Hydrosure O-3670R states the 96-hour LC50 as 3.09 mg/L (3.09 ppm) for fish in marine waters, with a 48-hour EC5028 of 5.66 mg/L (5.66 ppm) for aquatic invertebrates (Champion Technologies, 2013). Sano et al (2005) assessed the potential toxicity effects of glutaraldehyde, another representative biocide, and reported a 24-hour LC50 of 4.7 mg/L (4.7 ppm) for the aquatic invertebrate *Ceriodaphnia dubia*. Note that ecotoxicological studies are typically undertaken using constant doses for periods ranging from 24 to 96 hours under controlled conditions. This approach is in contrast to the natural environment, where the concentration and exposure durations can vary widely. For the purpose of this assessment, selection of an impact threshold of 1 ppm provides a conservative basis to evaluate the potential effects of biocide in the receiving environment.

The near-field modelling results showed that treated seawater would initially project upward at a 45-degree angle due to diffuser orientation and high exit velocity. Once the plume lost momentum, the plume descended slightly till it was neutrally buoyant with the ambient water and then mixed laterally due to ambient currents. Given the negligible difference in the density of the hydrotest water and the ambient waters, the discharge plume remained above the seabed for all modelled scenarios. The far-field modelling results indicate that for the 99th and 100th-percentile analysis (i.e. 99% and 100% of the time), the maximum distances from the release location to the predicted dilutions of 1:550 (i.e. 1 mg/L which represents the impact threshold concentration/trigger value) contour were 20 m and 156 m, respectively (Figure 6-10). Based on the 95th percentile analysis (or 95% of the time), the 1:550 dilution was achieved very close to the release location (<20 m). The treated seawater will have the same water temperature and salinity as the surrounding seawater.

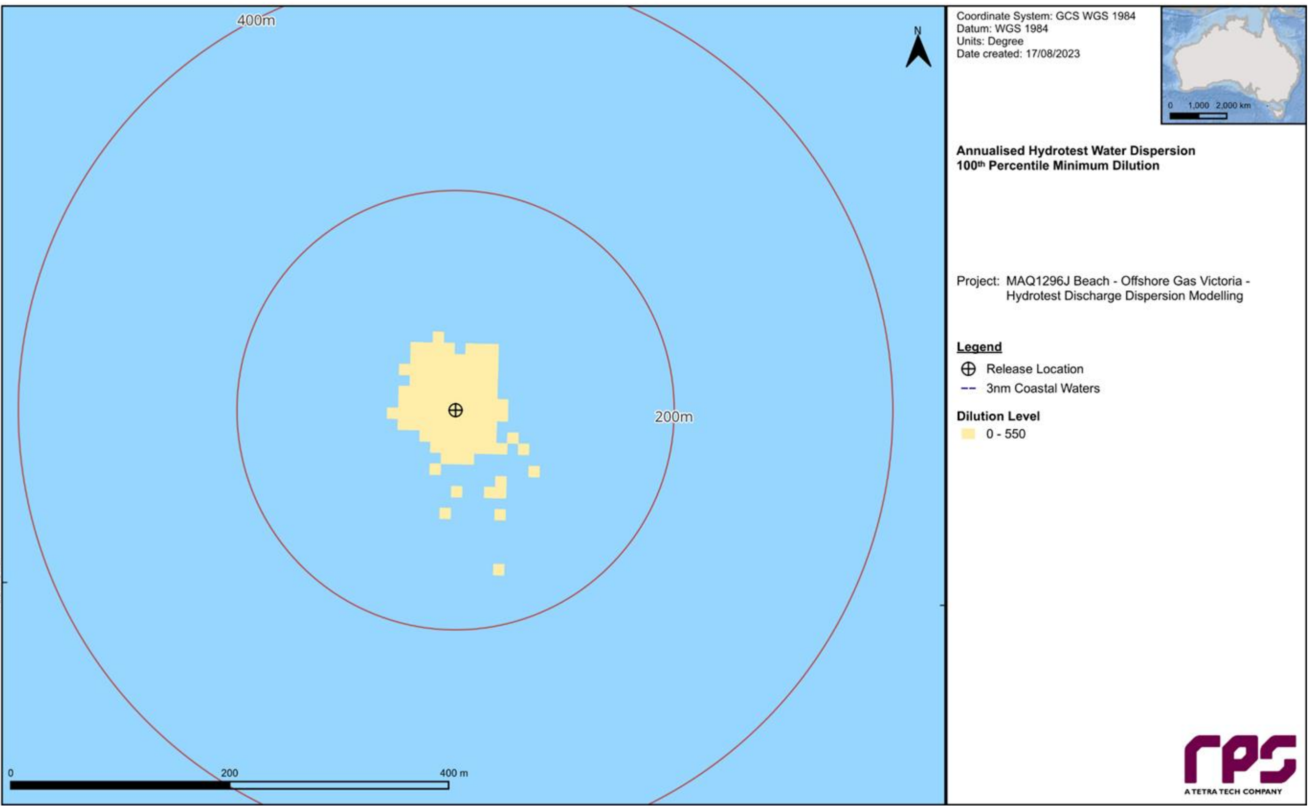


Figure 6-10: Predicted 100th-percentile Concentrations of the Hydrotest Discharge up until 550 Dilutions (1 ppm)

6.9.3 Impact Analysis and Evaluation

Planned discharges from commissioning and operational fluids to the marine environment have the potential to result in:

- change in water quality.

As a result of a change in water quality, further impacts may occur, including:

- injury/mortality to fauna.

The potential impact of injury/mortality to fauna will be limited to the Project Area, as such receptors potentially affected are:

- plankton
- fish, turtles, and marine mammals.

Hydrotest dispersion modelling (RPS, 2023a) indicates the dispersion plume (released 2 m from the seafloor) is neutrally buoyant with ambient sea water, driven upwards by discharge velocities. Given the similar densities of the hydrotest water to the surrounding water, the discharge plume remained predominately above the seabed for all modelled scenarios (RPS, 2023a). Due to there being no discernible impacts to water quality at or above the seabed, impacts to sediment quality and benthic habitats and communities have not been evaluated further.

Impacts to cultural and socio-economic receptors from commissioning and operational fluid discharges are not predicted, and have not been evaluated further, due to:

The discharge plume being restricted to the water column, without contacting surface or seabed features or commercially valued benthic species; and

The temporary nature of the plume and rapid dispersion by the open ocean environment.

6.9.3.1 Water Quality

Commissioning and operations discharges will include hydrotest and hydraulic fluids. These discharges are intermittent, non-continuous, and of short duration and may result in localised and temporary reduction in water quality during installation and commissioning, operations, and decommissioning phases of the Project. Based on operational experience, it is anticipated approximately 4 m^3 of hydraulic fluid will be released per year, from valve testing activities.

The hydrotest discharges from flowline commissioning activities, presents the worst-case for potential impacts to the marine environment. This discharge will result in localised and temporary reduction in water quality around the release location. As discussed in Section 6.9.2.4, the hydrotest modelling predicted the discharge plume will become neutrally buoyant in the water column and then mixed laterally with ambient currents. The plume is predicted to reach a maximum distance of 156 m from the release location to the 1 ppm threshold before dissipating in the water column to concentrations below the threshold.

Given the conservative volume modelled, high biodegradable rates of the chemical additives, and the high dispersion in the open, offshore environment, any reduction in water quality from the discharges is expected to be localised and short-term. Localised and short-term change to water quality from intermittent discharges of commissioning and operational fluids has been evaluated as a Minor (1) consequence.

6.9.3.2 Plankton

Intermittent planned discharges of commissioning and operational fluids have the potential to cause injury/mortality to plankton entrained within the discharge plume. Commissioning and operational fluids including hydrotest fluids contain residual chemicals, such as biocides, which have the potential to be acutely toxic to plankton. The acute toxicity threshold for Hydrosure (representative biocide) was defined as 1 ppm (Section 6.9.2.4). Hydrotest modelling predicted the resulting discharge plume to exceed the acute toxicity threshold at a maximum distance of 156 m from the release location before dissipating in the water column to concentrations below the threshold. It is anticipated that in the event sporadic distribution of plankton is present within the Project Area, non-consumptive mortality of plankton may occur if plankton is entrained within the discharge plume and exposed to acute toxicity levels of biocide. However, dilution of the plume is rapid and the concentration that the organism is exposed to will continually reduce with dispersion.

Plankton are widely distributed throughout the region, and, in the context of their lifecycle, impacts will be short term and negligible. Not all zooplankton are alive in the natural environment, non-consumptive mortality of zooplankton in marine habitats have been recorded from naturally occurring changes to oxygen layers, thermoclines, upwelling, and salinity gradients (Daase & Soreide 2021). As a result, zooplankton carcasses may play an important role in marine food webs as they may serve as nutritious food for benthic organisms (Daase & Soreide 2021). Consequently, the temporary and localised loss of plankton from planned discharge of commissioning and operational fluids will not significantly contribute to existing non-consumptive mortality of zooplankton naturally occurring in the marine habitats and therefore has been evaluated as a Minor (1) consequence.

6.9.3.3 Fish, Marine mammals, and Marine reptiles

A reduction in water quality through increased toxicity caused by the intermittent discharge of commissioning and operational fluids in the Project Area, will have negligible effects on fish, marine mammals, and marine reptiles.

Hydrotest fluids contain biocides at concentrations which are acutely toxic to smaller biota (such as plankton and algae) however are not acutely toxic to larger highly mobile marine fauna such as fish, marine mammals, and marine reptiles. Higher concentrations of biocide are required to elicit an effect on these larger species. For example, the Safety Data Sheet for Hydrosure O-3670R states the 96-hour LC50 for fish in marine waters as 3.09 mg/L (3.09 ppm). Therefore, for fish to receive a lethal concentration of biocide, individuals will need to remain within proximity to the discharge location for 96 hours for a 50% chance of mortality.

Based on the temporary and localised presence of the hydrotest discharge plume in the Project Area (Section 6.9.2.4), and the absence of habitats that encourages site fidelity and attachment for fish, marine mammals, and marine reptiles, there is no potential for acute or chronic exposure of these species to biocide concentrations contained within the discharge plume. With no potential for acute or chronic exposure, the potential for injury or mortality to occur to these species is not credible.

The discharge plumes are expected to be restricted within the Project Area (Section 6.9.2.4) and therefore will only overlap fish, marine mammal, and marine reptile BIAs relating to distribution (white shark), foraging (blue whale), and migration (southern right whale). These BIAs and the open offshore waters of the Project Area does not foster site fidelity or attachment for these species.

The Project Area overlaps the BIA distribution area for the white shark. No habitat critical to the survival of the white shark or behaviours were identified. The Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013c) does not identify waste discharges as a threat. As a result, the white shark is expected to be a highly mobile and transient species within the Project Area. The temporary exposure of toxicity levels from the hydrotest plume in the Project Area prevents acute or chronic exposure to transient white sharks, therefore, no injury or mortality is expected.

Three species of marine mammal listed as Vulnerable (sei whale, fin whale, humpback whale) and two species listed as Endangered (blue whale, southern right whale) are known or likely occur within the Project Area. The Project Area overlaps foraging and distribution BIAs for the pygmy blue whale and migration BIA for the southern right whale. The Conservation Management Plans for the Blue Whale (CoA, 2015b) and Southern Right Whale (DSEWPaC, 2012a) identifies acute and chronic chemical discharges as a threat mainly in relation to hydrocarbon spills and bioaccumulation of pollutants. Pollution (persistent toxic pollutions) is identified as a minor threat for the sei whale (Approved Conservation Advice for Balaenoptera borealis (Sei Whale) (TSSC, 2015e) and fin whale (Approved Conservation Advice for Balaenoptera physalus (Fin Whale) (TSSC, 2015d). Based on the low chance of bioaccumulation from exposure to the temporary hydrotest plumes in the Project Area, there is no potential for acute or chronic exposure of pollutants to marine mammals and therefore no injury or mortality is expected.

There are three marine turtle species with potential to be present, however no BIAs or habitat critical to the survival of the marine turtle species occur within the Project Area. The Recovery Plan for Marine Turtles in Australia, (CoA, 2017) identifies chemical and terrestrial discharge as a threat, although this is mostly in relation to pollution from agricultural, terrestrial industrial and domestic sources. The temporary exposure of toxicity levels from the hydrotest plume in the Project Area prevents acute or chronic exposure to transient marine reptiles, therefore, no injury or mortality is expected.

6.9.4 Impact Evaluation Summary

The impact evaluation for planned discharges of commissioning and operational fluids is summarised in Table 6-56.

Table 6-56: Impact Evaluations Summary for Planned Discharges – Commissioning and Operational Fluids

Summary	
Summary of impacts	Intermittent planned discharges of commissioning and operational fluids are expected to result in temporary and localised changes to water quality. This change acts as an impact pathway to the localised mortality of plankton if present within the Project Area. High dilution rates will reduce biocide concentrations to levels below thresholds required to elicit acute or chronic toxic effects to fish, marine mammals, and marine reptiles. The temporary and localised change to water quality and localised mortality of plankton will result in Minor (1) consequences that are considered acceptable, given controls are in place to ensure potential impacts are better than the defined acceptable level 1.
Extent of impacts	Localised – Hydrotest modelling predicted the resulting discharge plume to exceed the acute toxicity threshold at a maximum distance of 156 m from the release location before dissipating in the water column to concentrations below the threshold.
Duration of impacts	Temporary – the hydrotest plume is expected to dissipate rapidly in the water column from exposure to ambient water currents.

Summary	
Level of certainty	Impacts from planned discharges of commissioning and operational fluids are well understood and there is nothing new or unusual. There is high level of certainty on the predicted impacts from drill cuttings and fluids, including: Impact and fate in the environment based on Project specific modelling Toxicity of biocide within fluids Dilutions rates. Beach has long-term experience in the area on the application of good industry practice to ensure impacts associated with planned discharge of commissioning and operational fluids are acceptable.
Is the impact considered lower-order or higher-order?	Potential impacts from planned discharges of commissioning and operational fluids have been evaluated to result in Minor (I) consequences. Minor consequences are considered lower-order impacts that is acceptable with the application of good industry practice.
Impact Consequence	
Minor	

6.9.5 Demonstration of Acceptability

Table 6-57 demonstrates how and why predicted environmental impacts from planned discharges of commissioning and operational fluids meets the defined acceptable levels (Table 5-4).

Table 6-57: Demonstration of Acceptability – Planned Discharge – Commissioning and Operational Fluids

Demonstration of Acceptability		
Impact and risk comparison with relevant defined acceptable levels	The acceptable level relevant to planned commissioning and operational discharges is acceptable level 6 (as detailed in Table 5-4). A Minor (1) impact consequence level was assigned for this aspect based on the impact analysis and evaluation. Minor (1) consequences resulting from planned discharge – commissioning and operational fluids: • will contain chemical additives subject to Beach's chemical selection process • will result in a localised change in water quality (<2 km from discharge point located in the Project Area) which will return to baseline conditions following completion of planned discharges As a result, the predicted environmental impact for planned discharge – commissioning and operational fluids is lower than defined acceptable level 6.	
ESD Principles	Integration principle	Section 6.9.3 identifies and evaluates environmental impacts associated with planned commissioning and operational discharges. Conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental impact. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks. For Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders on the Project and associated activities. No objections or claims were raised against this aspect during Phase 1: Initial Project Consultation.

Demonstration of Acceptability		
		For Phase 2: Project OPP Public Comment Period (Section 10.2.4), the public had the opportunity to provide further comment to this OPP during the period (18/3/2024 – 20/5/2024). Beach prepared the public comment report summarising all comments, an assessment of the merits of each comment, a statement of the response to each comment, and an outline of any changes made to the OPP as a result of the comment (Appendix P). The impact assessment for this aspect has been updated to reflect the merit provided by public comment reference numbers PC265. As a result, the impact assessment now integrates responses to public comments of merit and therefore is of an acceptable level. The potential environmental impact against this aspect was assessed as having a Minor (1) consequences which is considered a lower-order environmental impact. Lower-order environmental impacts are considered 'broadly acceptable' and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental impacts against this aspect were assessed as having Minor (1) consequences which is considered a lower-order environmental impact and below defined acceptable level 6. Lower-order environmental impacts cannot result in serious or irreversible environmental damage. There is high confidence in the potential environmental impacts and effectiveness of controls against this aspect. Beach has significant experience operating in the Otway and Bass based on their existing offshore developments and associated activities including the Beach Otway Drilling Campaign in 2021/2022.
	Intergenerational principle	The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts due to planned commissioning and operational discharges is lower than the defined acceptable level 6; the health, diversity, or productivity of the environment for future generations is expected to be maintained.
	Biodiversity principle	Section 6.9.3 identifies and evaluates environmental impacts associated with planned commissioning and operational discharges. As part of identifying the potential impacts, conservation values and sensitivities including MNES in Section 4 were reviewed. Given predicted environmental impacts due to planned commissioning and operational discharges is lower than the defined acceptable level 6; no potential to affect biological diversity or ecological integrity is expected.
Internal context	Beach Policy compliance	The defined acceptable levels, EPOs and controls proposed for this aspect are consistent with Beach Environmental Policy objectives. As a result, potential environmental impacts and risks from Project can be managed to align with Beach Environmental Policy objectives.
External context	Stakeholder engagement is being carried out as part of this OPP process. Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable. Planned discharges of commissioning and operational fluids are not predicted to impact stakeholders. During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect.	

<table>
<tr><th colspan="2">Demonstration of Acceptability</th></tr>
<tr><td></td><td>During Phase 2: Project OPP Public Comment Period (Section 10.2.4), comments were raised against this aspect. The assessment of merit for these comments found this aspect to require updates. Changes to the OPP to address PC265 have been integrated into the impact evaluation for this aspect.
Any new guidance or advice in relation to this aspect will be assessed and incorporated into adaptive management plans prepared for activity specific EPs.</td></tr>
<tr><td>Other requirements</td><td>Other requirements associated with this aspect includes compliance with Australian legislative requirements.
Management of this aspect is aligned with the legislative requirements below.
<table>
<tr><th>Requirement</th><th>Demonstration</th></tr>
<tr><td>OPGGS Act 2006 (Cth)
Section 460(2) - a person carrying on activities in an offshore area under the permit must carry out those activities in a manner that does not interfere with the conservation of the resources of the sea and seabed to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.</td><td rowspan="2">This requirement is addressed through the adoption of the following control measures:
CM29 Chemical selection process
A process for chemical selection will be implemented to ensure chemicals used are environmentally acceptable whilst also meeting technical requirements.
CM34 Hydrotest assessment
Hydrotest assessments will be detailed in the relevant activity specific EPs developed during the detailed engineering and design studies of the Project. The EPs will detail the hydrotesting requirements including the definition of discharge characteristics (i.e. chemical additives and concentrations), discharge locations and volumes, methodology and species impact thresholds</td></tr>
<tr><td>The following management plans or conservation advice identify pollution, habitat degradation or discharges as a threat:
• Recovery Plan for Marine Turtles in Australia, 2017-2027 (CoA, 2017)
• Approved Conservation Advice for <i>Dermochelys coriacea</i> (Leatherback Turtle) (DEWHA, 2008)
• Conservation Management Plan for the Blue Whale, 2015-2025 (CoA, 2015b)
• National Recovery Plan for the Southern Right Whale <i>Eubalaena australis</i> (DCCEEW, 2024o)
• Approved Conservation Advice for <i>Balaenoptera borealis</i> (Sei Whale) (TSSC, 2015d)
• Approved Conservation Advice for <i>Balaenoptera physalus</i> (Fin Whale) (TSSC, 2015e)</td></tr>
</table>
</td></tr>
</table>

6.9.6 Environmental Performance

In accordance with NOPSEMA’s OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 6-58) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 6-57 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 6-58 are met

Table 6-58: Environmental Performance Outcomes – Planned Discharge – Commissioning and Operational Fluids

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 6: Localised change in water quality (<2 km from discharge point located in the Project Area) which will return to baseline conditions following completion of planned discharges (as defined in the OPP) containing chemical additives subject to Beach's chemical selection process is acceptable.	EPO17:	Implement CM29 Chemical selection process to ensure chemicals used are environmentally acceptable whilst also meeting technical requirements
	EPO23:	Implement CM34 Hydrotest assessment to detail the hydrotesting requirements including the definition of discharge characteristics (i.e. chemical additives and concentrations), discharge locations and volumes, methodology and species impact thresholds.

6.10 **Planned Discharge – Routine Operational Wastes from Vessels**

6.10.1 Hazard Identification

MODU and vessel operations will generate routine operational waste that will be discharged to surface waters. Routine operational wastes include discharges of cooling water, brine, deck drainage, bilge water, sewage, grey water, and putrescible waste, into the sea. This is a standard practice in the maritime industry and commonly undertaken in Australian offshore waters. While routine vessel operations will necessitate the discharge of routine operational waste, these discharges are subject to IMO regulations so most will undergo treatment prior to discharge.

Relevant stages and associated activities that have the potential for routine operational wastes from vessels are defined below in Table 6-59 and described in Section 6.10.2.

Table 6-59: Activities Undertaken During the Project which will Discharge Routine Operational Waste from Vessels

Stage	Activity
Support activities	Vessel operations MODU operations

6.10.2 Hazard Description

6.10.2.1Support operations

The type and number of vessels in the Project Area at any one time, and the duration of presence, will differ depending on the project stage. For a single activity, there will be no more than three vessels operating simultaneously. The longest duration for a single activity requiring support vessel operations is 40 days to drill a single well utilising a MODU and two support vessels. For concurrent activities, five vessels could operate in the Project Area at any one time, for example, pipelay or diving/tie-in activities may occur concurrently during MODU positioning. Concurrent operations will be kept to a minimum and are unlikely to occur for more than 13 days.

MODU and vessels operating in the Project Area will generate and discharge routine operational waste. MODU and vessels operations undertaken for the Project will adhere to the Navigation Act 2012, MARPOL and the various Marine Orders (as appropriate to vessel class) enacted under this Act.

Table 6-60 provides volume estimates for routine operational wastes calculated based on the number of people on board (POB), with the exception of bilge. The volume of bilge discharge from the MODU and vessel can vary depending on operational activities, maintenance and cleaning practices, and weather and sea conditions. Australian regulations, specifically the *Marine Pollution Control Act 1973*, impose strict limits on the discharge of oily bilge water. The maximum allowable oil content in discharged bilge water is 15 parts per million (ppm). Though the specific volume of bilge discharge cannot be definitively determined, the MODU and vessel will employ best practices and adhere to rigorous regulatory standards to minimise the environmental impact of these operations.

Table 6-60: Estimated MODU and Vessel Routine Operational Waste Discharge Volumes

Discharge Type	**Quantity MODU (approximate) 140 POB**	**Quantity Vessel (approximate) 15 POB**
Cooling Water	4,800 m^3/d combined (Rig + single vessel)	
RO Brine	170 m^3/day combined (Rig + single vessel)	
Sewage & Grey water	63 m^3 / day (0.45 m^3 pp/day)	7 m^3 / day (0.45 m^3 pp/day)
Putrescible waste	280 kg / day (1-2 kg pp/day)	30 kg / day (1-2 kg pp/day)

1. A description of each of the routine operational waste streams are provided as follows:Cooling Water and Brine (Desalination Unit Waste)

Cooling water is seawater used for non-contact, once through cooling of various machinery on the vessels and MODU. Seawater is extracted through intakes and circulated through heat exchanges and then discharged at elevated temperatures back to the sea. Desalination unit waste is residual high-concentration brine, associated with the process of creating freshwater from seawater. The concentrate is similar to sea water in chemical composition, however, anion and cation concentrations are higher. Brine discharges are typically 20 to 50% higher in salinity than the intake seawater (depending on the desalination process used).

Both discharges may contain low concentrations of chemical additives such as scale inhibitors and biocides (typically chlorine) used to mitigate biofouling on condenser tubes and intake and discharge conduits. These chemicals are usually consumed during the inhibition process resulting in little or no residual chemicals remaining upon discharge.

2. Deck Drainage

Deck drainage refers to any wastewater generated from deck washing, spillage, rainwater, and runoff from drains, including drip pans and wash areas. When this water contacts oil-coated surfaces, the water becomes contaminated. Oil and grease are the primary pollutants identified in the deck drainage waste stream (USEPA 1993). In addition to oil, various other chemicals used in drilling operations might be present in deck drainage. Such chemicals could include drilling fluids, ethylene glycol, lubricants, fuels, biocides, surfactants, detergents, corrosion inhibitors, cleaners, solvents, paint cleaners, bleach, dispersants, coagulants, and any other chemical used in the daily operations of the facility (Dalton, Dalton, and Newport 1985).

Contaminated waters will drain to a bilge/slops tank for treatment prior to discharge. Chemical selection procedures will be used to control the use of deck washdown detergents.

3. Treated Bilge

Bilge water is a collective term for fluid which comes from machinery and storage areas. The bilge system is designed to safely collect, contain and dispose of oily water from hazardous areas so that discharge of hydrocarbons to the marine environment is avoided. These fluids may contain contaminants such as oil, detergents, solvents, chemicals and solid waste, typically at low levels.

Bilge water will be processed via an oil-in-water separator (OWS), before being discharged into the sea, to reduce any oily residue to below 15 ppm. Residual oil will be retained onboard for onshore disposal.

4. Sewage, Greywater and Putrescible Waste

Sewage is waste discharged from toilets and urinals and treated with a marine sanitation device. The discharge is subject to secondary treatment and consists of chlorinated effluent. Greywater is waste from sinks, showers, laundries, safety showers, eyewash stations, and galleys. This can include kitchen solids, detergents, cleansers, oil and grease. Putrescible waste refers to solid food waste.

Sewage, grey water and putrescible waste generated onboard the vessels and MODU are commonly discharged to the marine environment. Volumes will vary, however, based on activities it is estimated that between 5 – 15 m^3 of sewage and greywater and up to 1 m^3 of putrescible waste could be generated per day. This waste will be treated prior to discharge to the environment as per guidelines under the MARPOL 73/78 Annex IV and Protection of the Sea (Prevention of Pollution from Ships) Act 1983.

6.10.3 Impact Analysis and Evaluation

Planned discharges of routine operational wastes from vessels to the marine environment have the potential to result in:

- change in water quality.

As a result of a change in water quality, further impacts may occur, including:

- behavioural changes
- injury/mortality to fauna.

The potential impact of injury/mortality to fauna will be limited to the Project Area, as such receptors potentially affected are:

- plankton
- fish, turtles, and marine mammals.

Impacts to cultural and socio-economic receptors from planned discharges of routine operational wastes from vessels are not predicted, and have not been evaluated further, due to:

- The discharge plume being restricted to the water column, without contacting seabed features or commercially valued benthic species; and

The temporary nature of the plume and rapid dispersion by the open ocean environment.

6.10.3.1Water quality

Routine operational discharges from vessels into the marine environment will result in localised and temporary changes in water quality within the Project Area. These contaminants have the potential to impact waters surrounding the discharge point by:

- Elevated water temperature from cooling water discharges, predicted to be less than 11°C above ambient within 100 m (horizontally) of the discharge point, and 10 m vertically (Woodside 2014). Cooling water will be less dense than the ambient water and will tend to remain at the surface. In contrast brine water density is greater and will tend to sink through the water column. Discharge rates are relatively low and temperature and salinity differentials will breakdown rapidly in the receiving environment.

- Intermittently elevated nutrient levels from sewage, putrescible waste, and grey water discharges, limited to 500 m from the rig and vessels based on discharges from a conservative 400 POB fixed facility (NERA 2017). As the volume estimated to be discharged per day from the vessels and MODU are below this discharge level the use of 500 m as the extent of impact is reasonable and likely to be conservative.

- Elevated salinity levels and chemical additives from brine discharges, modelled by the US EPA as diluted 40-fold within 4 m with no ocean current (Woodside 2014).

- Intermittently elevated hydrocarbon levels within 100 m of bilge water discharge (Shell 2009), from deck drainage, engine oil, lubricants, fuel residues and other petroleum-based substances that may have leaked or spilled into the bilge. The concentration of any bilge or deck drainage discharge will rapidly fall below levels which could impact the marine environment.

Discharges from routine operational wastes from vessels are intermittent, low volume, low toxicity and on release to the environment will rapidly dilute by prevailing waves and currents to below no effect levels, resulting in only localised and temporary impacts to water quality. The maximum extent of potential impact to water quality is conservatively predicted to be within 500 m of the MODU or vessels resulting in a Minor (1) consequence. [**PC266**] The consequence is assessed as Minor (1) based on:

- Discharges will be of low toxicity with controls such as treatment and chemical assessment in place.

- Discharges will be intermittent and of a low volume and as the discharges are discharged into an open oceanic environment, they are predicted to mix rapidly with the surrounding waters returning to a pre-impacted state without any long-term impacts to water quality.

- Cumulative impacts from planned routine operational discharges from vessels may occur for short periods when support vessels are within 500 m of the rig, i.e. during resupply activities. The small quantities involved, and intermittent nature of the discharges are not predicted to increase the impact extent beyond 500 m based on discharges from a conservative 400 POB fixed facility (NERA 2017).

6.10.3.2Plankton

Changes to water quality as a result of routine operational discharges from vessels could result in behavioural change or injury / mortality of plankton within 500 m of the rig and vessels.

Without controls, these discharges can contain contaminants such as oil, heavy metals, and bacteria that can degrade water quality and therefore result in the loss of plankton from acute or chronic exposure to contaminants. However, these discharges are subject to IMO regulations so most will undergo treatment prior to discharge (Section 6.10.2.1). The maximum extent of potential impact to water quality is conservatively predicted to be within 500 m of the MODU or vessels. On release to the environment, they will rapidly dilute resulting in only localised and temporary impacts to water quality [**PC267**]. The change in water quality from these discharges can result in possible changes in behaviour, if plankton are attracted and habituate to elevated nutrient levels from sewage, putrescible waste, and grey water discharges as a food source. Change in water quality from these discharges can also result in injury/mortality, if plankton are acutely or chronically exposed to elevated temperatures, salinity, chemical additives and hydrocarbon levels.

Plankton, including early life stages of fish (embryos, larvae), would be most susceptible to toxic exposure from chemicals in routine operational discharges from vessels, as they are less mobile and therefore can become entrained and exposed in the discharge plume. However, negligible effects are expected given previous studies on wastewater discharges which show no elevation in contaminant levels above background concentrations in proximity to the discharge point (Woodside 2008; 2014; Shell 2009). Not all zooplankton are alive in the natural environment, non-consumptive mortality of zooplankton in marine habitats have been recorded from naturally occurring changes to oxygen layers, thermoclines, upwelling, and salinity gradients (Daase & Soreide 2021). As a result, zooplankton carcasses may play an important role in marine food webs as they may serve as nutritious food for benthic organisms (Daase & Soreide 2021). Consequently, the temporary and localised loss of plankton from routine operational discharges from vessels will not significantly contribute to existing non-consumptive mortality of zooplankton naturally occurring in the marine habitats.

Change in water quality as a result of routine operational discharges from vessels is unlikely to lead to injury or mortality of plankton at a measurable level and will not result in a change in the viability of the population or ecosystem dynamics during regional upwelling events or otherwise. Impacts are likely to be limited to:

- localised non-consumptive mortality of plankton from exposure to elevated temperatures, salinity, chemical additives and hydrocarbon levels

- temporary attraction of plankton to elevated nutrient levels from sewage, putrescible waste, and grey water discharges as a food source.

Consequently, the temporary and localised attraction and loss of plankton, with no effects on plankton populations at a measurable level, from routine operational discharges from vessels has been evaluated as a Minor (1) consequence.

6.10.3.3 Fish, Marine Mammals, and Marine Reptiles

Changes to water quality as a result of routine operational discharges from vessels could result in behavioural change or injury / mortality of fish, marine mammals, and marine reptiles within 500 m of the rig and vessels.

Without controls, these discharges can contain contaminants such as oil, heavy metals, and bacteria that can degrade water quality and therefore harm marine life. However, these discharges are subject to IMO regulations so most will undergo treatment prior to discharge (Section 6.10.2.1). The maximum extent of potential impact to water quality is conservatively predicted to be within 500 m of the MODU or vessels. On release to the environment, they will rapidly dilute resulting in only localised and temporary impacts to water quality [**PC267**]. The change in water quality from these discharges can result in possible changes in behaviour, if fish, marine mammals, and marine reptiles are attracted and habituate to elevated nutrient levels from sewage, putrescible waste, and grey water discharges as a food source. Change in water quality from these discharges can also result in injury/mortality, if fish, marine mammals, and marine reptiles are acutely or chronically exposed to elevated temperatures, salinity, chemical additives and hydrocarbon levels.

- The temporary and localised presence of the discharge plume in the marine environment will prevent acute and chronic exposure and therefore injury/mortality to fish, marine mammals, and marine reptiles is not predicted, based on:
- A distribution BIA for the white shark has been identified within the Project Area. Routine operational discharges from vessels are not identified as a threat in the Recovery Plan for the white shark (*Carcharodon carcharias*) (DSEWPaC 2013c). Sharks will be transient through the Project Area thus impacts are not predicted due to the low toxicity of discharges and rapid dilution as a result of oceanic conditions.
- No BIAs or protected habitat were identified for other fish species within the Project Area. Although a variety of fish species, including commercial species, maybe be present in the area, impacts are not predicted due to the low toxicity of discharges and rapid dilution as a result of oceanic conditions. In addition, the sporadic discharge of macerated food scraps over short durations and are not predicted to result in habituation to this food source.
- No BIAs or critical habitat were identified for marine turtles within the Project Area although some species may occur. Chemical and terrestrial discharge are identified as a threat in the Recovery Plan for Marine Turtles in Australia (CoA 2017b). However, due to the low toxicity of planned discharges and their rapid dilution as a result of oceanic conditions, along with the transient nature of these species within the area, impacts are not predicted to occur.
- The Project Area also overlaps foraging BIAs for albatross, petrel, and shearwater species. As impacts to plankton and fish species are not predicted due to the low toxicity of planned discharges and their rapid dilution as a result of oceanic conditions, impacts to foraging seabirds are not predicted. In addition, the sporadic discharge of macerated food scraps over short durations and are not predicted to result in habituation to this food source.

- The Project Area overlaps the pygmy blue whale foraging and distribution BIAs. Routine operational discharges from vessels are not identified as a threat to the recovery of pygmy blue whales within the Conservation Management Plan for the Blue Whale (DoE 2015). Marine pollution by acute and chronic chemical discharge is identified as a threat that has minor consequences to the population by only affecting individuals (DoE 2015). Due to the low toxicity of planned discharges and their rapid dilution as a result of oceanic conditions, impacts are not predicted to occur to foraging blue whales or krill that they forage on.

- The Project Area is within the southern right whale migration BIA. Routine operational discharges from vessels are not identified as a threat to the National Recovery Plan for the Southern Right Whale *Eubalaena australis* (DCCEEW 2024o). Marine pollution by acute and chronic chemical discharge is identified as a threat that has minor consequences to the population by only affecting individuals (DCCEEW 2024o). Chemical pollution from sewage and other discharges is identified as a threat to the species, particularly within coastal BIAs where regular exposure may occur. However, due to the low toxicity of planned discharges and their rapid dilution as a result of oceanic conditions, along with the transient nature of these species within the area, impacts are not predicted to occur.

Potential impacts are expected to be limited to temporary and localised behavioural changes of attraction to food sources to fish, marine mammals, and marine reptiles within 500 m of the discharge source. Consequently, the temporary and localised attraction of fish, marine mammals, and marine reptiles to routine operational discharges from vessels has been evaluated as a Minor (1) consequence.

6.10.4 Impact Evaluation Summary

The impact evaluation for planned discharges of routine operational wastes from vessels is summarised in Table 6-61.

Table 6-61: Impact Evaluations Summary for Planned discharges – Routine Operational Wastes from Vessels

Summary	
Summary of impacts	Routine operational wastes from vessels into the marine environment will result localised and temporary changes in water quality. Change in water quality can result in possible changes in behaviour, where elevated nutrient levels from sewage, putrescible waste, and grey water discharges act as a food source and temporarily attracts plankton, fish, marine mammals, and marine reptiles. Change in water quality from these discharges can also result in injury/mortality to plankton exposed to elevated temperatures, salinity, chemical additives and hydrocarbon levels. High dilution rates will reduce elevated temperatures, salinity, chemical additives, and hydrocarbon levels to levels below thresholds required to elicit injury/mortality from acute or chronic toxic effects to fish, marine mammals, and marine reptiles. The temporary and localised change to water quality; temporary behavioural changes to plankton, fish, marine mammals, and marine reptiles attracted to food sources; and localised mortality of plankton will result in Minor (1) consequences that are considered acceptable, given controls are in place to ensure potential impacts are better than the defined acceptable level 1.
Extent of impacts	Localised - The extent of discharge of routine operational wastes from vessels is expected to be within 500 m of the discharge point from the MODU and support vessels.

Summary	
Duration of impacts	Temporary - intermittent routine operational wastes from vessels is expected to dissipate rapidly in the water column from exposure to ambient water currents.
Level of certainty	Impacts from planned discharges of routine operational wastes from vessels are well understood and there is nothing new or unusual. There is high level of certainty on the predicted impacts from routine operational wastes from vessels, including: Impact and fate in the environment High biodegradable rates of the chemical additives Dilutions rates. Beach has long-term experience in the area on the application of good industry practice to ensure impacts associated with planned discharge of routine operational wastes from vessels are acceptable.
Is the impact considered lower-order or higher-order?	Impacts from routine operational wastes from vessels has been evaluated to result in Minor consequences. Minor consequences are considered lower-order impacts that is acceptable with the application of good industry practice.
Impact Consequence	
Minor	

6.10.5 Demonstration of Acceptability

Table 6-62 demonstrates how and why predicted environmental impacts from planned discharges of routine operational wastes from vessels meets the defined acceptable levels (Table 5-4).

Table 6-62: Demonstration of Acceptability – Planned Discharge – Routine Operational Wastes form Vessels

Demonstration of Acceptability		
Impact and risk comparison with relevant defined acceptable levels	The acceptable level relevant to planned discharges of routine operational wastes from vessels is acceptable level 6 (as detailed in Table 5-4). A Minor (1) impact consequence level was assigned for this aspect based on the impact analysis and evaluation. Minor (1) consequences resulting from planned discharge – routine operational wastes from vessels: • will contain chemical additives subject to Beach's chemical selection process • will result in a localised change in water quality (<2 km from discharge point located in the Project Area) which will return to baseline conditions following completion of planned discharges As a result, the predicted environmental impact for planned discharge – routine operational wastes from vessels is lower than defined acceptable level 6.	
Principles of ESD	Integration principle	Section 6.10.3 identifies and evaluates environmental impacts associated with wastewater and putrescible discharges. As part of identifying the potential impacts; conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental impact. As a result, consideration of economic, environmental, social and

Demonstration of Acceptability		
		equitable receptors was conducted as part of identifying the impacts and risks. For Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders on the Project and associated activities. No objections or claims were raised in Phase 1: Initial Project Consultation. For Phase 2: Project OPP Public Comment Period (Section 10.2.4), the public had the opportunity to provide further comment to this OPP during the period (18/3/2024 – 20/5/2024). Beach prepared the public comment report summarising all comments, an assessment of the merits of each comment, a statement of the response to each comment, and an outline of any changes made to the OPP as a result of the comment (Appendix P). The impact assessment for this aspect has been updated to reflect the merit provided by public comment reference numbers PC266 and PC267. As a result, the impact assessment now integrates responses to public comments of merit and therefore is of an acceptable level. The potential environmental impact against this aspect was assessed as having a Minor (1) consequences which is considered a lower-order environmental impact. Lower-order environmental impacts are considered 'broadly acceptable' and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental impacts against this aspect were assessed as having a Minor (1) impact consequence level which is considered a lower-order environmental impact and below defined acceptable level 6. Lower-order environmental impacts cannot result in serious or irreversible environmental damage. There is high confidence in the potential environmental impacts and effectiveness of controls against this aspect. Beach has significant experience operating in the Otway and Bass based on their existing offshore developments and associated activities including the Beach Otway Drilling Campaign in 2021/2022.
	Intergenerational principle	The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts due to wastewater and putrescible discharges is lower than the defined acceptable level 6; the health, diversity, or productivity of the environment for future generations is expected to be maintained.
	Biodiversity principle	Section 6.10.3 identifies and evaluates environmental impacts associated with wastewater and putrescible discharges. As part of identifying the potential impacts, conservation values and sensitivities including MNES in Section 4 were reviewed. Given predicted environmental impacts due to wastewater and putrescible discharges is lower than the defined

<table>
<tr><th colspan="3">Demonstration of Acceptability</th></tr>
<tr><td></td><td></td><td>acceptable level 6; no potential to affect biological diversity or ecological integrity is expected.</td></tr>
<tr><td>Internal context</td><td>Beach Policy compliance</td><td>The defined acceptable levels, EPOs and controls proposed for this aspect are consistent with Beach Environmental Policy objectives. As a result, potential environmental impacts and risks from Project can be managed to align with Beach Environmental Policy objectives.</td></tr>
<tr><td>External context</td><td colspan="2">Stakeholder engagement is being carried out as part of this OPP process.
Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable.
Wastewater and putrescible discharges are not expected to result in impacts to stakeholders.
During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect.
During Phase 2: Project OPP Public Comment Period (Section 10.2.4), comments were raised against this aspect. The assessment of merit for these comments found this aspect to require updates. Changes to the OPP to address PC266 and PC267 have been integrated into the impact evaluation for this aspect.
Any new guidance or advice in relation to this aspect will be assessed and incorporated into adaptive management plans prepared for activity specific EPs.</td></tr>
<tr><td>Other requirements</td><td colspan="2">Other requirements associated with this aspect includes compliance with Australian legislative requirements.
Management of this aspect is aligned with the legislative requirements below.
<table>
<tr><th>Requirement</th><th>Demonstration</th></tr>
<tr><td>Navigation Act 2012 (Cth)
Several Marine Orders (MO) are enacted under this Act which relate to offshore petroleum activities, including:
• MO 91: Marine pollution prevention – oil
• MO 95: Marine pollution prevention – garbage</td><td rowspan="3">This requirement is addressed through the adoption of the following control measures:
CM29 Chemical selection process
A process for chemical selection will be implemented to ensure chemicals used are environmentally acceptable whilst also meeting technical requirements.
CM35 Marine orders
All wastewater discharges will comply with relevant MARPOL 73/78, Navigation Act 2012, Protection of the Sea (Prevention of Pollution) Act 1983 and subsequent Marine Order requirements (as appropriate for vessel classification):
Marine Order 91 (Marine Pollution Prevention – Oil), which implements Annex I of MARPOL 73/78, including (as required by vessel class):
• Machinery space bilge/oily water shall have IMO-approved oil filtering equipment (oil/water separator) with an on-line OIW monitoring device</td></tr>
<tr><td>Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cth)
Section 26F (implements MARPOL Annex I)</td></tr>
<tr><td>The following management plans or conservation advice identify pollution, habitat degradation or discharges as a threat:</td></tr>
</table>
</td></tr>
</table>

Demonstration of Acceptability		
	• Recovery Plan for Marine Turtles in Australia, 2017-2027 (CoA, 2017) • Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA, 2008) • Conservation Management Plan for the Blue Whale, 2015-2025 (CoA, 2015b) • National Recovery Plan for the Southern Right Whale *Eubalaena australis* (DCCEEW, 2024o) • Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC, 2015d) • Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale) (TSSC, 2015e)	• OIW content to be less than 15 ppm prior to discharge. • A deck drainage system capable of controlling the content of discharges for areas of high risk of fuel/oil/grease or hazardous chemical contamination. • Valid International Oil Pollution Prevention Certificate. Marine Order 95 (Marine Pollution Prevention – Garbage), which implements Annex V of MARPOL 73/78, including: • Garbage management plan in place. • Garbage record book maintained onboard. Marine Order 96 (Marine Pollution Prevention – Sewage), which implements Annex IV of MARPOL 73/78, including (as required by vessel class): • a valid International Sewage Pollution Prevention Certificate, • an IMO-approved sewage treatment plant, • a sewage comminuting and disinfecting system, a sewage holding tank sized appropriately to contain all generated waste (sewage and grey water), • discharge of sewage will occur at a moderate rate while vessel is proceeding (more than 4 knots).

6.10.6 Environmental Performance

In accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 6-63) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 6-62 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 6-63 are met

Table 6-63: Environmental Performance Outcomes – Planned Discharge – Routine Operational Wastes from Vessels

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 6: Localised change in water quality (<2 km from discharge point located in the Project Area) which will return to baseline conditions following completion of planned discharges (as defined in the OPP) containing chemical additives subject to Beach's chemical selection process is acceptable.	EPO17:	Implement CM29 Chemical selection process to ensure chemicals used are environmentally acceptable whilst also meeting technical requirements

Defined Acceptable Level	Environmental Performance Outcomes	
	EPO24:	Implement CM35 Marine orders to manage routine discharges of operational wastes from vessels in accordance with Marine Orders 91 and 95.

7 Environmental Risk Evaluation – Unplanned Events

7.1 **Invasive Marine Species**

7.1.1 Hazard Identification

Invasive marine species (IMS) are non-native plants, animals and microorganisms that have been introduced, either intentionally or unintentionally, to a new marine environment and can establish and spread, causing harm to the local ecosystem, economy, and human well-being. Within Australia, over 250 exotic marine species have been introduced with most having little impact, but some species have become aggressive pests in certain locations (DoA 2019b). Typical habitats of the ten species currently listed on the Marine Pest website (DoA 2019b) are shallow marine water areas. Highly disturbed environments (such as marinas) are more susceptible to colonisation than open-water environments (Paulay et al. 2002).

Introductory pathways for IMS include:

- ship ballast water
- biofouling on vessel hulls' niche areas such as anchor lockers, bilges, sea chests or internal seawater systems (DAFF 2003)

All Project stages involving MODU and vessel operations therefore have the potential to introduce IMS. Vessels may be required to adjust their ballast during installation, loading and offloading operations to maintain stability, balance and trim. During the uptake of ballast water from the surrounding environment in an international or domestic location, it is possible for a vessel to take in water that contains planktonic biota, including holoplankton, gametes, spores and larvae. This biota may then be discharged at the vessel's new location during ballast water exchange. Activities associated with the Project that could result in the introduction, establishment and spread of IMS are identified in Table 7-1 and described in the subsections below.

Table 7-1: Activities Undertaken During the Project which could cause Unplanned Introduction, Establishment and Spread of IMS

Stage	Activity
Operations	Inspection, maintenance and repair
Decommissioning	Removal of subsea infrastructure Well plugging and abandonment
Support operations	MODU operations

	Vessel operations ROV operations

7.1.2 Hazard Description

7.1.2.1 IMS already established in the region

In the South-east Marine Region, 115 marine pest species have been introduced and an additional 84 have been identified as possible introductions, or 'cryptogenic' species (NOO 2002a). Several introduced species have become pests either by displacing native species, dominating habitats, or causing algal blooms.

IMS known to occur were identified from 'www.marinepests.gov.au' (DAFF 2024) in ports where the rig and support vessels may mobilise from are detailed in Table 7-2.

Table 7-2: Marine Pests known to occur in Ports Relevant to the Project

Marine Pest	Description	Portland	Melbourne
Asian date mussel (*Musculista senhousia*)	Prefers soft sediments in waters up to 20 m deep, forming mats and altering food availability for marine fauna.	✓	✓
Asian shore crab (*Hemigrapsus sanguineus*)	Established in Victoria. Asian shore crabs were detected in Port Phillip Bay in 2020. Generally found hard substrates in intertidal areas, under rocks, shells, debris, or artificial structures. Likely habitats include burrowed up to 30cm deep, hard, and soft surfaces, shallow waters, up to 30m deep.	-	✓
European fan worm (*Sabella spallanzanii*)	Can form dense colonies and consume vast amounts of food to the detriment of native species. It fouls infrastructure and can increase operating costs for industry. Likely habitats include burrowed up to 30cm deep, hard, and soft surfaces, shallow waters, up to 30m deep.	✓	✓
European shore crab (*Carcinus maenas*)	Prefers intertidal areas, bays, estuaries, mudflats, and subtidal seagrass beds, but occurs in waters up to 60 m deep. It is widespread across Victorian intertidal reef and common in Western Port.	-	✓
Japanese kelp (*Undaria pinnatifida*)	Occupies cold temperate oceanic waters up to 20 m deep, growing on rock, reef, stones, and artificial structures. It rapidly forms dense forests and overgrows native species. It first established in Port Phillip Bay in the 1980s (Parks Victoria 2020).	-	✓
Northern pacific seastar (*Asterias amurensis*)	Prefer soft sediment habitat, but also use artificial structures and rocky reefs, living in water depths usually less than 25 m (but up to 200 m water depths). It is thought to have been introduced through ballast water from Japan.	-	✓

7.1.2.2 Operations

Marine growth removal from subsea infrastructure may be required during inspection, maintenance and repair activities which are undertaken by ROV or divers from an appropriate vessel.

7.1.2.3 Decommissioning

Marine growth may be dislodged during the removal of subsea infrastructure including flowlines, umbilicals and subsea equipment.

7.1.2.4 Support operations

Support operations including MODU, ROV and support vessel operations have the potential to introduce IMS from the discharge of ballast water or biofouling. MODU operations are relevant to drilling and completions activities, well intervention and workovers and well plugging and abandonment. ROV operations may be conducted through all Project stages including inspection, maintenance and repair. Support vessels are relevant to all stages of the Project for purposes such as transporting fuel, waste and supplies, MODU towing, flowline and umbilical installation and decommissioning, and inspections, maintenance and repairs.

MODU, ROV and support vessels have the potential to host IMS and may be sourced internationally or domestically. During Project activities, support vessels will transit between the Project Area and domestic ports.

7.1.3 Risk Analysis and Evaluation

Successful IMS colonisation requires the following three stages (Marine Pest Sectoral Committee 2018):

- colonisation and establishment of the marine pest on a vector (vessel, equipment or structure) in a donor region (a home port, harbour or coastal project site where a marine pest is established)
- survival of the settled marine pests on the vector during the voyage from the donor to the recipient region
- colonisation (for example, by reproduction or dislodgement) of the recipient region by the marine pest, followed by successful establishment of a viable new local population.

The potential risk of an IMS being able to successfully establish itself will depend on depth, distance from the coast, water movement and latitude. The probability of successful IMS settlement and recruitment will decrease in well mixed, deep ocean waters away from coastal habitats (Geiling 2014). An IMS travelling through several latitudes will also have to survive significant temperature and salinity changes.

Establishment of IMS could result in the following risk events:

- Change in ecosystem dynamics which may include
    - reduction in native marine species diversity and abundance
    - displacement of native marine species

Potential changes in ecosystem dynamics may result in the following secondary risks:

- Socio-economic impacts on commercial fisheries

- Changes to conservation values of protected areas
- Changes to First Nations cultural values and sensitivities

7.1.3.1 Change in Ecosystem Dynamics

The introduction of IMS may result in the colonisation of IMS in the Project Area. If this event is realised this could result in a change in ecosystem dynamics which may include a reduction in native marine species diversity and abundance, displacement of native marine species. The change in ecosystem dynamics also has the potential to result in secondary effects such as socio-economic impacts on commercial fisheries, changes to conservation values of protected areas and First Nations cultural values and sensitivities. The consequence of a successful IMS colonisation event are considered to be Serious (3).

More than 250 marine species have been introduced into Australian waters from around the world. Many of these species remain inconspicuous, but a few have established large populations and become pests. It is estimated that one in each six to 10 introduced marine species will become a pest (DCCEEW 2024q). Typical habitats of the species currently listed on the Marine Pest website (DAFF 2024) are shallow marine water areas for example Portland and Port Phillip Bay.

The likelihood of a successful translocation and establishment of IMS event into a new environment depends on several factors. Water currents, upwellings, habitat type, water depth, wave exposure, water temperature, salinity and the distance from the coast are all natural dispersion barriers which have been shown to limit the successful establishment and reproduction of IMS populations (Forrest et al. 2009). Based on these factors, the probability of successful IMS settlement and recruitment decreases in well-mixed, deep ocean waters away from coastal habitats. IMS colonisation also requires a suitable habitat in which to establish itself, such as rocky and hard substrates or subsea infrastructure.

The Project Area contains natural dispersion barriers to prevent IMS colonisation such as water depths greater than 50 m, strong ocean currents and an open-water environment. The probability of successful IMS settlement and recruitment will decrease in well mixed, deep ocean waters away from coastal habitats (Geiling 2014) such as the Project Area. It has been found that highly disturbed environments (such as marinas) are more susceptible to colonisation than open-water environments, where the number of dilutions and the degree of dispersal are high (Paulay et al. 2002). Based on the requirements for successful IMS establishment, the Project Area does not present an environment that is typically favourable to IMS survival. The Project Area is in an open-water offshore environment influenced by strong ocean currents associated with the East Australian Current. Ocean currents in the Project Area are expected to flow up to 5 knots in summer and 2-3 knots in winter, with the area therefore considered a well-mixed high energy offshore environment. The Australian Government Bureau of Resource Sciences (BRS) established that the relative risk of an IMS becoming established around Australia decreases with distance from the coast. Modelling conducted by BRS (BRS 2007) estimates: 33% chance of colonisation at 3 nm, 8% chance at 12 nm, and 2% chance at 24 nm. There Project Area is approximately ~11 nm from the Victorian coast and therefore the risk of IMS colonisation is anticipated to be 8%. .The likelihood of IMS colonisation in the Project Area is expected to be Remote (A) given the Project Area contains natural dispersion barriers to prevent IMS colonisation.

Established marine pest species can deplete fishing grounds and aquaculture stock, with between 10% and 40% of Australia's fishing industry being potentially vulnerable to marine pest incursion. The Project Area presents unfavourable conditions for IMS colonisation, therefore the potential for secondary impacts such as socio-economic impacts on commercial fisheries, changes to conservation values of protected areas and changes to First Nations cultural values and sensitivities from IMS colonisation is also considered to be Remote (A).

Given the impact of a successful IMS colonisation event can significantly impact local species and thus change local epifauna and infauna populations permanently, which could also impact State and Commonwealth fisheries and alter conservation values and First Nations cultural values and sensitivities, the consequences have been evaluated as Serious (3). However, it is considered that the likelihood of such an event is Remote (A) due to the unfavourable conditions within the Project Area required for colonisation and the implementation of the Beach Domestic IMS Biofouling Risk Assessment Process in accordance with regulatory requirements to manage the introduction of IMS. In addition, there has been no IMS introductions from Beach's previous Otway Drilling Campaign and ongoing activities in the area.

7.1.4 Risk Evaluation Summary

The risk evaluation for the introduction of IMS is summarised in Table 7-3.

Table 7-3: Risk Evaluation Summary for Introduction of IMS

Summary	
Summary of risks	The introduction of IMS in the Project Area has a Low risk of IMS colonisation resulting in change in ecosystem dynamics and therefore also a Low risk of secondary effects to commercial fisheries, values of protected areas and First Nations cultural values and sensitivities. The consequence and likelihood levels to determine the Low risk is defined as follows. The consequences of a successful IMS colonisation event are considered to be Serious (3) such that it may result in the reduction in native marine species diversity and abundance, displacement of native marine species, socio-economic impacts on commercial fisheries and changes to conservation values of protected areas and First Nations cultural values and sensitivities. The likelihood of such an event occurring is Remote (A) given the Project Area contains natural dispersion barriers to prevent IMS colonisation, such that the area is primarily in water depths greater than 50 m, exposed to strong ocean currents and in an open-water environment located away from coastal habitats. Based on the potential Serious (3) consequences and Remote (A) likelihood, the risk of introduction and establishment of IMS is Low.
Extent and duration of risk	Localised (isolated locations if there is no spread) to widespread (if colonisation and spread occurs).
Level of certainty	Beach has a high level of certainty about the risk of IMS introduction. The threat posed by invasive marine species is well known and strict regulatory requirements are in place to control the risk. With these regulatory controls in place, we have a high level of certainty that project activities will not introduce invasive marine species.
Is the impact considered lower-order or higher-order?	Risks from IMS has been evaluated to be Low risk. Low risks are considered lower-order risks that is acceptable with the application of good industry practice.
Risk Assessment	

Consequence	Likelihood	Risk rating
Serious	**Remote**	**Low**

7.1.5 Demonstration of Acceptability

Table 7-4 demonstrates how and why the risk of the introduction of IMS meets the defined acceptable levels (Table 5-4).

Table 7-4: Demonstration of Acceptability – Introduction of IMS

Demonstration of Acceptability		
Impact and risk comparison with relevant defined acceptable levels	Acceptable level 4 is relevant to the introduction of IMS (as detailed in Table 5-4). A **Low** risk rating was assigned for this aspect based on the combination of Serious (3) potential consequence and Remote (A) event likelihood. By implementing control measures that satisfy legislative and other requirements, the occurrence of an unplanned establishment of IMS event will be prevented, thereby ensuring Acceptable level 4 is met and achieved. Refer below to list of control measures to be implemented to prevent such an event from occurring.	
Principles of ESD	Integration principle	Section 7.1.3 identifies and evaluates environmental hazards associated with the introduction of IMS. As part of identifying the potential risks; conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental risk. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks. During Phase 1: Initial Project Consultation (Section 10.2.3) Beach consulted with relevant stakeholders for feedback in relation to the Otway project, the Project Area, environmental impact and risk evaluations, and the acceptability evaluation. No objections or claims were raised against this aspect during Phase 1: Initial Project Consultation (Section 10.2.4). The public, including relevant stakeholders, had the opportunity to provide further advice and responses for this OPP during the public consultation period (18/3/2024 – 20/5/2024). External context gained from the public consultation period allowed Beach to update the OPP. No public comment relating to this aspect was provided during the public consultation period. As a result, the risk assessment is considered acceptable to the public and therefore is of an acceptable level. The potential environmental impact against this aspect was assessed as having a Low risk which is considered a lower-order environmental risk. Lower-order environmental risks are considered 'broadly acceptable' and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental risks against this aspect were assessed as having a Low risk which is considered a lower-order environmental risk and below the defined acceptable level 4 . As a lower-order environmental risk there is confidence in the effectiveness of adopted

<table>
<tr><td></td><td></td><td colspan="2">control measures to prevent serious or irreversible environmental damage.
There is high confidence in the effectiveness of controls against this aspect. Beach has significant experience operating in the Otway and Bass based on their existing offshore developments and associated activities including the Beach Otway Drilling Campaign in 2021/2022.</td></tr>
<tr><td></td><td>Intergenerational principle</td><td colspan="2">The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts due to introduction of IMS is lower than the defined acceptable level 4; the health, diversity, or productivity of the environment for future generations is expected to be maintained.</td></tr>
<tr><td></td><td>Biodiversity principle</td><td colspan="2">The potential environmental risks against this aspect were assessed as Low which is considered a lower-order environmental risk and can be managed to meet the defined acceptable level 4. Lower-order environmental risks with high confidence in the effectiveness of adopted control measures to prevent serious or irreversible environmental damage cannot result in affects to biological diversity or ecological integrity.</td></tr>
<tr><td>Internal context</td><td>Beach Policy compliance</td><td colspan="2">The defined acceptable levels, EPOs and controls proposed for this aspect are consistent with Beach Environmental Policy objectives. As a result, potential environmental impacts and risks from Project can be managed to align with Beach Environmental Policy objectives.</td></tr>
<tr><td>External context</td><td colspan="3">Stakeholder engagement is being carried out as part of this OPP process.
Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable.
During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect.
During the public consultation period (18/3/2024 – 20/5/2024) (Section 10.2.4), comments were raised against this aspect. The assessment of merit for comments against this aspect found the responses provided in the public comment report to be sufficient to address the comments against this aspect. Given the thorough assessment and responses outlined in the public comment report, the impact evaluation for this aspect remains acceptable as is, demonstrating that public comments have been adequately addressed.</td></tr>
<tr><td rowspan="3">Other requirements</td><td colspan="2">Requirement</td><td>Demonstration</td></tr>
<tr><td colspan="2"><i>Biosecurity Act 2015</i> (Cth)
Chapter 4- Managing biosecurity risk
Chapter 5, Part 3- Management of discharge of ballast water)</td><td rowspan="2">CM36 IMS Management Plan
Implementation of Beach IMS Management Plan which includes the following minimum requirements:
• compliance with relevant Australian legislation and current regulatory guidance
• outline of when an IMS risk assessment is required and the associated inspection, cleaning and certification requirements
• implementation of management measures commensurate with the level of risk based on outcomes if the IMS risk assessment, such as inspections, cleaning and movement restrictions</td></tr>
<tr><td colspan="2"><i>Protection of the Sea (Harmful Anti-fouling Systems) Act 2006</i> (Cth)
Part 2- Application or use of harmful anti-fouling systems</td></tr>
</table>

	Part 3- Anti-fouling certificates and anti-fouling declarations MO 98 - Marine pollution – anti-fouling systems	- anti-fouling prevention measures, including vessels (of appropriate class) having a valid International Anti Fouling Systems (IAFS) Certificate CM37 Australian Ballast Water Management Requirements The MODU and vessels fulfil the requirements of the Australian Ballast Water Management Requirements (DAWR, 2020, v8). This includes requirements to: - Carry a valid Ballast Water Management Plan (BWMP). - Submit a Ballast Water Report (BWR) through the Maritime Arrivals Reporting System (MARS). - If intending to discharge internationally sourced ballast water, submit BWR through MARS at least 12 hours prior to arrival. - If intending to discharge Australian sourced ballast water, seek a low-risk exemption through MARS. - Hold a Ballast Water Management Certificate (BWMC). - Ensure all ballast water exchange operations are recorded in a Ballast Water Record System (BWRS)
	OPGGS Act 2006 (Cth) Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority or consent must carry out those activities in a manner that does not interfere with navigation or fishing (among others)	

7.1.6 Environmental Performance

In accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 7-) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 7-4 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 7- are met.

Table 7-5: Environmental Performance Outcomes: Introduction of IMS

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 4: Unplanned establishment of invasive marine species is unacceptable**.**	EPO25:	No introduction of a known or potential invasive marine species.

7.2 **Physical Presence – Interaction with Marine Fauna**

7.2.1 Hazard Identification

MODU, vessel and helicopter movements within the Project Area may result in unplanned interactions with marine fauna via MODU/vessel strike (collision with moving vessel or MODU and marine fauna) or bird strike (collision with helicopter and avifauna).

Activities undertaken during the Project which have the potential to result in unplanned interactions with marine fauna are identified in Table 7-6.

Table 7-6: Activities Undertaken During the Project with the Potential to Result in Unplanned Interactions with Marine Fauna

Stage	Activity
Drilling and Completions	MODU positioning

Stage	Activity
Support operations	Vessel operations Helicopter operations

7.2.2 Hazard Description

7.2.2.1 Drilling and Completions

1. MODU Positioning

A MODU will either mobilise to the Project Area with its own propulsion system or be towed into place by vessels and will only be present in the Project Area during drilling, well intervention and for decommissioning activities. MODU positioning will require a maximum of 2 support vessels on DP to tow and position the MODU into place within the Project Area. This process will take 9 to 13 days to complete depending on constraints and weather restrictions

Once the MODU is positioned within the Project Area it will primarily be stationary resulting in no potential for collision with marine fauna. The MODU will be present at each well location for 40 days before moving to the next well (maximum 9).

7.2.2.2 Support Operations

Vessel and helicopter operations will occur within the Project Area throughout the life of the Project.

The type and number of vessels in the Project Area at any one time, and the duration of presence, will differ depending on the project stage. For a single activity, there will be no more than three vessels operating simultaneously. The longest duration for a single activity requiring support vessel operations is 40 days to drill a single well utilising a MODU and two support vessels. For concurrent activities, five vessels could operate in the Project Area at any one time, for example, pipelay or diving/tie-in activities may occur concurrently during MODU positioning. Concurrent operations will be kept to a minimum and are unlikely to occur for more than 13 days.

Vessels undertaking petroleum activities described in this project will typically be holding station or travelling at speeds slower than typical shipping traffic, and therefore exhibit a lower risk of interactions with marine fauna.

Helicopters will be utilised as required, throughout the life of the project, primarily for crew change and medical evacuation. Helicopter operations are expected to be the greatest during drilling activities where 5-8 round trips per week are anticipated. No helicopter operations will be required for operational activities.

7.2.3 Risk Analysis and Evaluation

MODU, vessel and helicopter movements within the Project Area have the potential to result in:

- Injury / mortality to marine fauna.

The potential risk of injury/mortality to marine fauna will be limited to large marine fauna and birds within the Project Area, as such receptors potentially affected are:

- marine reptiles

- marine mammals
- seabirds and shorebirds.

The potential risk of injury/mortality to marine fauna also has the potential to result in indirect changes to the functions, interests, or activities of the following receptors:

- cultural values and sensitivities.

7.2.3.1 Marine Mammals

Five marine mammals were identified with biologically important areas and/or biologically important behaviours within the Project Area (Table 7-7). Two fur-seal species may occur within the Project Area according to the PMST (Appendix A)

Table 7-7: Marine Mammals with Biologically Important Behaviours within the Project Area

Species	Biologically Important Behaviour
Blue whale	Foraging, feeding or related behaviour known to occur within area.
	Foraging BIAs: foraging, known foraging area and annual high use area.
Fin whale	Foraging, feeding or related behaviour likely to occur within area.
	No BIAs
Pygmy right whale	Foraging, feeding or related behaviour may occur within area.
	No BIAs
Sei whale	Foraging, feeding or related behaviour likely to occur within area.
	No BIAs
Southern right whale	Migration BIA

Vessel collisions have the potential to result in injury/mortality to marine mammals, such as cetaceans and pinnipeds. Cetaceans and pinnipeds are naturally inquisitive species which are often attracted to offshore vessels, for example dolphins are commonly reported to 'bow ride'. The reaction of cetaceans to an approaching vessel is variable and unpredictable. Often species remain motionless whilst in the vicinity of a vessel, whereas others have been known to be curious, often approaching ships which have stopped or are slow moving. In general, they do not approach, and sometimes actively avoid, faster moving vessels (Richardson et al. 1995). For example, humpback whales have been shown to frequently change course to avoid a vessel after detection (WDCS 2006).

Vessel collisions with cetaceans occur more frequently in areas where high vessel traffic and cetacean habitat coincide (WDCS 2006). Peel et al. (2016) analysed the number of vessel collisions with cetaceans within Australian waters, stating at least 109 vessel collisions have been reported since 1840. However, the paper emphasises a lack of reporting as an issue in confirming exact numbers. Recorded instances of cetacean deaths due to vessel strikes indicate that they are much more likely to be associated with container ships and fast ferries (WDCS 2006). When vessels are stationary or slow moving, the risk of collision with cetaceans is extremely low, as the vessel's size and underwater noise 'footprint' will alert cetaceans to its presence and thus elicit avoidance.

The extent of the area of risk of interaction with marine mammals is within the Project Area and the risk could occur while Project activities are undertaken. The consequence is assessed as Minor (1) and likelihood as highly unlikely, and the resulting risk is Low based on:

- Minimising vessel collision is ranked as a high priority action within the Conservation Management Plans for the blue whale and southern right whale, and within the Conservation Advice for fin and sei whales.
- The foraging BIAs for the pygmy blue whale intersects with the Project Area. The Conservation Management Plan for the Blue Whale (CoA 2015b) details that vessel collisions will impede the recovery of blue whale populations if a sufficient number of individuals in the population lose reproductive fitness or are killed. A vessel strike to a whale is considered highly unlikely as it has not happened to date in 15 years of Beach's activities within the Otway Basin. It is further reduced by there being an appropriately qualified marine mammal observer on each support vessel to detect the presence of marine fauna and provide instruction to avoid collisions where feasible. (CM15, CM17, CM18: Whale Management Procedures).
- The Project Area is within a migration BIA of the southern right whale. The National Recovery Plan for the Southern Right Whale (DCCEEW 2024o) lists vessel strike collisions as a high-risk threat. The plan identifies managing, minimising and mitigating the threat of vessel strike as an action and notes that reducing ship strike mortality can be most easily done either by reducing vessel speed or by separating vessels and whales. As both these controls will be implemented, with the MODU and vessels being either stationary or operating at slow speeds (≤ 10 knots as per CM02: Vessel and MODU Operating Procedures) and vessels when transiting maintaining a distance of 300 m from a whale (CM15, CM17, CM18: Whale Management Procedures), reducing the likelihood of a strike. An appropriately qualified marine mammal observer will be present on each support vessel to detect the presence of marine fauna and provide instruction to avoid collisions where feasible (CM15, CM17, CM18: Whale Management Procedures).
- The Listing Advice for the Humpback Whale (DAWE 2022a) details that the species is no longer listed as Vulnerable and identifies vessel strike as a current impact not threatening or preventing population growth.
- The Recovery Plan for the Australian Sea-lion (DSEWPaC 2013d) identifies the need to investigate and mitigate other potential threats including vessel strike, to ensure that anthropogenic activities do not hinder the recovery of the species. An appropriately qualified marine mammal observer will be present on each support vessel to detect the presence of marine fauna and provide instruction to avoid collisions where feasible (CM15, CM17, CM18: Whale Management Procedures).
- Peel et al. (2016) reviewed vessel strike data (2000-2015) for marine species in Australian waters and identified that there were no vessel interaction reports during the period for Australia sea-lions, Australian or New Zealand fur- seals. There have been incidents of seals being injured by boat propellers, however all indications are rather than 'boat strike' these can be attributed to the seal interacting/playing with a boat, with a number of experts indicating the incidence of boat strike for seals is very low.
- A vessel strike to a marine mammal is considered highly unlikely as it has not happened to date in 15 years of Beach's activities within the Otway Basin.

- Rig and vessel movements in the Project Area will be low (≤ 10 knots as per CM02: Vessel and MODU Operating Procedures) which affords protection to fauna as the most severe injuries have been identified to be caused by vessels travelling faster than 14 knots (Jensen and Silber 2004, Laist et al. 2001).

- An appropriately qualified marine mammal observer will be present on each support vessel to detect the presence of marine fauna and provide instruction to avoid collisions where feasible as per CM15, CM17, CM18: Whale Management Procedures.

- Given the expected low likelihood of vessel strike, and if it did occur it will not affect the long-term recovery of marine mammal species in accordance with relevant conservation plans and advice.

7.2.3.2 Marine Reptiles

Three marine turtle species are likely or may occur within the Project Area, however, no BIAs or habitat critical to the survival of the species were identified according to the PMST (Appendix A).

Vessel strikes have been identified as a threat to marine turtles within the Recovery Plan for Marine Turtles in Australia (CoA 2017b). However, there is a limited amount of available data regarding vessel strike to fauna such as marine turtles; potentially due to a lack of vessel collisions being noticed, and a lack of reporting (Peel et al. 2016).

Marine turtles are most vulnerable to vessel collisions when they are either resting or returning to the surface to breathe. Studies have demonstrated that marine turtles spend limited time at the sea surface, approximately 3% to 6%, with dive times recorded from 15 to 60 minutes (Milton and Lutz 2003). A study on green turtles by Hazel (2009) found that individuals only exposed the dorsal-anterior part of the head above the water surface, and for never longer than two seconds.

Turtles can detect sound in water and will generally move from anthropogenic noise-generating sources, such as vessels, within their detection range (Popper et al. 2014). Studies have shown that the ability of turtles to respond and avoid vessels greatly depends on the speed of the vessel. In general, marine turtles are not able to avoid vessels when they are travelling faster than 4 km/h (2.2 knots) (Hazel 2009). The propagation characteristics of sound within the marine environment make it difficult for marine turtles to identify the direction of the source of vessel noise. Furthermore, individual noise from a vessel may be masked within areas of high vessel and other noise -generating activities use, which is likely to limit the ability of marine turtles to identify and avoid approaching vessels (Hazel 2009).

The extent of the area of risk of interaction with marine turtles is within the Project Area and the risk could occur while Project activities is undertaken. The consequence is assessed as Minor (1) and likelihood as highly unlikely, and the resulting risk is Low based on:

- The Recovery Plan for Marine Turtles in Australia (CoA 2017b) identifies vessel disturbance as a key threat but details that although the outcome can be fatal for individual turtles, boat strike (as a standalone threat) has not been shown to cause stock level declines.

- Three marine turtle species may occur within the Project Area, though no BIAs or habitat critical to the survival of the species were identified, and the presence of turtle species is expected to be of a transitory nature only.

- The presence of turtles in the Project Area and surrounds is considered unlikely, based on the following information provided in Section 4.4.9.5 [**PC229**]:
    - Green Turtles are predominantly found in Australian waters off the Northern Territory, Queensland, and Western Australian coastlines, with limited numbers in New South Wales, Victoria, and South Australia. There are no known nesting or foraging grounds for Green Turtles offshore Victoria; they occur only rarely in these waters (DoE 2023m) (Section 4.4.9.5.1).
    - This species (Leatherback Turtle) is an occasional visitor to the Otway shelf and has been sighted on a number of occasions during aerial surveys undertaken by the Blue Whale Study Group, particularly to the south-west of Cape Otway (CoA 2017a). (Section 4.4.9.5.2).
    - Loggerhead Turtles forage in all coastal states and the Northern Territory, but are uncommon in South Australia, Victoria, and Tasmania (CoA 2017a). Due to water depths, it is unlikely Loggerhead Turtle would be present in the Project Area but may be occasional visitors to the Planning Area (Section 4.4.9.5.3 Loggerhead Turtle).'
- A vessel strike to a turtle is considered highly unlikely as it has not happened to date in 15 years of Beach's activities within the Otway.
- An appropriately qualified marine mammal observer will be present on each support vessel to detect the presence of marine fauna and provide instruction to avoid collisions where feasible as per activity specific Whale Management Procedure.

The consequence of a strike on a single animal is not predicted to affect the overall population or recovery of marine turtles.

7.2.3.3 Seabirds and Shorebirds

A number of seabirds and shorebirds utilise the Otway region and may forage within or fly over the Project Area. BIAs for 10 species of seabirds overlap the Project Area and no habitats critical to the survival of a bird species were identified in the Project Area (refer to Section 4.4.9.4). However, considering the offshore location of the Project Area and the absence of roosting or nesting habitat individuals at potentially vulnerable life stages are not expected. Viola (2023) identified the following species that landed on a support vessel for the Beach Otway Drilling Campaign from March until 5 April 2022 and from 29 April until 31 May 2022:

- Australasian Pipit
- Brush bronzewing
- Galah
- Grey fantail
- Nankeen kestrel
- Rock dove

- Satin flycatcher
- Silvereye

No species were recorded as injured and all left the vessel within<24 h after arrival (Viola 2023).

Helicopters arriving to, or departing from, the Project Area have the potential to collide with birds, potentially result in injury/mortality. The risk of bird collision with helicopter operations is a safety consideration for flights to and from the MODU. The consequence of a helicopter bird strike varies and is influenced by the individual's seasonal distribution, body mass, flocking and flight behaviour, while the probability of a strike is related to the abundances of different bird species on or near the MODU.

The Wildlife Conservation Plan for Seabirds (CoA 2020a) recognises that seabirds are known to aggregate around oil and gas platforms in above average numbers due to night lighting, flaring, food concentrations and other visual cues (Wiese et al. 2001). While most interactions are harmless, some can be detrimental and may cause injury or death e.g. from collision or indirectly from depleted body reserves (Ronconi et al. 2015). Bird mortality has been documented due to collision with structures, and interactions with flaring activities (Wiese et al. 2021).

The extent of the area of risk of interaction with birds is within the Project Area and the risk could occur while the Project activities is undertaken. The consequence is assessed as Minor (1) and likelihood as possible, and the resulting risk is Low based on:

- The National Recovery Plan for Albatrosses and Petrels (2022) (CoA 2022) classifies marine infrastructure interactions including those associated with artificial light as having no risk category priority and affecting 'Nil' species in Australian jurisdiction.
- The National Recovery Plan for the Orange-bellied Parrot (DELWP 2016) identified as Critically Endangered, lists illuminated structures, and illuminated boats as potential barriers to migration and movement as a main threat. In 15 years of Beach's activities within the Otway and Bass an Orange-bellied parrot has not been reported on a vessel, rig, or platform.
- Albatross, petrels, shearwaters, and terns were identified to have foraging BIAs or foraging behaviour likely within the Project Area. In 15 years of Beach's activities within the Otway and Bass an albatross, shearwater or petrel has not been reported on a vessel, MODU or platform.
- The consequence of a strike on a single bird is not predicted to affect the overall population.

7.2.3.4 Cultural Values and Sensitivities

The following cultural values and sensitivities have been identified as potentially at risk from unplanned interaction with MODU, vessel and/or helicopters movements:

- Marine mammals
- Marine reptiles
- Seabirds and shorebirds

Noting that eels and fish are not identified at risk from MODU or vessel movements.

The marine fauna listed above are connected to places associated with songlines or connected to individuals through ceremony (Section 4.6). The connection of marine fauna to places or individuals are considered cultural intangible values.

MODU, vessel and/or helicopters movements have the potential unplanned interactions with marine fauna that have songlines, or spiritual connection to First Nations people. It is considered that risks to species at a population level may prevent First Nations people's obligations to maintain spiritual connections and care for culturally significant species and their habitat. As evaluated in Sections 7.2.3.1 to 7.2.3.3, potential risks to marine mammals, marine reptiles, and shorebirds and seabirds from unplanned interaction will not impact these species at a population level, any interactions would be expected to be individuals only.

Based on the potential risk of unplanned interaction to individual species of cultural value, the consequence is assessed as Minor (1) and likelihood as possible, and the resulting risk is Low.

7.2.4 Risk Evaluation Summary

The risk evaluation for interaction with marine fauna is summarised in Table 7-9.

Table 7-8: Risk Evaluation Summary for Physical Presence – Interaction with Marine Fauna

Summary		
Risk summary	An unplanned interaction with marine fauna event, resulting in injury or mortality to an individual marine mammal, marine reptiles or seabird or shorebird, has been evaluated as a Low risk. The consequence and likelihood levels to determine the Low risk is defined as follows. The consequence of injury or mortality to an individual marine mammal, marine reptile or seabirds or shorebird is assessed as Minor (1), given the loss of a single animal is not predicted to affect the overall population or recovery of the species. The likelihood of such an event occurring is Highly Unlikely as it has not happened to date in the 15 years of Beach's activities within the Otway Basin.	
Extent and duration of risk	Localised – limited to individuals interacting with vessel or helicopter operations. Temporary – Vessels and helicopters may periodically be present in the Project Area, creating a temporary risk.	
Level of certainty	Beach has a high level of certainty about the risks of unplanned interaction with marine fauna. The threat posed by vessel and helicopter collision is well known and strict regulatory requirements are in place to control the risk. With these regulatory controls in place, Beach has a high level of certainty that Project activities will not result in the injury or death of an individual marine mammal, marine reptile or seabird or shorebird from vessel or helicopter collision.	
Is the risk considered lower-order or higher-order	The risk of an unplanned interaction with marine fauna event has been evaluated to be Low. Low risks are considered lower-order risks that is acceptable with the application of good industry practice.	
Risk Assessment		
Consequence	Likelihood	Risk rating
Minor	**Highly unlikely**	**Low**

7.2.5 Demonstration of Acceptability

Table 7-9 demonstrates how and why the risk of interaction with marine fauna meets the defined acceptable levels (Table 5-4).

Table 7-9: Demonstration of Acceptability – Physical Presence – Interaction with Marine Fauna

Demonstration of Acceptability		
Impact and risk comparison with relevant and defined acceptable levels	Acceptable level 12 is relevant to the unplanned interaction with marine fauna (as detailed in Table 5-4). A **Low** risk rating was assigned for this aspect based on the combination of Minor (1) potential consequence and Highly Unlikely event likelihood. By implementing control measures that satisfy legislative and other requirements, the occurrence of an unplanned interaction with marine fauna event will be prevented, thereby ensuring that Acceptable level 12 is met and achieved. Refer below to list of control measures to be implemented to prevent such an event from occurring.	
Principles of ESD	Integration principle	Section 7.2.4 identifies and evaluates environmental risks associated with interaction with marine fauna. As part of identifying the potential risks; conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental risk. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks. For Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders on the Project and associated activities. No objections or claims were raised in Phase 1: Initial Project Consultation. For Phase 2: Project OPP Public Comment Period (Section 10.2.4), the public had the opportunity to provide further comment to this OPP during the period (18/3/2024 – 20/5/2024). Beach prepared the public comment report summarising all comments, an assessment of the merits of each comment, a statement of the response to each comment, and an outline of any changes made to the OPP as a result of the comment (Appendix P). The impact assessment for this aspect has been updated to reflect the merit provided by public comment reference number PC229, PC301 and PC314. As a result, the impact assessment now integrates responses to public comments of merit and therefore is of an acceptable level. The potential environmental risk against this aspect was assessed as having a Low risk level which is considered a lower-order environmental risk. Lower-order environmental risks are considered 'broadly acceptable' and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental risks against this aspect were assessed as having a Low risk level which is considered a lower-order environmental risk and below the defined acceptable level 12. Lower-order environmental risks cannot result in serious or irreversible environmental damage. There is high confidence in the potential environmental impacts and risks and effectiveness of controls against this aspect. Beach has significant experience operating in the Otway and Bass based on their existing offshore developments and associated activities including the Beach Otway Drilling Campaign in 2021/2022.

<table>
<tr><td></td><td>Intergenerational principle</td><td>The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts due to interaction with marine fauna is lower than the defined acceptable level 12; the health, diversity, or productivity of the environment for future generations is expected to be maintained.</td></tr>
<tr><td></td><td>Biodiversity principle</td><td>Section 7.2.4 identifies and evaluates environmental risks associated with interaction with marine fauna. As part of identifying the potential impacts and risks; conservation values and sensitivities including MNES in Section 4 were reviewed.
The potential risks against this aspect were assessed as having a Low risk ranking which is considered a lower-order environmental risk and can be managed to meet the defined acceptable level 12. Lower-order environmental risks cannot result in affects to biological diversity or ecological integrity.</td></tr>
<tr><td>Internal context</td><td>Policy compliance</td><td>The defined acceptable levels, EPOs and controls proposed for this aspect are consistent with Beach Environmental Policy objectives. As a result, potential environmental impacts and risks from Project can be managed to align with Beach Environmental Policy objectives.</td></tr>
<tr><td>External context</td><td colspan="2">Stakeholder engagement is being carried out as part of this OPP process.
Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable.
During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect.
During Phase 2: Project OPP Public Comment Period (Section 10.2.4), comments were raised against this aspect. The assessment of merit for these comments found this aspect to require updates. Changes to the OPP to address PC229, PC301 and PC314 have been integrated into the impact evaluation for this aspect.
Any new guidance or advice in relation to this aspect will be assessed and incorporated into adaptive management plans prepared for activity specific EPs.</td></tr>
<tr><td rowspan="4">Other requirements</td><td colspan="2">Other requirements associated with this aspect includes compliance with Australian legislative requirements.
Management of this aspect is aligned with the legislative requirements below.</td></tr>
<tr><td>Requirement</td><td>Demonstration</td></tr>
<tr><td>**National Strategy for Reducing Vessel Strikes on Cetaceans and other Marine Megafauna (DoEE, 2017c).**
Vessel movements will be aligned to ‘Objective 3: Mitigation’ of the Strategy by:
• maintaining separation of vessels and whales
• maintaining slow vessel speeds
• avoidance manoeuvres</td><td rowspan="2">This requirement is addressed through the adoption of the following control measures:
CM14 EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans
• Vessels will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans.
• Helicopters will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans</td></tr>
<tr><td>**OPGGS Act 2006 (Cth)**
Section 460(2) - a person carrying on activities in an offshore area under the permit must carry out those activities in a manner that does not interfere with the conservation of the resources of the sea and seabed to a greater extent than is necessary</td></tr>
</table>

	for the reasonable exercise of the rights and performance of the duties of the first person.	
	The following management plans or conservation advice identify vessel or aircraft strike as a threat: • Wildlife Conservation Plan for Migratory Shorebirds (CoA, 2015a) • National Recovery Plan for Albatrosses and Petrels 2022 (CoA, 2022) • Recovery Plan for Marine Turtles in Australia, 2017-2027 (CoA, 2017) • Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA, 2008) • Conservation Management Plan for the Blue Whale, 2015-2025 (CoA, 2015b) • Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC, 2015e) • Approved Listing Advice *Megaptera novaeangliae* (Humpback Whale) (TSSC, 2022) • National Recovery Plan for the Southern Right Whale *Eubalaena australis* (DCCEEW, 2024o) • Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale) (TSSC, 2015d) • Recovery Plan for the Australian sea -lion (*Neophoca cinerea*) (DSEWPaC, 2013d)	

7.2.6 Environmental Performance

In accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 7-) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 7-9 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 7- are met

Table 7-10: Environmental Performance Outcomes – Physical Presence – Interaction with Marine Fauna

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 12: Death or injury to listed threatened, migratory or cetacean species from unplanned interactions with marine fauna is unacceptable.	EPO7:	No death or injury to listed threatened or migratory species from Project activities.

7.3 **Accidental Discharge – Hazardous and Non-Hazardous Materials**

7.3.1 Hazard Identification

Small quantities of hazardous and non-hazardous materials are used during routine vessel and MODU operations, and consequently result in waste generation which requires handling and storage on vessels and the MODU. Non-hazardous materials could be accidentally dropped or blown overboard due to overfull bins, crane incidents or improper storage or handling throughout Project phases. Hazardous waste may also be accidentally dropped or lost overboard as a result of leaks, overfilling of tanks or emergency disconnection of hoses.

Table 7-11 summarises activities within the Project stages that could result in the accidental release of hazardous and non-hazardous materials.

Table 7-11 Activities Undertaken During the Project which may Result in the Accidental Release of Hazardous and Non-hazardous Materials

Stage	Activity
Drilling and completions	Blow-out Preventer Installation and Function testing
Installation and commissioning	Installation
Operations	Inspection, maintenance and repair
Decommissioning	Decommissioning
Support operations	MODU operations Vessel operations ROV and AUV operations

7.3.2 Hazard Description

7.3.2.1 Drilling and Completions

Subsea infrastructure (non-hazardous), such as the BOP, have the potential to be accidentally dropped from support vessels or the MODU during drilling.

7.3.2.2 Installation and Commissioning

Subsea infrastructure (non-hazardous) including trees, manifolds, spools, jumpers and stabilisation materials will be installed under the scope of the OPP. These objects have the potential to be accidentally dropped from support vessels during installation.

7.3.2.3 Operations

1. Inspection, Maintenance and Repair

Objects (non-hazardous) such as small tools have the potential to be accidentally dropped from support vessels during IMR activities.

7.3.2.4 Decommissioning

Removal of subsea infrastructure (non-hazardous) such as trees, manifolds and spools, is the base case for decommissioning. These objects, or parts of, have the potential to be accidentally dropped during recovery.

7.3.2.5 Support Operations

An accidental LOC of hydrocarbons, chemicals or non-hazardous waste during support operations may occur due to:

- deck spills and a loss of primary containment.
- equipment failure including rupture, line failure, bunding and lifting equipment.
- dropped objects from supply cranes.
- bulk transfer failure between supply vessels and the MODU or project vessels.

Deck spills from vessels or the MODU may occur from mishandling or human error, poor handling processes, mechanical integrity failures and inadequate hazard analysis. Typical deck spills will be captured by onboard drainage systems, where liquids are diverted to a bilge tank (or similar), where it can be treated or transported onshore for proper disposal.

7.3.3 Risk Analysis and Evaluation

In the event of a loss of material or waste overboard, injury/mortality to fauna could occur.

In the event hazardous decommissioning waste is incorrectly disposed of onshore, contamination of air, soil and water at onshore facilities could occur.

Loss of material or waste overboard could occur within the Project Area potentially impacting:

- Sharks, seabirds, marine reptiles, and marine mammals.

These marine fauna species are values of the following within the Project Area:

- Conservation values and sensitivities
- Cultural values and sensitivities

Incorrect disposal of hazardous decommissioning waste onshore results in indirect contamination of air, soil, and water at the disposal site/facility. No impacts on valued species or habitats within the Project Area is expected.

In the event of a loss of material or waste overboard, potential risks are limited to within the Project Area.

7.3.4 Marine Fauna

The Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Wildlife of Australia’s Coasts and Ocean (CoA 2018) details harmful marine debris impacts on a range of marine life, including protected species of birds, sharks, turtles, and marine mammals. Harmful marine debris refers to all plastics and other types of debris from domestic or international sources that may cause harm to vertebrate marine wildlife. This includes land sourced plastic garbage (e.g. bags, bottles, ropes, fibreglass, piping, insulation, paints, and adhesives), derelict fishing gear from recreational and commercial fishing activities and ship-sourced, solid non-biodegradable floating materials lost or disposed of at sea.

Solids accidently released to the marine environment may lead to injury or death to individual marine fauna through ingestion or entanglement. Impacts will be restricted in exposure and quantity and will be limited to individual fauna.

A distribution BIA for the white shark has been identified within the Project Area. The Recovery Plan for the White Shark (DSEWPaC 2013c) does not identify waste or marine debris as a threat. White shark presence within the Project Area is expected to be transitory in nature.

Three marine turtle species (or species habitat) may occur within the Project Area though no BIAs or critical habitat to the survival of the species were identified. The Recovery Plan for Marine Turtles in Australia (CoA 2017b) identified marine debris as a threat.

The Project Area also overlaps foraging BIAs for albatross, petrel, and shearwater species. Marine debris is identified as a threat in the National Recovery Plan for Albatrosses and Petrels 2022 (CoA 2022).

Five marine mammals were identified with biologically important areas and/or biologically important behaviours within the Project Area according to the PMST (Appendix A). Foraging behaviours were identified for some species (blue, fin, pygmy right and sei whales); no other important behaviours that potentially lead to the ingestion of materials were identified. The Project Area intersects foraging BIAs for the pygmy blue whale and migration BIA for the southern right whale.

The Conservation Management Plan for the blue whale (CoA 2015b) and Conservation Advice for the sei whale (TSSC 2015e) and fin whale (TSSC 2015d) do not identify marine debris as threat. The National Recovery Plan for the Southern Right Whale (DCCEEW 2024o) identifies marine debris as a threat, specifically vessel-sourced, solid, non-biodegradable floating materials disposed of or lost at sea. It details that ingestion of marine debris, however, is thought to be unlikely for southern right whales in Australian coastal waters given whales are less likely to be feeding. No actions from the recovery plan were identified specific to vessel debris.

According to the PMST (Appendix A), the Project Area does not contain any threatened marine invertebrate species or benthic habitats.

The extent of the area of impact is adjacent to the MODU or support vessels within the Project Area. The consequence to ecological receptors is assessed as Minor (1) and likelihood as Unlikely, and the resulting risk is Low based on:

- MODU and vessel management systems addressing dropped object, waste storage and chemical handling and storage are well practiced, well understood.
- An unplanned release of waste will be of a very low volume if an incident occurred, and impacts would be restricted to individual fauna and would not impede the recovery of a protected species.

- Where possible material lost overboard would be recovered.
- The Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Ocean (CoA 2018) suggests that most marine plastic debris are associated to shipping and fishing activities (fishing gear, balloons and plastic bags).
- Waste will be handled in accordance with AMSA Discharge Standards and respective MODU and vessel Garbage Management Plans. Given this, any waste lost overboard would be in minimal quantities.
- Hazardous decommissioning waste will be disposed on in accordance with *Hazardous Waste (Regulation of Exports and Imports) Act 1989* to prevent the likelihood of incorrect disposal of infrastructure.
- The likelihood of losing waste or other materials overboard is unlikely with the MODU and vessels management systems in place. The consequence of a loss of material or waste overboard would be limited to individuals and not affect an entire population.

7.3.5 Socio-economic Receptors

In the event a buoyant object is accidentally released and cannot be recovered by a vessel, the buoyant object may present a navigation or entanglement hazard to commercial fishers and other marine users. Further the buoyant object may become non-buoyant overtime and sink to the seabed, where it may present a snagging hazard on the seafloor for commercial trawling activities.

The extent of the area of impact is adjacent to the MODU or vessels within the Project Area. The consequence to socio-economic receptors is assessed as Minor (1) and likelihood as Unlikely, and the resulting risk is Low based on:

- MODU and vessel management systems addressing dropped object, waste storage and chemical handling and storage are well practiced and well understood.
- An unplanned release of waste will be of a very low volume if an incident occurred, and impacts would be restricted to individual marine users or individual fishers.
- Where possible material lost overboard would be recovered.
- Waste will be handled in accordance with AMSA Discharge Standards and respective MODU and vessel Garbage Management Plans. Given this, any waste lost overboard would be in minimal quantities.
- Disposal of hazardous decommissioning waste to be compliant with *Hazardous Waste (Regulation of Exports and Imports) Act 1989* to prevent the likelihood of incorrect disposal of infrastructure.
- The likelihood of losing waste or other materials overboard is unlikely with the MODU and vessels management systems in place. The consequence of a loss of material or waste overboard would be restricted to impacts to individual marine users or individual fishers.

7.3.6 Risk Evaluation Summary

The risk evaluation for the accidental discharge of hazardous and non-hazardous materials is summarised in Table 7-12.

Table 7-12: Risk Evaluation Summary for Accidental Discharge – Hazardous and Non-hazardous Materials

Summary		
Risk summary	An unplanned accidental discharge event, resulting in injury or mortality to a single animal or present a navigation or entanglement hazard to other marine users, has been evaluated as a Low risk. The consequence and likelihood levels to determine the Low risk is defined as follows. The consequence of injury or mortality to single animal is assessed as Minor (1), given the loss of a single animal is not predicted to affect the overall population or recovery of the species. The consequence of a navigation or entanglement hazard to other marine users is assessed as Minor (1), given impacts would be restricted to individual marine users or individual fishers. The likelihood of such an event occurring is Unlikely given the controls in place to prevent such an event from occurring.	
Extent and duration of risk	Localised – risks are limited to an individual animal or marine user or commercial fisher. Temporary – Vessels may periodically be present in the Project Area, creating a temporary risk of an event occurring.	
Level of certainty	Beach has a high level of certainty about the risks of unplanned accidental discharge of hazardous and non-hazardous materials. The threat posed by dropped objects is well known and strict regulatory requirements are in place to control the risk. With these regulatory controls in place, Beach has a high level of certainty that Project activities will not result in the injury or death of an individual animal or pose a navigation or entanglement hazard to other marine users or commercial fishers.	
Is the risk considered lower-order or higher-order?	The risk of an unplanned interaction with marine fauna event has been evaluated to be Low. Low risks are considered lower-order risks that is acceptable with the application of good industry practice.	
Risk Assessment		
Consequence	**Likelihood**	**Risk rating**
Minor	**Unlikely**	**Low**

7.3.7 Demonstration of Acceptability

Table 7-13 demonstrates how and why environmental risks from the accidental discharge of hazardous and non-hazardous materials meets the defined acceptable levels (Table 5-4).

Table 7-13: Demonstration of Acceptability – Accidental Discharge of Hazardous and Non-hazardous Materials

Demonstration of Acceptability	
Impact and risk comparison with relevant defined acceptable levels	Acceptable level13 is relevant to accidental discharge of hazardous and non-hazardous materials (as detailed in Table 5-4). A **Low** risk rating was assigned for this aspect based on the combination of Minor (1) potential consequence and Unlikely event likelihood. By implementing control measures that satisfy

	legislative and other requirements, the occurrence of an accidental discharge – hazardous and non-hazardous materials event will be prevented, thereby ensuring that Acceptable level 13 is met and achieved. Refer below to list of control measures to be implemented to prevent such an event from occurring	
Principles of ESD	Integration principle	Section 7.1.3 identifies and evaluates environmental risks associated with the accidental discharge of hazardous and non-hazardous materials. As part of identifying the potential risks; conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental risk. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks. For Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders on the Project and associated activities. No objections or claims were raised in Phase 1: Initial Project Consultation.. For Phase 2: Project OPP Public Comment Period (Section 10.2.4), the public had the opportunity to provide further comment to this OPP during the period (18/3/2024 – 20/5/2024). Beach prepared the public comment report summarising all comments, an assessment of the merits of each comment, a statement of the response to each comment, and an outline of any changes made to the OPP as a result of the comment (Appendix P). The assessment of merit for comments against this aspect found the response provided in the public comment report to be sufficient to address the comments against this aspect. Therefore, no further updates were required for this aspect. Given the thorough assessment and responses outlined in the public comment report, the impact evaluation for this aspect remains acceptable as is, demonstrating that public comments have been adequately addressed. The potential environmental risk against this aspect was assessed as having a Low risk rating which is considered a lower-order environmental risk. Lower-order environmental risks are considered 'broadly acceptable' and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental risks against this aspect were assessed as having a Low risk rating which is considered a lower-order environmental risk and below defined acceptable level 13 (as detailed in Table 7-14). Lower-order environmental risks cannot result in serious or irreversible environmental damage. There is high confidence in the potential environmental impacts and risks and effectiveness of controls against this aspect. Beach has significant experience operating in the Otway and Bass based on their existing offshore developments and associated activities including the Beach Otway Drilling Campaign in 2021/2022.
	Intergenerational principle	The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts due to the accidental discharge of hazardous and non-hazardous materials is lower than the defined acceptable level 13; the health, diversity, or productivity of the environment for future generations is expected to be maintained.
	Biodiversity principle	Section 7.3.3 identifies and evaluates environmental risks associated with the accidental discharge of hazardous and non-hazardous materials. As part of identifying the potential impacts and risks; conservation values and sensitivities including MNES in Section 4 were reviewed.

		The potential risks against this aspect were assessed as having a Low risk ranking which is considered a lower-order environmental risk and can be managed to meet the defined acceptable level 13 detailed in Table 5-4. Lower-order environmental risks cannot result in affects to biological diversity or ecological integrity.
Internal context	Policy compliance	The defined acceptable levels, EPOs and controls proposed for this aspect are consistent with Beach Environmental Policy objectives. As a result, potential environmental impacts and risks from Project can be managed to align with Beach Environmental Policy objectives.
External context	Stakeholder engagement is being carried out as part of this OPP process. Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable. During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect. During Phase 2: Project OPP Public Comment Period (Section 10.2.4), comments were raised against this aspect. The assessment of merit for comments against this aspect found the responses provided in the public comment report to be sufficient to address the comments against this aspect. Given the thorough assessment and responses outlined in the public comment report, the impact evaluation for this aspect remains acceptable as is, demonstrating that public comments have been adequately addressed.	
Other requirements	**Requirement**	**Demonstration**
	Navigation Act 2012 (Cth) Section 4 – Prevention of pollution MO 47 MO 94: Marine pollution prevention – packaged harmful substances MO 95: Marine pollution prevention - garbage	**CM10 Seabed assessments** Seabed assessments undertaken of each well location and tie-back route prior to final selection to identify seabed composition, benthic habitats and communities and ensure areas of high relief outcrops, reefs, sponge beds, maritime archaeology, submerged cultural heritage and landscapes are avoided where practicable within technical and safety constraints. Seabed assessment data will be provided to the following appropriately qualified specialists to identify sensitive benthic receptors: • Marine benthic ecologist to identify seabed habitat types including areas of high relief outcrops, reefs or sponge beds that are likely to be associated with site-attached fish. • Underwater archaeologist to identify shipwrecks and other maritime archaeological heritage. • Geophysical data analyst to identify location of unexploded ordinances. • Underwater archaeologist to identify submerged cultural heritage and landscapes. Reports from each specialist evaluation of seabed assessment data will be provided to Beach. Beach will assess the reports and identify any areas of
	Protection of the Sea (Prevention of Pollution by Ships) Act 1983 (Cth) Part III – Prevention of pollution by noxious substances Part IIIA – Prevention of pollution by packaged harmful substances Part IIIC – Prevention of pollution by garbage	
	OPGGS Act 2006 (Cth) Section 460(2) - a person carrying on activities in an offshore area under the permit must carry out those activities in a manner that does not interfere with the conservation of the resources of the sea and seabed to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.	

	The following management plans or conservation advice identify marine debris as a threat: • Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia’s coasts and oceans (CoA, 2018a) • Wildlife Conservation Plan for Seabirds (CoA, 2020a) • National Recovery Plan for Albatrosses and Petrels 2022 (CoA, 2022) • Conservation Management Plan for the Blue Whale, 2015-2025 (CoA, 2015b) • Recovery Plan for Marine Turtles in Australia, 2017-2027 (CoA, 2017) • Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA, 2008)	overlap, potential risks from Project activities, and determine any exclusion areas that may be required. **CM11 Cultural heritage assessments** Imagery and data from seabed surveys and assessments will be provided to appropriately qualified underwater archaeologists to identify any maritime archaeological and submerged cultural heritage and landscapes and inform protection priorities, management measures and reporting requirements. Should any maritime archaeological and submerged cultural heritage and landscapes be identified, Beach will report the findings in accordance with the *Underwater Cultural Heritage Act 2018*, and will consult with the relevant First Nations groups and determine any exclusion areas or further cultural heritage management procedures that may be required. **CM35 Marine orders** All wastewater discharges will comply with relevant MARPOL 73/78, Navigation Act 2012, Protection of the Sea (Prevention of Pollution) Act 1983 and subsequent Marine Order requirements (as appropriate for vessel classification): • Marine Order 91 (Marine Pollution Prevention – Oil), which implements Annex I of MARPOL 73/78, including (as required by vessel class): ◦ Machinery space bilge/oily water shall have IMO-approved oil filtering equipment (oil/water separator) with an on-line OIW monitoring device ◦ OIW content to be less than 15 ppm prior to discharge. ◦ A deck drainage system capable of controlling the content of discharges for areas of high risk of fuel/oil/grease or hazardous chemical contamination. ◦ Valid International Oil Pollution Prevention Certificate. • Marine Order 95 (Marine Pollution Prevention – Garbage), which implements Annex V of MARPOL 73/78, including: ◦ Garbage management plan in place. ◦ Garbage record book maintained onboard. • Marine Order 96 (Marine Pollution Prevention – Sewage), which implements Annex IV of MARPOL 73/78, including (as required by vessel class): ◦ a valid International Sewage Pollution Prevention Certificate, ◦ an IMO-approved sewage treatment plant,

		◦ a sewage comminuting and disinfecting system, a sewage holding tank sized appropriately to contain all generated waste (sewage and grey water) discharge of sewage will occur at a moderate rate while vessel is proceeding (more than 4 knots)**CM38 Waste Management Plan** Beach Waste Management Plan implemented that includes details of: • Classification and segregation of wastes • Appropriate storage of wastes • Transportation and disposal of wastes to licensed treatment and disposal facilities onshore **CM39 Lifting** Crane and lifting operations will comply with the following: • Lifting equipment will be inspected and certified • Preventative maintenance will be carried out • Lifting operators will be competent and qualified

7.3.8 Environmental Performance

In accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 7-) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 7-13 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 7- are met

Table 7-14: Environmental Performance Outcomes – Accidental Discharge of Hazardous and Non-hazardous Materials

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 13: Unplanned accidental discharge of hazardous and non-hazardous materials is unacceptable.	EPO26:	No unplanned discharge of materials or waste to the marine environment.
	EPO7:	No death or injury to listed threatened or migratory species from Project activities.

7.4 Loss of Containment – Hydrocarbons and Chemicals

7.4.1 Hazard Identification

Hydrocarbons and chemicals may be accidentally released from vessels, subsea equipment or the MODU over the life of the Project (see Table 7-15).

The risk of an unplanned release of minor volumes of hazardous chemicals and hydrocarbons for the Project is assessed in Section 7.3.

Stages and associated activities which may result in an unplanned loss of hydrocarbons or chemicals are defined in Table 7-15 and further described in Section 7.4.4.

Table 7-15: Activities Undertaken During the Project Resulting in the Unplanned Release of Hydrocarbons and Chemicals

Stage	Activity
Drilling and completions	Drilling method Completions
Installation and commissioning	Commissioning
Operations	Hydrocarbon extraction and export Well intervention and workovers
Support operations (all stages)	MODU operations Vessel operations
Decommissioning	Well plugging and abandonment

It is noted that MODU and vessel operations within the Project Area are considered part of a petroleum activity. MODU and vessel operations outside of the Project Area are excluded from the scope of this OPP, as these operations are fall under maritime legislation such as the *Navigation Act 2012*.

7.4.2 Hazard Description

Marine Diesel Oil (MDO) will be the fuel type used by the vessels and MODU commissioned by the Project. An accidental release of MDO may occur as a result of a collision between the MODU and a project vessel, between project vessels or between a project vessel and a third-party vessel within the Project Area. During support activities, there is the potential for a loss of containment of hazardous substances, from handling, use and transfer activities.

Further, an accidental release of gas and condensate may result from a loss of well containment (LOWC) or integrity failure during Project activities. Credible spill scenarios are provided in Table 7-16.

Activities associated with the Project have the potential to result in an accidental release of hydrocarbons or chemicals to the marine environment as follows:

7.4.2.1 Drilling and Completions

Drilling Method

Drilling of subsea wells introduces the potential for unplanned release of gas and condensate. Up to eight exploration wells are anticipated to be drilled within permits VIC/P43 and VIC/P73, with each well taking approximately 30-40 days per well (Section 3.1). Wells will be drilled by a MODU using standard offshore drilling methods with the wells drilled in sections which decrease in diameter at increasing depths until the target reservoir is reached. A LOWC event is a credible risk during drilling and may be caused by:

- dropped objects, collision, mooring lines and anchor drag;
- a loss of well integrity resulting from the failure of multiple well control barriers; and
- a prolonged and uncontrolled influx of formation fluid into the well bore (a well kick).

The Project is in offshore Commonwealth waters in the Otway Basin, approximately 17 km (south) and 80 km (west) of Victoria and King Island (Tas) respectively.

7.4.2.2 Installation and Commissioning

Commissioning

During commissioning activities subsea infrastructure will be tested and flushed prior to the introduction of hydrocarbons. A loss of containment of MEG stored in flowlines may occur from subsea facilities as a result of erosion, corrosion, or external forces (e.g. dropped object; fishing vessel interactions). The maximum credible MEG spill volume from subsea infrastructure loss of containment during commissioning is in the order of up to 400 m^3, assuming 50% loss of contents (80% MEG and 20% treated water used to displace existing fluid in the flowline) from 30km of 8-inch flowline, prior to pressure equilibrium being reached.

7.4.2.3 Operations

Hydrocarbon Extraction and Export

An accidental loss of containment of condensate may occur from the OGPP during the operations phase, as a result from a loss of integrity from an inadvertent third-party interaction or corrosion defects. Reservoir fluids, from Project wells will flow via flowlines to the existing OGPP for export to the Otway Gas Plant.

Loss of flowline containment from the subsea facilities may result from erosion, corrosion, or external forces (e.g. dropped object; fishing vessel interactions). The greatest length of infield flowlines transporting condensate from potential wells to the OGPP is approximately 23 km length (Section 3.8.5). Condensate fluids from the Project will be commingled with fluids in the existing OGPP.

A loss of containment from flowlines may also result in the discharge of gas and condensate from the OGPP pipeline as the current design does not include actuated valves at the flowline. Further, if the flowline is connected to a producing well, additional hydrocarbons may be introduced to the flowline if the well cannot be shut in quickly (e.g. – if the hydraulic umbilical has been damaged). However, as the subsea control system is configured for all wells to fail-safe in the event of loss of communication and/or hydraulics as a core design philosophy, this is not considered a credible scenario.

In a flowline rupture scenario, combined loss of condensate from a flowline (141m, see Table 7-16) and loss of condensate from the OGPP (up to 320 – 560m^3 modelled in the Otway Offshore Operations EP CDN/ID 3977021), is estimated at up to 701m^3, a substantially smaller volume that the worst-case scenario for loss of containment from a well (69,188m^3 at northern location and 16,308m^3 at the southern location). As a result, LOWC is used as the worst-case scenario to evaluate the risks for loss of containment for wells and for flowline/pipeline rupture.

Table 7-16 details the worst-case loss of containment for this scenario.

Well Intervention and Workovers

Wells may require maintenance and completion activities, also known as a workover or downhole intervention. These activities involve re-entering the well bore and carry the risk of a loss of hydrocarbon containment. Re-entry activities are planned during the initial drilling campaign for the Artisan 1 well. Following this, it is anticipated up to one well may require intervention or workover activities every seven years, for the duration of the Project. The duration for workovers is up to 30 days.

The potential loss of condensate volumes, resulting from well intervention and workovers would be similar to those discussed in drilling activities.

7.4.2.4 Support Operations

MODU Operations; Vessel Operations

A loss of MDO may result from an unplanned collision between the project vessels, including a project vessel and the MODU, or a project vessel and a third-party passing vessel within the project area. Vessel grounding has not been considered as a credible risk, as there are no shallow areas or emergent features in the project area.

The various project vessels will be required for specific purposes, depending on the project phase, and are listed in Table 3-5. The MODU and support vessels will be present in the project area during drilling, operations, and decommissioning stages, for approximately 40 days per well. Vessels used for support operations will vary in size and duration and are detailed in Table 3-6.

To support the impact analysis and evaluation, Beach assessed the worst-case credible spill scenario that could result from a vessel collision. Considering AMSA's guideline for indicative maximum credible spill volumes for other, non-oil tanker, vessel collision (AMSA, 2015), the worst-case scenario for a vessel loss of containment (MDO) scenario was an instantaneous release of MDO due to a vessel collision rupturing a vessel fuel tank (~603.7 m^3 of MDO over 6 hours). This was based on a collision between an installation, resupply or IMR vessel and third-party vessel. Based on the types of vessel used for installation, IMR and resupply activities the loss of the largest tank volume of 603.7 m^3 is considered appropriate.

Vessels and MODU used throughout the Project will contain hazardous substances stored on board. The transfer and handling of these chemicals could result in the potential loss of containment to the marine environment and are outlined further in Table 7-16.

7.4.2.5 Decommissioning

Well Plugging and Abandonment

Plugging and abandoning a well can lead to a LOC of gas and condensate. These activities will be carried out from a MODU and are projected to take up to 30 days per well (Section 3.8.7). Abandonment activities involve setting a series of mechanical and cement plugs within the wellbore, to isolate the reservoir and prevent any further flow from the well.

Well abandonment activities can similarly lead to the loss of well control (LOWC) as drilling activities. At the time when decommissioning activities are commenced, the pressures and volumes of hydrocarbon reservoirs are expected to be lower, than those during drilling, as gas reservoirs will likely have been depleted over time by production.

7.4.3 Hydrocarbon Spill Modelling

Guidance on the identification of worst-case credible spill scenarios is given in AMSA's Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities (AMSA 2015) and Technical Report on Calculation of Worst-Case Discharge (SPE 2016). These documents were used to identify the potential significant and credible loss of containment scenarios associated with the Project as detailed in Table 7-16.

Historical LOWC incidents listed in the IOGP Risk Assessment Data Directory (2019) found blowout events during development drilling for a gas well to be at a frequency of 4.2×10^{-5} per drilled well; for development drilling operations on deep, normal wells of North Sea standard (IOGP, 2019). This frequency is based on two blowout incidents occurring in the UK between 1980 and 2014 during development drilling (IOGP, 2019); and represents the frequency of the cause (i.e. LOWC) that results in the worst-case consequence.

Review of Australian Transport Safety Bureau vessel collision type marine investigations in Victorian waters between found only two vessel collision incidents both between container ship and fishing vessel (ATSB 2024). Both collisions did not result in loss of hydrocarbons.

To date no incidents relating to LOWC or vessel collision events have occurred during Beach operations in Australia including in the Otway basin. Future spills from LOWC or vessel collision events are considered remote and highly unlikely events based on history of no known MDO or condensate spills in southern Australia from LOWC or vessel collision events. [**PC275**].

Table 7-16: Risk Assessment Summary for the Accidental Release of Hydrocarbons and Chemicals

Scenario	Description	Worst-case release volume and rate
Loss of Containment – hazardous substances stored on drill MODU and vessels	Routine operation of the MODU and vessels includes handling, use and transfer of hydrocarbons and chemicals with the following were identified as potentially leading to a loss of containment event: Use, handling and transfer of hydrocarbons and chemicals on board. Hydraulic line failure from equipment.	Hydraulic line failure and use of hazardous materials onboard are associated with small volume spill events – with the maximum volume based upon the loss of an intermediate bulk container ~1 m^3.
Vessel Collision -Marine Diesel Oil (MDO) spill	Collision between an installation, resupply or IMR vessel and third-party vessel.	Based on the types of vessel used for installation, IMR and resupply activities the loss of the largest tank volume of 603.7 m^3 is considered appropriate.
Flowline and/or pipeline loss of containment – gas and condensate	Loss of containment from a flowline and/or pipeline from the subsea facilities as a result of erosion, corrosion, or external forces (e.g. dropped object; fishing vessel interactions).	Maximum credible condensate spill volume from the longest proposed flowline is a loss of containment up to a maximum of 141 m^3 depending on production rates and the production wells online. This may also include up to 320 to 560m^3 additional condensate release volume should the OGPP pipeline be

Scenario	Description	Worst-case release volume and rate
		ruptured, for a total of up to 701 m^3 condensate.
Umbilical or flowline loss of containment – MEG	Loss of containment from an umbilical from the subsea facilities as a result of erosion, corrosion, or external forces (e.g. dropped object; fishing vessel interactions) or from a flowline during installation and commissioning	Maximum credible MEG spill volume from subsea infrastructure loss of containment is in the order of up to 400 m^3.
Loss of well containment - gas and condensate	Loss of containment as a result of well integrity failure during drilling, completions, operations or well workover.	Worst case release volumes for all currently identified exploration prospects within the Project Area were calculated. The highest potential discharge volume for wells in the northern fields of the Project Area (Vic/P43) are: 69,118 m^3 over 86 days The highest potential discharge volume for wells in the southern fields of the Project Area at TW1 (T/L2) are: 16,308 m^3 over 86 days

7.4.3.1 Project Quantitative Spill Modelling

Beach commissioned RPS Group (RPS) to conduct quantitative spill modelling for the vessel collision and loss of well control spill scenarios as the worst case for both hydrocarbon types (RPS, 2024) with the report available as Appendix M. Due to changes in the Project Area – these scenarios were remodelled by RPS (2024). The worst-case scenario, hydrocarbon types and volumes remained the same, only the location changed.

The flowline and/or pipeline loss of containment scenario (including loss of containment from OGPP) was not modelled due to the potential condensate volume of up to 701 m^3 being less than the volume of the loss of well containment scenario; which is considered the worst case scenario for a condensate spill.

The umbilical or flowline loss of containment scenario was not modelled due to the relatively small volume (up to 400 m^3) and MEG being a category ‘E’ OCNS chemical, with no substitution warning, readily biodegradable with a low potential for bioaccumulation and a Minor potential impact consequence ranking.Beach acknowledge that despite the very low aquatic toxicity of MEG there is potential for the chemical to contribute to hypoxic conditions within the water column (ANZG 2018). However, due to the metocean conditions within the Otway region, which facilitate the rapid dispersion of the discharge throughout the marine environment, it is not anticipated that there would be a noticeable change in dissolved oxygen concentrations to an extent that would result impacts to marine fauna [**PC285**].

Modelling of MDO and condensate spill scenarios, from within the Project Area were selected to ensure a conservative assessment, and are detailed in Table 7-17 and presented in Figure 7-1.

Thylacine fluid composition was used as a conservative analogue for the LOWC scenarios. The release duration represents the time estimated to implement a full dynamic well kill through the drilling of a relief well. This is considered the worst-case scenario for potential gas condensate releases and therefore yields the largest spatial extent that could possibly occur from the Project.

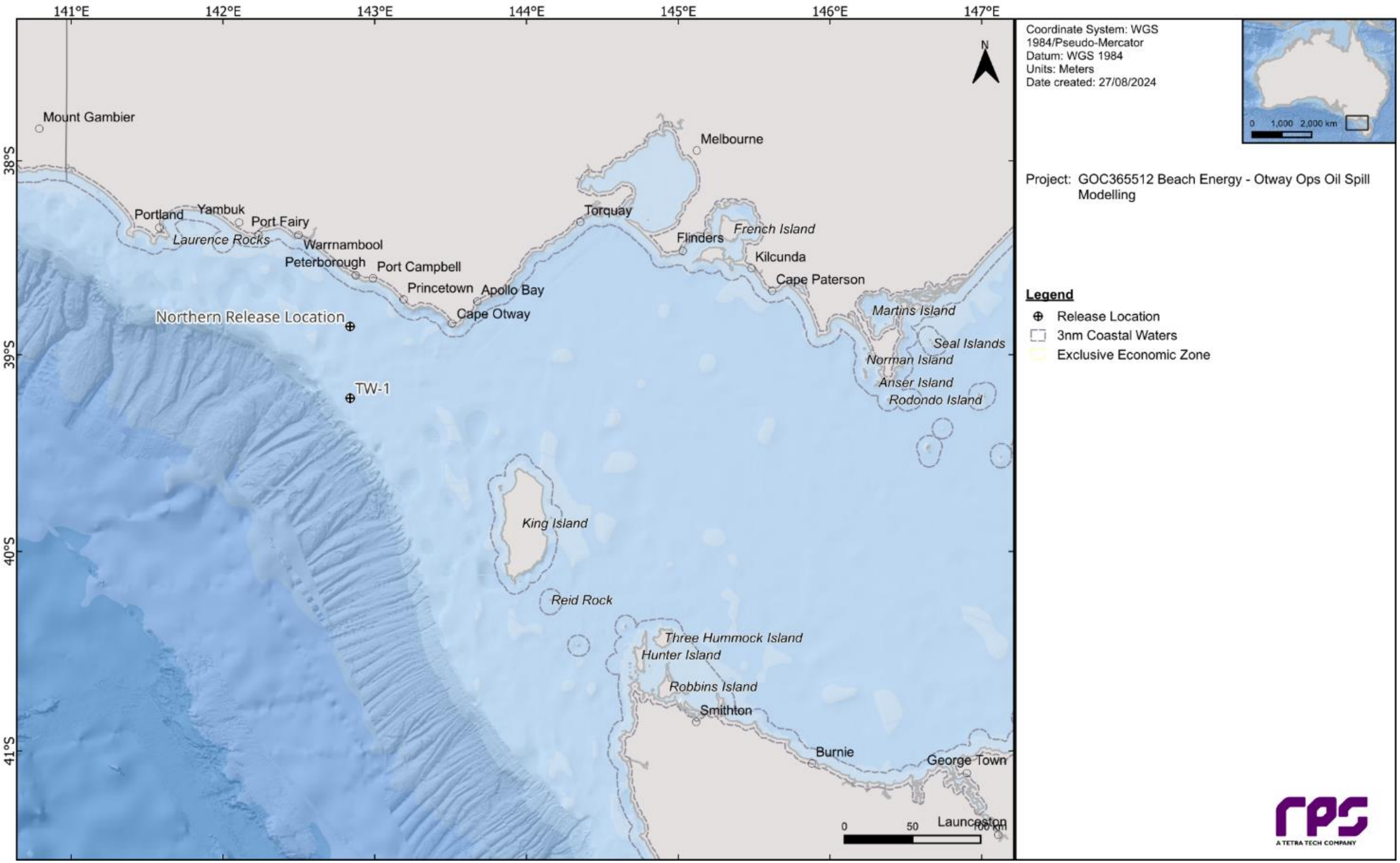


Figure 7-1: Assessed Hydrocarbon Release Locations

Table 7-17: Worst-case Credible Hydrocarbon Scenarios Modelled

Location	Latitude	Longitude	Water depth (m)	Hydrocarbon Type	Volume (m^3)	Release Duration	Reasoning	Report
Loss of well containment – gas and condensate								
Northern Release Location	38.8552° S	142.8381° E	71.5	Condensate	69,118	86 days	Furthermost north proposed well location. Largest flow rate for Vic/P43 and Vic/P73 wells. Worse case for impacts to Victoria.	RPS 2024
TW1	39.2223° S	142.8386° E	105	Condensate	16,308	86 days	Furthest southern proposed well location. Largest flow rate for T/L2 wells. Worse case for impacts to Tasmania and King Island.	RPS 2024
Vessel Collision -Marine Diesel Oil (MDO) spill								
Northern Release Location	38.8552° S	142.8381° E	N/A	MDO	603.7	6 hours	Furthest northern proposed well location. Largest flow rate for Vic/P43 and Vic/P73 wells. Worse case for impacts to Victoria.	RPS 2024
TW1	39.2223° S	142.8386° E	N/A	MDO	603.7	6 hours	Furthest southern proposed well location. Largest flow rate for T/L2 wells. Worse case for impacts to Tasmania and King Island.	RPS 2024

GCS: WGS84

7.4.3.2 Hydrocarbon Characteristics

Beach produces gas from the Thylacine field in the Otway Basin and has comprehensive data on its hydrocarbon characteristics. The hydrocarbon characteristics used for the quantitative spill modelling conducted by RPS are detailed in Table 7-18.

All offshore fields in the greater Shipwreck Trough area of the Otway Basin belong to the Austral 2 Petroleum System (Mehin and Link 1994; Foster and Hodgson 1995; Luxton et al 1995; Boreham et al. 2004), consisting of Thylacine Member, Flaxman Formation, and Waarre Formation reservoirs charged by the regionally extensive marine shales, organic-rich mudstones and coals of the underlying Eumeralla Formation source rock (Edwards et al. 1999; Boreham et al. 2004; O'Brien et al. 2009). Based on burial history modelling and geochemical data, this source rock is interpreted as gas/condensate-prone, also evidenced in multiple discoveries across the Otway Basin. As a consequence of all fields in the region being charged from the same source, significant variations in condensate properties are not expected.

An assessment of offset field data from the currently producing Thylacine and Geographe Fields (operated by Beach, with first production in 2007) was made to inform input parameters for spill modelling. Thylacine Field condensate properties are used as the primary analogue, with the exception of the Condensate Gas Ratio (CGR) which is taken from the Geographe Field. The Geographe Field CGR, which features the highest CGR of the Otway wells (16 bbl/MMscf), is used for modelling as it represents the largest potential condensate discharge and therefore worst-case scenario. In addition to the assessment of offset field data from the producing Thylacine and Geographe Fields, well data from Artisan 1 (drilled 2021) and La Bella 1 (drilled 1993) was also assessed to inform hydrocarbon spill modelling. As Artisan 1 and La Bella 1 have not been connected and produced to date, relevant geotechnical data that may be used to inform spill modelling is restricted to downhole MDT sampling undertaken at the time of drilling. As these downhole samples are typically small in volume (further reduced by the low CGR observed in the wells), condensate assay analysis was not undertaken, with compositional information only sufficient to indicate that upon production the CGR in Artisan 1 and La Bella 1 will be lower than that observed in the Thylacine and Geographe Fields. Therefore, the hydrocarbon characteristics for spill modelling are best represented by Thylacine condensate properties with Geographe CGR.

The Thylacine condensate hydrocarbon characteristics are used for the quantitative spill modelling. Beach commissioned RPS to conduct quantitative spill modelling for the vessel collision and loss of well control spill scenarios (RPS 2024).

Thylacine condensate has an API of 44.3 and a density of 804.6 kg/m^3 (at 15ºC) with a viscosity value (0.875cP) classifying it as a Group I (not-persistent) oil according to the International Tankers Owners Pollution Federation (ITOPF 2020) and US EPA/USCG classifications.

The condensate is a mixture of volatile and persistent hydrocarbons with high proportions of volatile and semi- to low-volatile components. In favourable evaporation conditions, 64.0% of the oil mass should evaporate within the first 12 hours (BP < 180°C), a further 19.0% is expected to evaporate within the first 24 hours (180°C < BP < 265°C) and a further 16.0% should evaporate over several days (265°C < BP < 380°C). Approximately 1.0% of the condensate is shown to be persistent.

MDO has an API of 37.6 and a density of 829.1 kg/m^3 (at 25ºC) with a viscosity value (4.0 cP) classifying it as a Group II (light-persistent) oil according to the International Tankers Owners Pollution Federation (ITOPF 2014) and US EPA/USCG classifications.

The MDO is a mixture of volatile and persistent hydrocarbons with high proportions of volatile and semi- to low-volatile components. In favourable evaporation conditions, about 6.0% of the oil mass should evaporate within the first 12 hours (BP < 180°C); a further 34.6% should evaporate within the first 24 hours (180°C < BP < 265°C); and a further 54.4% should evaporate over several days (265°C < BP < 380°C). Approximately 5.0% of the oil is shown to be persistent.

Table 7-18: Hydrocarbon Characteristics of the Hydrocarbons Modelled for the Project

Hydrocarbon Type	**API**	**Density (kg/m^3)**	**Viscosity (cP)**	**Pour Point (°C)**	**Wax Content (%)**
Thylacine Condensate	44.3	804.6 at 15ºC	0.875 at 15ºC	-50	<1%
Geographe Condensate	56.9	751 at 15ºC	0.50 at 25ºC	-50	<1%
Marine Diesel Oil	37.6	829.1 at 15ºC	4.0 at 25ºC	-14	1

7.4.3.3 Hydrocarbon Exposure thresholds

In the event of an oil spill incident, the environment may be affected in several ways, depending on the concentration and duration of exposure of the environment to hydrocarbons. The hydrocarbon exposure thresholds used for the spill modelling are based on the NOPSEMA Bulletin: Oil Spill Modelling (NOPSEMA 2019) and are detailed in Table 7-19.

These thresholds have been used to:

- Predict potential hydrocarbon exposure at conservative (low exposure) concentrations to inform the description of the environment (Section 4)
- Inform the oil spill impact and risk evaluation (Section 7.4.4)
- Inform oil spill response planning based on the actionable thresholds of:
    - Surface moderate exposure (10 g/m^2)
    - Shoreline moderate exposure (100 g/m^2)
    - Inform oil spill monitoring planning based on the low exposure thresholds.

Table 7-19: Hydrocarbon Exposure Thresholds

	Threshold	Description
Surface		
Low exposure	1 g/m^2	Approximates range of socioeconomic effects and establishes planning area for scientific monitoring.
Moderate exposure	10 g/m^2	Approximates lower limit for harmful exposures to birds and marine mammals.
High exposure	50 g/m^2	Approximates surface oil slick and informs response plan.
Shoreline		
Low exposure	10 g/m^2	Predicts potential for some socio-economic impact.
Moderate exposure	100 g/m^2	Loading predicts area likely to require clean-up effort.
High exposure	1000 g/m^2	Loading predicts area likely to require intensive clean-up effort.
Dissolved*		
Low exposure	10 ppb	Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers.
Moderate exposure	50 ppb	Approximates potential toxic effects, particularly sublethal effects to sensitive species.
High exposure	400 ppb	Approximates toxic effects including lethal effects to sensitive species
Entrained*		
Low exposure	10 ppb	Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers.
High	100 ppb	As appropriate given oil characteristics for informing risk evaluation.

7.4.3.4 Summary of Modelling Results

The potential environmental impacts to receptors from are discussed in Table 7-20 to Table 7-22 (MDO spill) and Table 7-23 to Table 7-25 (Condensate LOWC) and are based on the spill modelling areas of exposure from the two release locations, detailed in Appendix M and summarised below.

7.4.3.5 Extent of Hydrocarbon Exposure - Marine Diesel

1. Northern Release Location

- The maximum distance from the release location to the low (1–10 g/m^2), moderate (10–50 g/m^2) and high (>50 g/m^2) surface exposure thresholds was 32.65 km (ESE), 19.85 km (SE) and 10.53 km (SE), recorded during winter months.

- No State waters were predicted to be exposed to surface hydrocarbons at any threshold.

- No conservation values or sensitivities (Section 4.2) were identified to be exposed to surface hydrocarbons at any threshold.

- The probability of accumulation to any shoreline at, or above, the low level (10 g/m^2) threshold was 31% during summer conditions and 27% during winter conditions.

- The minimum time before shoreline accumulation above the low threshold was 4 days (summer) ,and 2 days (winter), predicted for Cape Otway West.
- The maximum volume ashore for a single spill trajectory during the summer and winter conditions was 30.86 m^3 and 58.33 m^3, respectively, whilst the maximum length of shoreline accumulation at the low threshold was 29.23 km and 43.19 km, respectively.
- Only the receptors that the Northern Release Location resides within were contacted by dissolved hydrocarbon at the low threshold.
- At the depths of 0-10 m the maximum dissolved hydrocarbon concentration was 101.35 ppb and 65.67 ppb during summer and winter respectively.
- At the depths of 0-10 m, during summer and winter, the maximum entrained concentration at any given receptor was predicted to be 11,343.38 ppb and 11,396.24 ppb, respectively.
- Outside of the receptors that the release location resides within, the maximum entrained hydrocarbon exposure predicted during summer and winter was 745.77 ppb and 1,391.43 ppb, respectively.

a. TW1 Location

- The maximum distance from the release location to the low (1–10 g/m^2), moderate (10–50 g/m^2) and high (>50 g/m^2) surface exposure thresholds was 64.97 km (SE), 49 km (SE) and 10.08 km (SSE), recorded during winter months.
- No State waters were predicted to be exposed to surface hydrocarbons at any threshold.
- No conservation values or sensitivities (Section 4.2) were identified to be exposed to surface hydrocarbons at any threshold.
- The probability of accumulation to any shoreline at, or above, the low level (10 g/m^2) threshold was 9% during winter conditions. No shoreline accumulation was predicted during summer conditions at any threshold.
- The minimum time before shoreline accumulation above the low threshold was 15.02 days, predicted for King Island Council.
- The maximum volume ashore for a single spill trajectory during winter conditions was 9.67 m^3, whilst the maximum length of shoreline accumulation at the low threshold was 17.67 km.
- At the depths of 0-10 m, during the summer and winter conditions the maximum dissolved hydrocarbon concentration was 67.28ppb and 73.23 ppb during summer and winter, respectively. Outside of the receptors that the release location resides within, the maximum dissolved hydrocarbon exposure during summer and winter was 23.94 ppb and 23.23 ppb, respectively.
- At the depths of 0-10 m, during summer and winter, the maximum entrained concentration at any given receptor was predicted to be 7,505.14 ppb and 7,419.26 ppb, respectively. Outside of the receptors that the release location resides within, the maximum entrained hydrocarbon exposure during summer and winter was 2,776.45 ppb and 1,760.94 ppb, respectively.

7.4.3.6 Extent of Hydrocarbon Exposure – Condensate

1. Northern Release Location

- The maximum distance from the low (1–10 g/m^2) and moderate (10–50 g/m^2) surface exposure zones was 54.03 km (E) and 5.83 km (ESE), recorded during winter months. No contact was predicted for the high threshold (>50 g/m^2).

- Victorian State waters were predicted to be exposed to surface hydrocarbons at low surface exposure thresholds at a low probability of 3% only during winter conditions.

- No conservation values or sensitivities (Section 4.2) were identified to be exposed to surface hydrocarbons at any threshold.

- The probability of accumulation to any shoreline at, or above, the low level (10 g/m^2) threshold was 99% during summer conditions and 96% during winter conditions. The minimum time before shoreline accumulation at or above the low threshold was 5.7 days (summer) and 3.7 days (winter), predicted for Cape Otway West.

- The maximum volume ashore for a single spill trajectory during the summer and winter conditions was 67.91 m^3 and 87.54 m^3, respectively, whilst the maximum length of shoreline accumulation at the low threshold was 104.17 km and 114.39 km, respectively.

- At the depths of 0-10 m, during the summer and winter conditions the maximum dissolved hydrocarbon concentration was 742.67 ppb and 1,332.51 ppb during summer and winter, respectively. Outside of the receptors that the release location resides within, the maximum dissolved hydrocarbon exposure during summer and winter was 570.15 ppb and 620.89 ppb, respectively.

- At the depths of 0-10 m, during summer and winter, the maximum entrained concentration at any given receptor was predicted to be 3,246.16 ppb and 3,192.69 ppb, respectively. Outside of the receptors that the release location resides within, the maximum entrained hydrocarbon exposure during summer and winter was 358.93 ppb and 527.26 ppb, respectively.

   a. TW1 Location

- The maximum distance from the low threshold (1–10 g/m^2) surface exposure zones was 24.49 km (SE) and 18.35 km (S) during summer and winter conditions, respectively. No contact was predicted for the moderate (10–50 g/m^2) or high thresholds (>50 g/m^2).

- No State waters were predicted to be exposed to surface oil.

- No conservation values or sensitivities (Section 4.2) were identified to be exposed to surface oil at the low threshold or above.

- The probability of accumulation to any shoreline at, or above, the low level (10 g/m^2) threshold was 32% during summer conditions and 57% during winter conditions. The minimum time before shoreline accumulation at or above the low threshold was 25.38 days (summer) ,and 21.93 days (winter), predicted for King Island Council.

- The maximum volume ashore for a single spill trajectory during the summer and winter conditions was 6.15 m^3 and 8.36 m^3, respectively, whilst the maximum length of shoreline accumulation at the low threshold was 12.62 km and 13.90 km, respectively.
- At the depths of 0-10 m, during the summer and winter conditions the maximum dissolved hydrocarbon concentration was 770.64 ppb and 1,280.79 ppb during summer and winter, respectively. Outside of the receptors that the release location resides within, the maximum dissolved hydrocarbon exposure during summer and winter was 553.15 ppb and 528.54 ppb, respectively.
- At the depths of 0-10 m, during summer and winter, the maximum entrained concentration at any given receptor was predicted to be 1,111.04 ppb and 1,179.85 ppb, respectively. Outside of the receptors that the release location resides within, the maximum entrained hydrocarbon exposure during summer and winter was 338.67 ppb and 328.89 ppb, respectively.

7.4.4 Risk Analysis and Evaluation

The potential impacts on environmental receptors from hydrocarbon spills (MDO and/or Condensate) may result from a change in water quality.

As a result of a change in water quality, further impacts may occur, which include:

- Injury / mortality to fauna.
- Change in fauna behaviour.
- Change in ecosystem dynamics.
- Changes to the conservation, socio-economic and cultural values and sensitivities.

The potential environmental impacts to receptors from hydrocarbon exposure from a loss of containment of condensate and MDO are discussed in the following sections.

7.4.4.1 Marine Diesel Oil Exposure

Sea Surface Exposure

Table 7-20: Environmental Impact Summary from Floating Oil Exposure (MDO Spill)

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
Marine fauna	Seabirds	Change in fauna behaviour Injury / mortality to fauna	Several listed Threatened, Migratory and/or listed marine species have the potential to be rafting, resting, diving and feeding within predicted worst-case extent of exposure to moderate levels of surface hydrocarbons, 19.85 km of the northern release location and 49 km of the TW1 release location. Foraging BIAs for several albatross species, common diving-petrel and	When first released, MDO has higher toxicity due to the presence of volatile components. Individual birds making contact close to the spill source at the time of the spill (i.e. areas of moderate concentrations >10 g/m^2 out to 19.85 km of the northern release location and 49 km of the TW1 release location) may be impacted; however, it is unlikely that many birds will be affected as the majority of volatile

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			short-tailed shearwater are present in the areas with potential to be exposed to moderate levels of surface hydrocarbons. Foraging and breeding BIAs for little penguins are within the planning area, but not within the predicted area of surface exposure at moderate levels. Colonies of little penguins, without defined BIAs, are known to be present along parts of Port Campbell Bay area; therefore, it is possible that little penguins may be present in the area exposed to surface hydrocarbon at moderate levels.	surface hydrocarbons are expected to evaporate or entrain over 24 hours. Seabirds rafting, resting, diving or feeding at sea have the potential to encounter areas where hydrocarbons concentrations are greater than 10 g/m^2 and due to physical oiling may experience lethal surface concentrations. As such, acute or chronic toxicity impacts (death or long-term poor health) to birds are possible but unlikely for an MDO spill because of the limited period of exposure above 10 g/m^2. Due to the hydrocarbon characteristics of MDO, majority of the surface oil is expected to either evaporate or entrain within the first 24 hours under variable-wind conditions. Surface oil is only predicted to remain after 24 hours in calm conditions (RPS, 2024). Therefore, potential impact would likely be limited to individuals, however, impacts to aggregations may occur. There is the potential for serious impact on valued species or habitats with a consequence considered to be Serious (3).
	Marine reptiles	Change in fauna behaviour Injury / mortality to fauna	There may be marine turtles in the area predicted to be exposed to surface oil. However, there are no BIAs or habitat critical to the survival of a marine turtle species within this area.	Marine turtles are vulnerable to the effects of oil at all life stages. Marine turtles can be exposed to surface oil externally (i.e. swimming through oil slicks) or internally (i.e. swallowing the oil). Ingested oil can harm internal organs and digestive function. Oil on their bodies can cause skin irritation and affect breathing. The number of marine turtles that may be exposed to surface MDO is expected to be low as there are no BIAs or habitat critical to the survival of the species present; however, turtles may be transient within the area of exposure. Due to the hydrocarbon characteristics of MDO, majority of the surface oil is expected to either evaporate or entrain within the first 24 hours under variable-wind conditions. Surface oil is only predicted to remain after 24 hours in calm conditions (RPS, 2024). Therefore, potential impact would likely be

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				limited to individuals, with population impacts not anticipated. There could be expected to be minor short-term impacts and some impact on valued species or habitats with a potential consequence considered to be Moderate (2)
	Pinnipeds (seals and sea lions)	Change in fauna behaviour Injury / mortality to fauna	The Australian and New Zealand fur-seals may occur within the area predicted to be exposed to moderate surface hydrocarbons >10 g/m^2. No BIAs, breeding colonies or haul outs areas are within the area of exposure.	Seals are vulnerable to sea surface exposures given they spend much of their time on or near the surface of the water, as they need to surface every few minutes to breathe. Exposure to surface oil can result in skin and eye irritations and disruptions to thermal regulation. Fur seals are particularly vulnerable to hypothermia from oiling of their fur. The number of seals that may be exposed to surface MDO at >10 g/m^2 is expected to be low as there are no BIAs or habitat critical to the survival of the species present; however, seals may be transient in low numbers within areas of potential surface exposure at >10 g/m^2. Due to the hydrocarbon characteristics of MDO, majority of the surface oil is expected to either evaporate or entrain within the first 24 hours under variable-wind conditions. Surface oil is only predicted to remain after 24 hours in calm conditions (RPS, 2024). Therefore, potential impact would be limited to individuals, with population impacts not anticipated. There could be expected to be minor short-term impacts and some impact on valued species or habitats with a potential consequence considered to be Moderate (2)
	Cetaceans (whales)	Change in fauna behaviour Injury / mortality to fauna	Several threatened, migratory and/or listed marine species have the potential to be within the area predicted to be exposed to moderate surface hydrocarbons of >10 g/m^2. Foraging and distribution BIAs for pygmy blue whales and the migration BIA for southern right whales are within the area predicted to be exposed to surface hydrocarbons >10 g/m^2.	Geraci (1988) found little evidence of cetacean mortality from hydrocarbon spills; however, some behaviour disturbance (including avoidance of the area) may occur. However, observations during spills have recorded whales and dolphins traveling through and feeding in oil slicks. During the Deepwater Horizon spill cetaceans were routinely seen swimming in surface slicks offshore (and nearshore) (Aichinger Dias et al.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				2017). Cetaceans observed during the spill response for the Montara oil spill included oceanic species such as false killer whales, bottlenose dolphins, spotted dolphins and spinner dolphins (Watson et al. 2009). [**PC282**] Cetaceans exposed to surface hydrocarbons above moderate exposure thresholds may suffer external oiling, ingestion of oil and inhalation of toxic vapours (Deepwater Horizon Natural Resource Damage Assessment Trustees 2016). [**PC282**] In addition, active avoidance of an area may displace individuals from important habitat, such as foraging. If whales are foraging at the time of the spill, a greater number of individuals may be present in the area where sea surface oil is present. However, due to the hydrocarbon characteristics of MDO, majority of the surface oil is expected to either evaporate or entrain within the first 24 hours under variable-wind conditions. Surface oil is only predicted to remain after 24 hours in calm conditions (RPS, 2024). Also, the area exposed by moderate levels of surface hydrocarbons (19.85 km from the northern release location and 49 km from the TW1 release location) is relatively small compared to the overall distribution area of cetaceans. Given this is a relatively small area of the total distribution and foraging BIAs for pygmy blue whales and migration BIA for southern right whales, the risk of displacement to whales is considered low. Project activities could occur at any time of year. Therefore, there is potential for interaction with southern right whales given the activity has the potential to overlap with the northern migration period of May-June, the peak breeding (July-August) and southern migration period (September-November). The activity timing may overlap with the blue whale season for migration and foraging in the impact area. Visual and acoustic surveys suggest that blue

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				whales are present in the Otway region between November to June, peaking in February and March. It is expected that foraging whales would be present in the area. As such in the event of a spill potential hydrocarbon exposure could possibly affect aggregations of blue or other foraging whale species. There is the potential for serious impact on valued species or habitats with a consequence considered to be Serious (3).
	Cetaceans (dolphins)	Change in fauna behaviour Injury / mortality to fauna	Several dolphin species have the potential to be within the area predicted to be exposed to moderate surface hydrocarbons of >10 g/m^2. However, there are no BIAs or habitat critical to the survival of a dolphin species.	Dolphins surface to breathe air and may inhale hydrocarbon vapours or be directly exposed to dermal contact with surface hydrocarbons. Direct contact with oil can result in direct impacts to the animal, due to toxic effects if ingested, damage to lungs when inhaled at the surface, and damage to the skin and associated functions such as thermoregulation (AMSA 2010). Dolphins are highly mobile and are considered to have some ability to detect and avoid oil slicks (Geraci and St. Aubin, 1988; Smith et al, 1983). Direct surface hydrocarbon contact may pose little problem to dolphins due to their extraordinarily thick epidermal layer which is effective as a barrier to the substances found in hydrocarbons (Geraci and St. Aubin, 1990; Volkman et al., 1994). The number of dolphins exposed is expected to be low. If dolphins are foraging at the time of the spill, a greater number of individuals may be present in the area where sea surface oil is present, however due to the short duration of the surface exposure above the impact threshold (approximately 24 hrs dependent on the weather conditions), this is not likely. There could be expected to be minor short-term impacts and some impact on valued species or habitats with a potential consequence considered to be Moderate (2)

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
Socio-economic	Petroleum Exploration and Production	Displacement of other marine users	There are no oil and gas operations or activities within the area predicted to be exposed to surface hydrocarbons >10 g/m^2 (19.85 km from the northern release location and 49 km from the TW1 release location).	No impact predicted as there are no non-Beach oil and gas platforms located within the area predicted to be exposed to surface hydrocarbons.
	Shipping	Displacement of other marine users	Shipping occurs within the area predicted to be exposed to surface hydrocarbons >10 g/m^2 (19.85 km from the northern release location and 49 km from the TW1 release location).	Vessels may be present in the area where sea surface oil is present, however, due to the short duration of the surface exposure (approximately 24 hrs depending on weather conditions) deviation of shipping traffic would be unlikely.
	Tourism and recreation (including recreational diving and recreational fisheries)	Change in aesthetic value Changes to the functions, interests or activities of other users	Marine pollution can result in reduced visual aesthetic. The modelling predicts visible surface sheen at the low threshold up to 32.65 km from the northern release location or 64.97 km from the TW1 release location. This oil may be visible as a rainbow sheen on the sea surface during calm conditions.	Visible surface hydrocarbons (i.e. a rainbow sheen) have the potential to reduce the visual amenity of the area for tourism and discourage recreational activities. Due to the expecting weathering of the surface oil, there may be short-term and localised consequences, which are ranked as Moderate (2). Refer also to ecological receptors above.
	Commercial fisheries	Change in aesthetic value Changes to the functions, interests or activities of other users	Commercial fishing occurs within the area predicted to be exposed to surface hydrocarbons >10 g/m^2 (19.85 km from the northern release location and 49 km from the TW1 release location).	Commercial fishing vessels may be present in the area where sea surface oil is present, however, due to the short duration of the surface exposure (approximately 24 hrs depending on weather conditions) deviation of vessels would be unlikely. Impacts to commercial fish and invertebrate species are not predicted from surface oil. A short-term fishing exclusion zone may be implemented. However, given the temporary nature of any surface oil and the low intensity in the area of exposure, there are unlikely to be any significant impact on fisheries in terms of lost catches (and associated income). There may be short-term and localised consequences, which are ranked as Moderate (2)
First Nations	Sea Country	Change in aesthetic value Changes to the functions,	Marine pollution can result in reduced visual aesthetic. The modelling predicts visible surface sheen at the low threshold up to 32.65 km from the northern release	Beach understands that First nations people are linked to the marine environment and may be affected by a change in the environment. Due to the hydrocarbon characteristics of MDO,

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
		interests or activities of other users	location or 64.97 km from the TW1 release location. This oil may be visible as a rainbow sheen on the sea surface during calm conditions.	majority of the surface oil is expected to either evaporate or entrain within the first 24 hours under variable-wind conditions. Surface oil is only predicted to remain after 24 hours in calm conditions (RPS, 2024). Therefore, although no long term or permanent changes to marine environment are expected it is considered that the visual presence of floating oil may impact Sea Country at a spiritual level (i.e. rituals, songlines, culturally important species) and could affect culturally important activities such as mutton birding or affect culturally important species including whales. There may be short-term and localised consequences, which are ranked as Moderate (2). [**PC274**] Refer also to: cetaceans (whales) exposure and consequence evaluation

Shoreline Exposure

Table 7-21: Environmental Impact Summary form Shoreline Oil Exposure (MDO Spill)

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
Threatened and Migratory species	Birds [**PC270**]	Injury/Mortality to fauna Change in fauna behaviour	The modelling predicts potential shoreline exposure at the moderate threshold at Cape Otway West and Moonlight Head from MDO release at the north release location. The moderate threshold is not predicted to be reached based on MDO release at the TW1 release location. Several listed threatened, migratory and/or listed marine seabird and shorebird species have the potential to be foraging at these locations. Shorelines at the Otway coast with the potential to be exposed to moderate hydrocarbon thresholds overlap a foraging BIA and a breeding BIA and therefore may expose birds to shoreline	Shorebird species foraging for invertebrates in intertidal feeding habitats, such as exposed sand and mud flats at lower tides, will be at potential risk of both direct impacts through contamination of individual birds (ingestion or soiling of feathers) and indirect impacts through the contamination of foraging areas that may result in a reduction in available prey items (Clarke 2010). Any direct impact of oil on terrestrial habitats has the potential to contaminate seabirds present at the breeding sites (Clarke 2010). Bird eggs may also be damaged if an oiled adult sits on the nest. Fresh crude was shown to be more toxic than weathered crude, which had a medial lethal dose of 21.3 mg/egg (Clarke 2010). Studies of contamination of duck eggs by small quantities of crude oil, mimicking the effect of oil transfer by parent birds, have been shown to result in mortality of developing embryos (French-McCay 2009).

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			hydrocarbons for the short-tailed and wedge-tailed shearwater at Muttonbird Island.	Shoreline accumulation will be concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA 1995). As breeding activities of shorebirds and seabirds generally occurs above the high tide mark, exposure to hydrocarbons is considered unlikely to occur. However, oiled bird species may track oil into their nests, which may then have subsequent impacts on any eggs present. The little penguin would be the highest-risk species, as they have to traverse through the intertidal area to reach nesting sites. Based on the worst-case scenario, the modelling predicted the maximum probability of shoreline accumulation at, or above, the moderate (100 g/m^2) threshold from MDO release at the northern release location to occur at Cape Otway West (6% probability) with the minimum time for shoreline contact predicted as 6.8 days with a peak volume ashore of 4.46 m^3 and Moonlight Head (2% probability) with the minimum time for shoreline contact predicted as 7.7 days with a peak volume ashore of 2.45 m^3 (RPS 2024). Acute or chronic toxicity impacts (death or long-term poor health) to seabirds and shorebirds is possible, however, with the minimum time for shoreline contact predicted as 6-7 days, potential contamination of nests and eggs from oiled parent bird species is limited to weathered MDO. The Otway coast, including Cape Otway West and Moonlight Head, is exposed to substantial wave action that would further break down any shoreline hydrocarbons. The limited exposure to shoreline hydrocarbons will prevent potential death or long-term poor health to seabirds and shorebirds over multiple breeding seasons, therefore it is expected that shoreline hydrocarbons will only impact a single breeding season at most. Consequently, the potential consequence to seabirds and shorebirds is considered to be Serious (3), as there is potential for serious impact on valued species or habitats.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
Socio-economic	Coastal settlements Recreation and tourism (including recreational fisheries)	Change in aesthetic value Changes to the functions, interests or activities of other users	Marine pollution can result in reduced visual aesthetic. The modelling predicts shoreline exposure at the low threshold along the Otway coast, including Bay of Islands (1%), Cape Otway West (24%), Cape Patton (10%), Childers Cove (1%), Moonlight Head (9%), Point Hicks (1%), Port Campbell (2%), around to Lorne (3%), Apollo Bay (8%), and Anglesea (1%). There is a low probably of shoreline exposure at the low threshold on King Island (9% from TW1 and 1% from the northern release location).	Shoreline oil had potential for exposure on along the Victorian coast including the Otway coast, Port Campbell and Anglesea. The minimum time for shoreline accumulation ranged from 2.03 days at Cape Otway West, 3.18 days at Moonlight Head, 15.05 days at King Island, up to 26.11 days at Anglesea. Visible shoreline hydrocarbons have the potential to reduce the visual amenity of the area for tourism and discourage recreational activities. Given the minimum time to shoreline accumulation ranged from 2-26 days it is likely that majority of the oil will have dissipated. Both the Otway coast and the west side of King Island are exposed to substantial wave action that would further breakdown any shoreline hydrocarbons. There may be minor short-term consequences, which are ranked as Moderate (2).
	Seaweed industry	Change in ecosystem dynamics Changes to the functions, interests or activities of other users	The modelling predicts a low probability of shoreline exposure at the low threshold at King Island (1% from the northern release location and 9% from TW1 release location) where bull kelp may be collected.	Experiments verified the susceptibility of *Nereocystis luetkeana* (bull kelp – North America) tissue to the direct exposure to several petroleum types. Antrim et al (1995) showed that petroleum treatments resulted in visible tissue damage, with a distinct bleached line being the most visible indication of plant contact with the petroleum. Moderate to heavy colour loss, which was generally followed by rapid decay of tissue, was most pronounced in 24 h exposures to unweathered and weathered MDO. As bull kelp is collected from the shoreline there is a potential for some plants to be affected and not be suitable for collection and processing. However, given the low levels of shoreline oil predicted (peak volume of 1.38 m^3) it is unlikely to be a significant impact on seaweed collection and associated income. There may be minor short-term consequences, which are ranked as Moderate (2).

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
First Nations	Sea Country Native Title	Change in aesthetic value Changes to the functions, interests or activities of other users	Marine pollution can result in reduced visual aesthetic. The modelling predicts shoreline exposure at the low and moderate threshold along the Otway coast (Eastern Maar native title claim) and further east at Anglesea (Wadawurrung native title claim).	Beach understands that First nations people are linked to the marine environment and may be affected by a change in the environment. Although no long term or permanent changes to marine environment are expected it is considered that the visual presence of shoreline oil may impact Sea Country at a spiritual level (i.e. rituals, songlines) and could affect culturally important activities such as mutton birding. The predicted minimum time for oil to reach a shoreline means it is likely to have dissipated during that time. The Otway coast is exposed to substantial wave action that would further breakdown any shoreline hydrocarbons. [**PC274**] The relatively low volume means there may be short-term and localised consequences, which are ranked as Moderate (2)

In Water Exposure

Table 7-22: Environmental Impact Summary from In water Oil Exposure (MDO Spill)

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
Conservation Values and Sensitivities	Australian Marine Parks	Change in values Changes to the functions, interests or activities of other users	Apollo AMP may be exposed to entrained hydrocarbons at the moderate threshold within the upper 0 -10 m of the water column for up to 11 hours (RPS 2024). Zeehan AMP may be exposed to entrained hydrocarbons at the moderate threshold within the upper 0 -10 m of the water column for up to 7.25 hours (RPS 2024). No AMPs were predicted to be exposed to dissolved hydrocarbons at any threshold.	The Apollo AMP is located in waters 80 m to 120 m deep and thus conservation values such as ecosystems, habitats and communities associated with the Western Bass Strait Shelf Transition and the Bass Strait Shelf Province and associated with the seafloor features and the wreck of the MV City of Rayville are not predicted to be impacted. The conservation value of important migration area for blue, fin, sei and humpback whales is unlikely to be impacted as these whales would be moving through the area and thus unlikely to be exposed to in water hydrocarbons within 0 -10 m of the water column for a substantial period to elicit a toxic effect. The Apollo AMP is an important foraging area for black-browed and shy albatross, Australasian gannet, short-tailed shearwater and crested tern. These seabirds forage over an

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				extensive area and are distributed over a wide geographic range. The area of entrained hydrocarbon predicted to meet the high threshold is relatively small compared to the Bass Strait and Otway region. It is these small areas where sub-lethal and toxic effects to birds may occur. There is a low probability that seabirds would be feeding exclusively or predominantly on fish found in these areas of higher hydrocarbon thresholds, meaning there is low probability of seabirds themselves experiencing sub-lethal or toxic impacts as a result of consuming hydrocarbon-tainted fish. The Zeehan AMP is located in waters 50 m to 3,000 m deep and thus conservation values such as ecosystems, habitats and communities associated with the Tasmania Province, the West Tasmania Transition and the Western Bass Strait Shelf Transition and associated with the seafloor features are not predicted to be impacted. The conservation value of important migration area for blue and humpback whales is unlikely to be impacted as these whales would be moving through the area and thus unlikely to be exposed to in water hydrocarbons within 0 -10 m of the water column for a substantial period to elicit a toxic effect. The Zeehan AMP is also an important foraging habitat for black-browed, wandering and shy albatrosses, and great-winged and cape petrels. These seabirds forage over an extensive area and are distributed over a wide geographic range. The areas of dissolved hydrocarbon predicted to meet the moderate threshold and entrained hydrocarbon predicted to meet the high threshold are relatively small compared to the Bass Strait and Otway region. It is these small areas where sub-lethal and toxic effects to birds may occur. There is a low probability that seabirds would be feeding exclusively or predominantly

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				on fish found in these areas of higher hydrocarbon thresholds, meaning there is low probability of seabirds themselves experiencing sub-lethal or toxic impacts as a result of consuming hydrocarbon-tainted fish. Consequently, the potential consequence to these AMPs are considered to be Moderate (2), as they could be expected to result in minor short-term impacts to an area of recognised conservation value.
	State Marine Protected Areas	Change in values Changes to the functions, interests or activities of other users	The Twelve Apostles Marine National Park has a 1% probability of being exposed to entrained hydrocarbons at the moderate threshold within the upper 0 -10 m of the water column for up to 6.75 hours. The Arches and Mushroom Reef Marine Sanctuaries may be exposed to entrained hydrocarbons at the low threshold within the upper 0-10 m of the water column for up to 35.5 hours (2% probability) and 8 hours (1 % probability), respectively.	As impacts are only predicted within 0 – 10 m of the water column values such as the wreck of the Loch Ard, underwater limestone formations of arches and canyons, diverse range of encrusting invertebrates and dive sites are not predicted to be impacted. The unique limestone rock formations, including the Twelve Apostles, marine habitats representative of the Otway marine bioregion and indigenous culture based on spiritual connection to sea country and a history of marine resource use are unlikely to be impacted by entrained hydrocarbons at the low threshold. Consequently, the potential consequence to the Twelve Apostles Marine National Park and The Arches and Mushroom Reef Marine Sanctuaries is considered to be Moderate (2), as they could be expected to result in minor short-term impacts to an area of recognised conservation value.
	Key Ecological Features	Change in ecosystem dynamics	The West Tasmanian Canyons KEF may be exposed to entrained hydrocarbons at the low threshold within the upper 0 -10 m of the water column for up to 59.25 hours. The Bonney Coast Upwelling KEF may be exposed to entrained hydrocarbons at low threshold within the upper 0-10 m of the water column for up to 67 hours.	The West Tasmanian Canyons KEF is in water depths > 70 m and thus impacts from in-water hydrocarbons are not predicted. No impacts from the low threshold of in-water hydrocarbons are predicted to the Bonney Coast Upwelling KEF.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			No KEF was predicted to be contacted by dissolved hydrocarbons.	
Benthic Habitat	Algae	Change in habitat	Video surveys confirmed the presence of high density macroalgae dominated epibenthos in waters shallower than 20 m, however, communities are typically limited to intertidal and shallow subtidal rocky substrates (Section 4.4.3). In-water exposure (dissolved and entrained hydrocarbons) is only predicted to occur within the 0 -10 m of the water column. Dissolved hydrocarbons in the upper 0–10 m of the water column at the moderate threshold could impact algae found within Victorian waters where waters may be shallower than 10 m. Entrained hydrocarbons in the upper 0–10 m of the water column at the moderate threshold could impact algae found within Victorian waters to the west of Cape Otway where waters may be shallower than 10 m.	Reported toxic responses to oils have included a variety of physiological changes to enzyme systems, photosynthesis, respiration, and nucleic acid synthesis (Lewis & Pryor 2013). A review of field studies conducted after spill events by Connell et al (1981) indicated a high degree of variability in the level of impact, but in all instances, the algae appeared to be able to recover rapidly from even very heavy oiling. Given the restricted range of exposure (shallow nearshore and intertidal waters only) and only the predicted moderate threshold concentrations of dissolved hydrocarbons predicted in shallow waters, any impact to algae is not expected to result in long-term or irreversible damage. Consequently, the potential consequence to algae are considered to be Minor (1), as they could be expected to result in localised low-level impacts.
	Soft Coral	Change in habitat	Corals do not occur as a dominant habitat type within the Planning Area. However, their presence has been recorded around areas such as Twelve Apostles Marine Park and Cape Otway where low threshold concentrations of entrained hydrocarbons are predicted to be reached.	Exposure of entrained hydrocarbons to shallow subtidal corals has the potential to result in lethal or sublethal toxic effects, resulting in acute impacts or death at moderate to high exposure thresholds (Shigenaka 2001). Contact with corals may lead to reduced growth rates, tissue decomposition, and poor resistance and mortality of sections of reef (NOAA 2010). However, given the lack of coral reef formations, and the sporadic cover of hard or soft corals in mixed nearshore reef communities along the Otway coast, such impacts are considered to be limited to isolated corals. Consequently, the potential consequence to soft corals are considered to be Minor (1), as they

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				could be expected to result in localised low-level impacts.
	Seagrass	Change in habitat	Seagrass may be present within the area predicted to be exposed to in-water hydrocarbons as seagrass is known to occur within Twelve Apostles Marine Park which has the potential to be exposure to entrained hydrocarbons at the moderate threshold.	There is the potential that entrained in-water hydrocarbon exposure could result in sub-lethal impacts from smothering, more so than lethal impacts, possibly because much of seagrasses' biomass is underground in their rhizomes (Zieman et al., 1984). Potential impacts are considered to be Moderate (2), as they could be expected to result in minor short-term impacts to an area of recognised conservation value.
Marine fauna	Plankton	Injury/ Mortality to fauna	Plankton are likely to be exposed to in-water hydrocarbons. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest.	Relatively low concentrations of hydrocarbon are toxic to both plankton including zooplankton and ichthyoplankton (fish eggs and larvae). Plankton risk exposure through ingestion, inhalation and dermal contact. Impacts would predominantly result from exposure to dissolved fractions, as larval fish and plankton are pelagic, and are moved by seawater currents. Potential impacts would largely be restricted to planktonic communities, which would be expected to recover rapidly following a hydrocarbon spill. Plankton are numerous and widespread but do act as the basis for the marine food web, meaning that an oil spill in any one location is unlikely to have long-lasting impacts on plankton populations at a regional level. Once background water quality conditions have re-established, the plankton community may take weeks to months to recover (ITOPF, 2011a), allowing for seasonal influences on the assemblage characteristics. Additionally, with the elevated nutrient loading expected during seasonal upwelling events within the Otway region (November to April), plankton are likely to recover more rapidly than when upwelling of nutrient-rich waters is less prevalent. the potential consequence to plankton are considered to be Minor (1), as they could be expected to

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				result in low-level short-term and recoverable impacts.
	Marine invertebrates	Injury/ Mortality to fauna	In-water invertebrates of value have been identified to include squid, crustaceans (rock lobster, crabs) and molluscs (scallops, abalone). Impact by direct contact of in-water hydrocarbons to benthic species in the deeper areas of potential exposure are not predicted. Species located in shallow nearshore or intertidal waters may be exposed to in-water hydrocarbons low thresholds. Several commercial fisheries for marine invertebrates are within the area predicted to be exposed to moderate levels of entrained in-water hydrocarbons.	Acute or chronic exposure through contact and/or ingestion can result in toxicological risks. Larval or juvenile forms of invertebrates may be more prone to impacts (Suchanek, 1993). Localised impacts to larval stages may occur which could impact on population recruitment that year. Tainting of recreation or commercial species is considered unlikely to occur given exposure is limited to entrained hydrocarbons, however if it did it is expected to be localised and low level with recovery expected. Consequently, the potential consequence to invertebrates, including commercially fished invertebrates are considered to be Moderate (2), as they could be expected to result in localised and minor short-term impacts to species of value.
	Fish (including eels) [**PC294**]	Injury/ Mortality to fauna	Entrained hydrocarbon droplets can physically affect fish exposed for an extended duration (weeks to months). Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest. Several fish communities in these areas are demersal and therefore more prevalent towards the seabed, which is not likely to be exposed). Therefore, any impacts are expected to be highly localised. The Australian grayling spends most of its life in fresh water, with parts of the larval or juvenile stages spent in coastal marine waters, therefore it is not expected to be present in offshore waters in large numbers. There is a known distribution and foraging BIA for the white	Pelagic free-swimming fish and sharks are unlikely to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons in water are not expected to be sufficient to cause harm (ITOPF, 2011a). Subsurface hydrocarbons could potentially result in acute exposure to marine biota such as juvenile fish, larvae, and planktonic organisms, although impacts are not expected cause population-level impacts. Environmental monitoring of pelagic and demersal fishes immediately following the Montara oil spill indicated that fish were exposed to hydrocarbons, although no adverse effects were detected (Gagnon and Rawson 2012, 2011). Further sampling and testing over time indicated that fish captured in close proximity to the Montara wellhead were comparable to those collected from reference sites (Gagnon and Rawson 2012, 2011). [**PC282**] Consequently, the potential consequence to fish, including those

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			shark in the area of exposure, however, it is not expected that this species spends a large amount of time close to the surface where thresholds may be highest.	commercially fished, are considered to be Moderate, as they could be expected to result in localised low-level short-term impacts to species of value. Impacts on fish eggs and larvae entrained in the upper water column are not expected to be significant given the temporary nature of the resulting change in water quality. As egg/larvae dispersal is widely distributed in the upper layers of the water column it is expected that current induced drift will rapidly replace any oil affected populations. Consequently, the potential consequence to eggs/larva are considered to be Minor (1), as they could be expected to result in localised low-level short-term impacts.
	Pinnipeds (seals and sea lions)	Injury/ Mortality to fauna Change in fauna behaviour	Australian and New Zealand fur-seals may occur within the area of exposure There are no identified BIAs for seals or sea lions within the area of exposure. No known breeding colonies of Australian or New Zealand fur-seals are exposed to moderate dissolved or high entrained exposure thresholds. Given the mobility of pinnipeds, there may be small numbers of seals in the areas predicted to be temporarily exposed to moderate dissolved or high entrained exposure thresholds in the water column, noting that in-water exposure (dissolved or entrained) is only predicted to occur within the upper 0 - 10 m of the water column.	Exposure to moderate dissolved or high entrained exposure thresholds in the water column or consumption of prey affected by the oil may cause sub-lethal impacts to pinnipeds. Due to the temporary and localised nature of the spill, pinnipeds widespread nature, the low-level exposure zones and rapid loss of the volatile components of MDO in choppy and windy seas (such as that of the area exposed), the potential consequence to pinnipeds are considered to be Moderate (2), as they could be expected to result in localised and minor short-term impacts to species of recognised conservation value.
	Cetaceans (whales and dolphins)	Injury/ Mortality to fauna Change in fauna behaviour	Several threatened, migratory and/or listed marine cetacean species have the potential to be migrating or foraging within the area predicted to be exposed to in-water hydrocarbons.	Cetacean exposure to entrained hydrocarbons can result in physical coating as well as ingestion (Geraci and St Aubin, 1988; Deepwater Horizon Natural Resource Damage Assessment Trustees 2016). Such impacts are associated with 'fresh'

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			BIAs for foraging for pygmy blue whales and the migration BIA for southern right whales are within the area predicted to be exposed to moderate dissolved or high entrained exposure thresholds in the water column, noting that in-water exposure (dissolved or entrained) is only predicted to occur within the upper 0-10 m of the water column.	hydrocarbon; the risk of impact declines rapidly as the MDO weathers. The potential for impacts to cetaceans and dolphins would be limited to a relatively short period following the release and would need to coincide with seasonal foraging or aggregation event to result in exposure to a large number of individuals, as may be the case during seasonal upwelling events within the Otway region. However, such exposure is not anticipated to result in long-term population viability effects. A proportion of the foraging or distributed population of whales could be affected in the relatively localised area and water depth of the total foraging BIA for pygmy blue whales and migration BIA for southern right whales. There is the potential for serious impact on valued species or habitats with a consequence considered to be Serious (3).
	Birds [**PC284**]	Injury/ Mortality to fauna Change in fauna behaviour	The extent of in-water hydrocarbons at the moderate threshold from a MDO release overlaps foraging BIAs for several seabird species, including various albatross species (i.e. antipodean, black-browed, Bullers, Campbell, Indian-yellow-nosed, shy and wandering), petrels (common-diving and white-faced storm) and shearwaters (short-tailed and wedge-tailed).	Seabirds could be impacted by in-water hydrocarbon exposure directly (i.e., whilst diving through the water column foraging) or indirectly (i.e. by consuming hydrocarbon-tainted fish, resulting in sub-lethal or toxic impacts). As seabirds are top order predators, any impact on other marine life (e.g., pelagic fish) from hydrocarbon exposure may disrupt and limit food supply both for the maintenance of adults and the provisioning of young. Furthermore, the foraging BIAs are typically over relatively extensive areas, therefore, impacts are not anticipated at a population level due to the localised and temporary exposure of moderate levels of surface hydrocarbons. Acute or chronic toxicity impacts (death or long-term poor health) to seabirds is possible, however, the presence of birds within areas exposed to moderate threshold levels is expected to be limited, due to the transitory nature of foraging

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				individuals, and given the absence of offshore aggregation areas in the area. However, due to the anticipated hydrocarbon weathering and fate of the MDO, the majority is expected to have either evaporated or entrained during that time. Modelling predicted between approximately 40% of the volume to evaporate and up to approximately 60% to entrain within the first 24 hours, depending on the wind conditions (RPS 2023). Furthermore, tidal and wave action within the area is anticipated to breakdown any shoreline hydrocarbons. Consequently, the potential consequence to seabirds and shorebirds is considered to be Moderate (2), as they could be expected to result in minor, short-term impact to species of recognised conservation value.
Socio-economic	Commercial and recreational fisheries	Change in ecosystem dynamics Changes to the functions, interests or activities of other users	In-water exposure to hydrocarbons may result in a reduction in commercially targeted marine species, resulting in impacts to commercial fishing and aquaculture. Actual or potential contamination of seafood can affect commercial and recreational fishing and can impact seafood markets long after any actual risk to seafood from a spill has subsided (NOAA, 2002) which can have economic impacts to the industry. Several commercial fisheries operate in the planning area and overlap the spatial extent of the water column hydrocarbon predictions	Any acute impacts are expected to be limited to small numbers of juvenile fish, larvae, and planktonic organisms, which are not expected to affect population viability or recruitment. Impacts from entrained exposure are unlikely to manifest at a fish population viability level. Any exclusion zone established would be limited to the immediate vicinity of the release point, and due to the rapid weathering of MDO would only be in place 1-3 days after release, therefore physical displacement to vessels is unlikely to be a significant impact. Consequently, the potential consequence to commercial and recreational fisheries are considered to be Moderate (2), as they could be expected to result in localised minor short-term impacts.
	Recreation and tourism	Change in ecosystem dynamics Changes to the functions, interests or activities of other users	Tourism and recreation are also linked to the presence of marine fauna (e.g. whales), particular habitats and locations for recreational fishing. The area between	Any impact to receptors that provide nature-based tourism features (e.g. whales) may cause a subsequent negative impact to recreation and tourism activities.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			Cape Otway and Port Campbell is frequented by tourists. It is a remote stretch of coastline dominated by cliffs with remote beaches subject to the high energy wave action. Access to the entire coastline is via a 7 to 8-day walking track from Apollo Bay ending at the Twelve Apostles. Recreation is also linked to the presence of marine fauna and direct impacts to marine fauna such as whales, birds, and pinnipeds can result in indirect impacts to recreational values. It is important to note that the impact from a public perception perspective may be even more conservative. This may deter tourists and locals from undertaking recreational activities. If this occurs, the attraction is temporarily closed, economic losses to the business are likely to eventuate. The extent of these losses would be dependent on how long the attraction remains closed.	Any impact to receptors that provide nature-based tourism features (e.g. fish and cetaceans) may cause a subsequent negative impact to recreation and tourism activities. However, impacts would be localised and for a relatively short duration. Consequently, the potential consequence to recreation and tourism are considered to be Moderate (2), as they could be expected to result in localised minor short-term impacts.
	Seaweed Industry	Change in ecosystem dynamics Changes to the functions, interests or activities of other users	In-water exposure to entrained MDO may result in a reduction in commercially targeted seaweed species. Areas along the west side of King Island where bull kelp is collected may be exposed to entrained hydrocarbons at the moderate threshold within the upper 0 -10 m of the water column.	Experiments verified the susceptibility of *Nereocystis luetkeana* (bull kelp – North America) tissue to the direct exposure to several petroleum types. Antrim et al (1995) showed that petroleum treatments resulted in visible tissue damage, with a distinct bleached line being the most visible indication of plant contact with the petroleum. Moderate to heavy colour loss, which was generally followed by rapid decay of tissue, was most pronounced in 24-hour exposures to unweathered and weathered MDO. The study did not look at how this would affect the productivity of bull kelp. However, given the low levels of entrained hydrocarbons predicted it is unlikely to be a significant impact on seaweed collection and associated

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				income. The relatively low volume means there may be short-term localised consequences, which are ranked as Moderate (2).
First Nations	Sea Country Native Title Indigenous Protected Area	Change in aesthetic value Changes to the functions, interests or activities of other users	In-water exposure to hydrocarbons is predicted along the Victorian and Tasmanian coastal waters within the planning area which is Sea Country for a number of First Nations groups and is adjacent to the Eastern Maar Native Title claim.	Section 4 details the connection First Nations people have to Sea Country which could be potentially impacted by in-water exposure to hydrocarbons. The relatively low volume means there may be short-term and localised consequences. Although no long-term or permanent changes to marine environment are expected the short-term contamination of Sea Country may result in impacts associated at a spiritual level (i.e. rituals, songlines, culturally important species) and could affect culturally important activities such as mutton birding or affect culturally important species including eels and whales. The potential short-term and localised consequences are ranked as Moderate (2). [**PC274**] Refer also to: fish (including eels) and cetaceans (whales) exposure and consequence evaluations above.

7.4.4.2 Condensate Exposure

Sea Surface Exposure

Table 7-23: Environmental Impact Summary from Floating Oil Exposure (Condensate Spill)

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
Marine fauna	Seabirds	Injury / mortality to fauna Change in fauna behaviour	Several listed Threatened, Migratory and/or Listed Marine species have the potential to be rafting, resting, diving or feeding within predicted worst-case extent of exposure to moderate levels of surface hydrocarbons, up to 5.83 km from the northern release location. Surface hydrocarbons are not predicted to reach moderate threshold levels from a loss of well control at the TW1 release location.	When first released, gas condensate has higher toxicity due to the presence of volatile components. Individual birds making contact close to the spill source at the time of the spill (i.e. areas of concentrations >10 g/m^2 up to between 5.83 km from the northern release location) may be impacted however it is unlikely that a large number of birds will be affected. Seabirds exposed to surface hydrocarbons at moderate exposure levels may experience

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			No exposure at the high threshold is predicted from either to extend only 1 km from the release location. Foraging BIAs for several albatross species, the short-tailed shearwater, and common diving-petrel overlap the area predicted to be exposed to moderate thresholds of surface oil from the northern release location. The release location resides within the boundaries of all of these BIAs.	acute or chronic toxicity impacts, however the area of contact is relatively localised and the presence of birds is expected to be limited to foraging individuals of a transitory nature, given the absence of offshore aggregation areas and the large foraging BIAs. Consequently, the potential consequence is considered to be Serious (3), as they could be expected to result in serious impact on valued species or habitat.
	Marine reptiles	Injury / mortality to fauna Change in fauna behaviour	There may be transiting marine turtles within up to 5.83 km of the northern release locations predicted to be exposed to moderate levels of surface hydrocarbons. However, there are no BIAs or habitat critical to the survival of the species within the area predicted to be exposed to moderate thresholds of surface oil. No exposure at the high threshold is predicted from either release location.	Marine turtles are vulnerable to the effects of oil at all life stages. Marine turtles can be exposed to surface oil externally (i.e. swimming through oil slicks) or internally (i.e. swallowing the oil). Ingested oil can harm internal organs and digestive function. Oil on their bodies can cause skin irritation and affect breathing. The number of marine turtles that may be exposed to surface condensate is expected to be low as there are no BIAs or habitat critical to the survival of the species present and the localised (up to 5.83 km from the northern release location) extent of exposure above the 10 g/m^2 threshold; however, turtles may be transient within the area. Therefore, potential impact would be limited to individuals, with population impacts not anticipated. Consequently, the potential consequence is considered to be Moderate (2), as they could be expected to result in localised and minor short-term impacts to species of value.
	Pinnipeds (seals and sea-lions)	Injury / mortality to fauna Change in fauna behaviour	The Australian and New Zealand fur-seals may occur within 5.83 km of the northern release location predicted to be exposed to moderate levels of surface hydrocarbons. No BIAs, breading colonies or haul outs	Exposure to surface oil can result in skin and eye irritations and disruptions to thermal regulation. Fur seals are particularly vulnerable to hypothermia from oiling of their fur – however the characteristics of Thylacine

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			areas within the area predicted to be exposed to moderate thresholds of surface oil.	condensate mean this is not likely. The number of pinnipeds exposed is expected to be low, with population impacts not anticipated. The potential consequence is considered to be Moderate (2) as they could be expected to result in short term effects and some impact on valued species or habitat.
	Cetaceans (whales)	Injury / mortality to fauna Change in fauna behaviour	Several threatened, migratory and/or listed cetacean species have the potential to be foraging within 5.83 km of the northern release location predicted to be exposed to moderate levels of surface hydrocarbons. The area of predicted moderate exposure overlaps a foraging BIA for pygmy blue whales and the migration BIA for southern right whale. The release location resides within the boundaries of these BIAs.	Geraci (1988) found little evidence of cetacean mortality from hydrocarbon spills; however, some behaviour disturbance (including avoidance of the area) may occur. However, observations during spills have recorded whales and dolphins traveling through and feeding in oil slicks. During the Deepwater Horizon spill cetaceans were routinely seen swimming in surface slicks offshore (and nearshore) (Aichinger Dias et al. 2017). Cetaceans observed during the spill response for the Montara oil spill included oceanic species such as false killer whales, bottlenose dolphins, spotted dolphins and spinner dolphins (Watson et al. 2009). [**PC282**] Cetaceans exposed to surface hydrocarbons above moderate exposure thresholds may suffer external oiling, ingestion of oil and inhalation of toxic vapours (Deepwater Horizon Natural Resource Damage Assessment Trustees 2016). [**PC282**] In addition, active avoidance of an area may displace individuals or aggregations from important habitat, such as foraging. If whales are foraging at the time of the spill, a greater number of individuals may be present in the plume, however due to the small area of the surface exposure above the impact threshold (5.83 km from release location), this is not likely. Given this is a

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				relatively small area of the total foraging BIA for pygmy blue whales and migration BIA for southern right whales, the risk of displacement to whales is considered low. There is potential for interaction with southern right whales given that the activity window may overlap with the northern migration period of May-June, the peak breeding (July-August) and southern migration period (September-November). The activity window timing may also overlap with the blue whale season for migration and foraging. Visual and acoustic surveys suggest that blue whales are present in the Otway region between November to June, peaking in February and March. As such in the event of a spill potential hydrocarbon exposure could possibly affect blue or other foraging whale species. Consequently, the potential consequence is considered to be Serious (3), as they could be expected to result in serious impact on valued species or habitat.
	Cetaceans (dolphins)	Injury / mortality to fauna Change in fauna behaviour	There may be dolphins within 5.83 km of the northern release location predicted to be exposed to moderate levels of surface hydrocarbons However, it is not identified as critical habitat, and there are no spatially defined aggregations within the area predicted to be exposed to moderate thresholds of surface oil.	Dolphins surface to breathe air and may inhale hydrocarbon vapours or be directly exposed to dermal contact with surface hydrocarbons. Direct contact with oil can result in direct impacts to the animal, due to toxic effects if ingested, damage to lungs when inhaled at the surface, and damage to the skin and associated functions such as thermoregulation (AMSA 2010). Dolphins are highly mobile and are considered to have some ability to detect and avoid oil slicks (Geraci and St. Aubin, 1988; Smith et al, 1983). Direct surface hydrocarbon contact may pose little problem to dolphins due to their extraordinarily thick epidermal layer which is effective as a barrier to the substances

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				found in hydrocarbons (Geraci and St. Aubin, 1990; Vol kman et al., 1994). The number of dolphins exposed is expected to be low, with population impacts not anticipated. Due to the rapid weathering of condensate, the potential exposure to surface hydrocarbons is relatively short, with the majority of surface condensate evaporating or entraining within 24 hours (RPS, 2024). Consequently, the potential consequence to dolphins are considered to be Moderate (2), as they could be expected to result in localised minor short-term impacts to species of recognised conservation value.
Socio-economic	Petroleum Exploration and Production	Displacement of other marine users	There are no oil and gas platforms, or activities within 5.83 km of the northern release location predicted to be exposed to moderate levels of surface hydrocarbons	No impact predicted as there are no non-Beach oil and gas platforms located within the area predicted to be exposed to surface hydrocarbons.
	Shipping	Displacement of other marine users	Shipping may occur within 5.83 km of the northern release location predicted to be exposed to moderate levels of surface hydrocarbons	Vessels may be present in the area where moderate levels of sea surface oil are predicted, however, due to small area of exposure (5.83 km) no impact is predicted.
	Tourism and recreation (including recreational diving and recreational fisheries)	Change in aesthetic value Changes to the functions, interests or activities of other users	Marine pollution can result in reduced visual aesthetic. The modelling predicts visible surface sheen at the low threshold up to approximately 54 km from the northern release location or 24.5 km from the TW1 release location. This oil may be visible as a rainbow sheen on the sea surface during calm conditions.	Visible surface hydrocarbons (i.e. a rainbow sheen) have the potential to reduce the visual amenity of the area for tourism and discourage recreational activities. However, the distance from shore means there may be minor consequences and some impact, which are ranked as Moderate (2).
	Commercial fisheries	Displacement of other marine users	Commercial fishing may occur within 5.83 km of the release location predicted to be exposed to moderate levels of surface hydrocarbons	Commercial fishing vessels may be present in the area where moderate levels of sea surface oil are predicted, however, due to the timeframes of presence given the LOWC scenarios a Moderate (2) impact is assigned.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
First Nations	Sea Country	Change in aesthetic value Changes to the functions, interests or activities of other users	Marine pollution can result in reduced visual aesthetic. The modelling predicts visible surface sheen at the low threshold up to approximately 54 km from the northern release location or 24.5 km from the TW1 release location. This oil may be visible as a rainbow sheen on the sea surface during calm conditions.	Visible surface hydrocarbons (i.e. a rainbow sheen) have the potential to reduce the visual amenity of the areas of Sea Country. The distance from shore means there may be minor consequences and some impact. Beach understands that First Nations people are linked to the marine environment and may be affected by a change in the environment. Although no long term or permanent changes to marine environment are expected it is considered that the visual presence of floating oil may impact Sea Country at a spiritual level (i.e. rituals, songlines, culturally important species) and could affect culturally important activities such as mutton birding or affect culturally important species including whales. There may be short-term and localised consequences, which are ranked as Moderate (2). [**PC274**] Refer also to cetaceans (whales) exposure and consequence evaluation above.

Shoreline Exposure

Table 7-24: Environmental Impact Summary from Shoreline Oil Exposure (Condensate Spill)

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
Conservation Values and Sensitivities	National Heritage Places	Change in aesthetic value Changes to the functions, interests or activities of other users	Marine pollution can result in reduced visual aesthetic. The modelling predicts potential shoreline exposure at the low and moderate threshold at Great Ocean Road and Scenic Environs.	Visible shoreline hydrocarbons have the potential to reduce the visual amenity of the area for tourism and discourage recreational activities. The predicted minimum time for oil at the low threshold to reach the Otway coast where the Great Ocean Road and Scenic Environs is located was 3.7 days. The condensate will likely be dissipated by that time. The relatively short area of shoreline and low volume means there may be short-term and

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				localised consequences, which are ranked as Moderate (2).
	Nationally Important Wetlands	Change in aesthetic value Change in ecosystem dynamics Changes to the functions, interests or activities of other users	Marine pollution can result in reduced visual aesthetic. The modelling predicts potential shoreline exposure at the low threshold at Aire River/Lower Aire River and Princetown Wetlands (Section 4.2.7).	Visible shoreline hydrocarbons have the potential to reduce the visual amenity of the area for tourism and discourage recreational activities within protected areas. The predicted minimum time for oil to reach the shoreline adjacent to the River/Lower Aire River and Princetown Wetlands is 3.7 days and it is likely to have dissipated during that time. Cape Otway is exposed to substantial wave action that would further breakdown any shoreline hydrocarbons. The Aire River/Lower Aire River Wetlands consist of three shallow freshwater lakes, brackish to saline marshes and an estuary on the Aire River floodplain. Depending on where the shoreline contact occurs there is a potential for shoreline oil to move into the estuary and wetlands at low concentrations which are not predicted to impact the aesthetic and ecological value of the wetlands. The Princetown Wetlands and upstream of the Gellibrand River mouth at Princetown Beach. Depending on where the shoreline contact occurs there is a potential for shoreline oil to move into the estuary and wetlands at low concentrations which are not predicted to impact the aesthetic and ecological value of the wetlands. The relatively short duration and low volume means there may be short-term and localised consequences, which are ranked as Moderate (2).
	State Terrestrial Protected Area	Change in aesthetic value Change in ecosystem dynamics	Marine pollution can result in reduced visual aesthetic. The modelling predicts potential shoreline exposure at the low and moderate thresholds at	Visible shoreline hydrocarbons have the potential to reduce the visual amenity of the area for tourism and discourage recreational activities within

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
		Changes to the functions, interests or activities of other users	Great Otway National Park, Port Campbell Southern Wilsons Promontory, Wilsons Promontory and Wilson Promontory Islands National Parks, and the following on the west side of King Island; Cape Wickham Conservation Area, Cataraqui Point Conservation Area, Porky Beach Conservation Area, Seal Rocks State Reserve, Stokes Point Conservations Area and West Point State Reserve.	protected areas. Seal Rocks on King Island is also a New Zealand fur-seal breeding colony. The predicted minimum time for oil to reach a shoreline is 3.7 days for the Victorian coast. The condensate is likely to have dissipated during that time due to substantial wave action that would further breakdown any shoreline hydrocarbons. The predicted minimum time for oil to reach King Island was 22 days. As above, the condensate it is likely to have dissipated during that time due to substantial wave action that would further breakdown any shoreline hydrocarbons. Consequently, the potential consequence is considered to be Serious (3), as they could be expected to result in serious impact on valued species or habitat.
	Threatened Ecological Communities Saltmarsh	Change in habitat Change in ecosystem dynamics	The modelling predicts potential shoreline exposure at the low , and some isolated moderate, thresholds where saltmarsh communities and the Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community and Subtropical and Temperate Coastal Saltmarsh Threatened Ecological Communities may be present.	Saltmarshes are considered to have a high sensitivity to hydrocarbon exposure. Saltmarsh vegetation offers a large surface area for oil absorption and tends to trap oil. Evidence from case histories and experiments shows that the damage resulting from oiling, and recovery times of oiled marsh vegetation, are very variable. In areas of light to moderate oiling where oil is mainly on perennial vegetation with little penetration of sediment, the shoots of the plants may be killed but recovery can take place from the underground systems. Good recovery commonly occurs within one to two years (IPIECA, 1994). Consequently, the potential consequences to saltmarsh exposed to shoreline hydrocarbons is considered to be Moderate (2), as they could be

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				expected to short-term and localised.
Marine fauna	Pinnipeds (seals and sea lions)	Injury/Mortality to fauna Change in fauna behaviour	The modelling predicts potential shoreline exposure at the low threshold at Seal Rocks on King Island which is a New Zealand fur-seal breeding colony.	Breeding colonies (used to birth and nurse until pups are weaned) are particularly sensitive to hydrocarbon spills (Higgins & Gass, 1993) and have shown to be impacted by oil at the moderate and high thresholds. The predicted minimum time for oil to reach the King Island coastline (such as Seal Rocks) was 22 days for the low threshold. No contact at King Island was predicted for the moderate or high thresholds. This is ranked as Moderate (2) consequence.
	Birds [**PC270**]	Injury/Mortality to fauna Change in fauna behaviour	The modelling predicts potential shoreline exposure at or above the moderate threshold only along the Otway coast from LOWC condensate release at the northern location. No shoreline exposure at, or above, the moderate threshold was predicted for the southern release locations. Several listed Threatened, Migratory and/or listed marine bird species have the potential to be foraging or nesting at these locations. Shorelines exposed at or above moderate hydrocarbon thresholds include a breeding BIA for the wedge-tailed shearwater as well as breeding BIAs and surrounding foraging BIAs for the black-faced cormorant, common diving-petrel, little penguin and short-tailed shearwater.	Shorebird species foraging for invertebrates in intertidal feeding habitats, such as exposed sand and mud flats at lower tides, will be at potential risk of both direct impacts through contamination of individual birds (ingestion or soiling of feathers) and indirect impacts through the contamination of foraging areas that may result in a reduction in available prey items (Clarke 2010). Any direct impact of oil on terrestrial habitats has the potential to contaminate seabirds present at the breeding sites (Clarke 2010). Bird eggs may also be damaged if an oiled adult sits on the nest. Fresh crude was shown to be more toxic than weathered crude, which had a medial lethal dose of 21.3 mg/egg (Clarke 2010). Studies of contamination of duck eggs by small quantities of crude oil, mimicking the effect of oil transfer by parent birds, have been shown to result in mortality of developing embryos (French-McCay 2009). Shoreline accumulation will be concentrated along the high tide mark while the lower/upper parts

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				are often untouched (IPIECA 1995). As breeding activities of shorebirds and seabirds generally occurs above the high tide mark, exposure to hydrocarbons is considered unlikely to occur. However, oiled bird species may track oil into their nests, which may then have subsequent impacts on any eggs present. The little penguin would be the highest-risk species, as they have to traverse through the intertidal area to reach nesting sites. Based on the worst-case scenario, the modelling predicted the maximum probability of shoreline accumulation at, or above, the moderate (100 g/m^2) threshold from a LOWC condensate release at the Northern location at Cape Otway West (34%), followed by Moonlight Head (11%), Point Hicks (10%) and Port Campbell (1%). The minimum time to shore was at Cape Otway West (9 days), followed by Moonlight Head and Port Campbell (both 18 days), then Point Hicks (46 days). Cape Otway West had the maximum peak volume ashore predicted (6.6 m^3), followed by Point Hicks (5.56 m^3), Moonlight Head (4.39 m^3), and Port Campbell (1.76 m^3). The modelling predicted no shoreline accumulation at, or above, the moderate (100 g/m^2) threshold to occur from the southern spill release location. Acute or chronic toxicity impacts (death or long-term poor health) to seabirds and shorebirds is possible, however, with the minimum time for shoreline contact predicted as 9-46 days, potential contamination of nests and eggs from oiled parent bird species is limited to weathered condensate. Also, given the predicted minimum time for oil to reach shorelines within

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				breeding BIAs is 9-46 days. The majority of condensate at sea is likely to have dissipated during that time. The Cape Otway coast is exposed to wave and tidal action that would further breakdown any shoreline hydrocarbons. The limited exposure to shoreline hydrocarbons will prevent potential death or long-term poor health to seabirds and shorebirds over multiple breeding seasons, therefore it is expected that shoreline hydrocarbons will only impact a single breeding season at most. Consequently, the potential consequence is considered to be Serious (3), as they could be expected to result in serious impact on valued species or habitat.
Socio-economic	Coastal settlements Recreation and tourism (including recreational fisheries)	Change in aesthetic value Changes to the functions, interests or activities of other users	Marine pollution can result in reduced visual aesthetic. The modelling predicts shoreline exposure at the low and moderate threshold several local government areas (LGA)	Visible shoreline hydrocarbons have the potential to reduce the visual amenity of the area for tourism and discourage recreational activities. The predicted minimum time for oil at low thresholds to reach any shoreline was 3.7 days (Colac Otway) up to 89 days (Cape Nelson), Majority of the oil is likely to have dissipated during that time due to substantial wave action that would breakdown any shoreline hydrocarbons. The relatively short duration and low volume means there may be short-term and localised consequences, which are ranked as Moderate (2).
	Seaweed industry	Change in ecosystem dynamics Changes to the functions, interests or activities of other users	The modelling predicts potential shoreline exposure at the low threshold in areas along the west side of King Island where bull kelp is collected. No shoreline accumulation at, or above, the moderate threshold was predicted for King Island from either spill release location.	Experiments verified the susceptibility of *Nereocystis luetkeana* (bull kelp – North America) tissue to the direct exposure to several petroleum types. Antrim et al (1995) showed that petroleum treatments resulted in visible tissue damage, with a distinct bleached line being the most visible indication of plant contact with the

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				petroleum. Moderate to heavy colour loss, which was generally followed by rapid decay of tissue, was most pronounced in 24 h exposures to unweathered and weathered MDO. As bull kelp is collected from the shoreline there is a potential for some plants to be affected and not be suitable for collection and processing. However, given the low levels of shoreline oil predicted it is unlikely to be a significant impact on seaweed collection and associated income. The relatively low volume and absence of contact at the moderate threshold indicates that any impact will be short-term and localised consequences to a valued species or habitats, which have been ranked as Serious (3).
First Nations	Sea Country Native Title	Change in aesthetic value Changes to the functions, interests or activities of other users	Marine pollution can result in reduced visual aesthetic. The modelling predicts shoreline exposure at the low threshold within Victorian Traditional Owner areas of Eastern Maar Native Title determination (Tribunal File No. VCD2023/001), Gunditjmara Native Title determination (Tribunal File No. VCD2007/001) and Bunurong Land Council Aboriginal Corporation. [**PC269**] The modelling predicts shoreline exposure at the low threshold on the western side of King Island..	Visible shoreline hydrocarbons have the potential to reduce the visual amenity of Sea Country. The predicted minimum time for oil to reach a shoreline is 3.7 days for the Victorian coast, and 22 days for King Island. Condensate is likely to have dissipated during that time due to substantial wave action that would breakdown any shoreline hydrocarbons. Although no long term or permanent changes to marine environment are expected it is considered that the visual presence of shoreline oil may impact Sea Country at a spiritual level (i.e. rituals, songlines) and could affect culturally important activities such as mutton birding. [**PC274**] The relatively localised extent and low volume means there may be short-term and localised consequences, which are ranked as Moderate (2).

In-Water Exposure

Table 7-25: Environmental Impact Summary from In-Water Oil Exposure (Condensate Spill)

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
Conservation Values and Sensitivities	Australian Marine Parks	Change in values Changes to the functions, interests or activities of other users	Apollo and Zeehan AMPs may be exposed to dissolved in water hydrocarbons at, or above, the low threshold within the upper 0 -10 m of the water column. Apollo and Zeehan AMPs were predicted to be exposed to in water entrained hydrocarbons at, or above, the low threshold within the upper 0 -10 m of the water column.	The Apollo AMP is located in waters 80 m to 120 m deep and thus conservation values such as ecosystems, habitats and communities associated with the Western Bass Strait Shelf Transition and the Bass Strait Shelf Province and associated with the seafloor features and the wreck of the MV City of Rayville are not predicted to be impacted. The conservation value of important migration area for blue, fin, sei and humpback whales is unlikely to be impacted as these whales would be moving through the area and thus unlikely to be exposed to in water hydrocarbons within 0 -10 m of the water column for a substantial period to elicit a toxic effect. The Apollo AMP is an important foraging area for black-browed and shy albatross, Australasian gannet, short-tailed shearwater and crested tern. These seabirds forage over an extensive area and are distributed over a wide geographic range. The areas of dissolved hydrocarbon predicted to meet the moderate or high threshold and entrained hydrocarbon predicted to meet the moderate threshold are relatively small compared to the Bass Strait and Otway region. It is these small areas where sub-lethal and toxic effects to birds may occur. There is a low probability that seabirds would be feeding exclusively or predominantly on fish found in the hydrocarbon exposed area, thus there is low probability of seabirds themselves experiencing sub-lethal or toxic impacts as a result of consuming hydrocarbon-tainted fish. The Zeehan AMP is located in waters 50 m to 3,000 m deep and thus conservation values such as ecosystems, habitats and communities associated with the Tasmania Province, the West Tasmania Transition and the Western Bass Strait Shelf Transition and associated with the seafloor features are not predicted to be impacted. The conservation value of important migration area for blue and humpback

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				whales is unlikely to be impacted as these whales would be moving through the area and thus unlikely to be exposed to in water hydrocarbons within 0 -10 m of the water column for a substantial period to elicit a toxic effect. The Zeehan AMP is also an important foraging habitat for black-browed, wandering and shy albatrosses, and great-winged and cape petrels. These seabirds forage over an extensive area and are distributed over a wide geographic range. The areas of dissolved hydrocarbon predicted to meet the moderate or high threshold and entrained hydrocarbon predicted to meet the moderate threshold are relatively small compared to the Bass Strait and Otway region. It is these small areas where sub-lethal and toxic effects to birds may occur. There is a low probability that seabirds would be feeding exclusively or predominantly on fish found in these areas of hydrocarbon exposure, thus there is low probability of seabirds themselves experiencing sub-lethal or toxic impacts as a result of consuming hydrocarbon-tainted fish. Consequently, the potential consequence is considered to be Serious (3), as they could be expected to result in serious impact on valued species or habitat.
	State Marine Protected Areas	Change in values Changes to the functions, interests or activities of other users	Bunurong and Point Addis were predicted to be exposed to in-water entrained hydrocarbons at high thresholds. Twelve Apostles was predicted to be exposed to in-water dissolved hydrocarbons at high thresholds. Discovery Bay has potential for being impacted at the moderate threshold of in water entrained hydrocarbons. The Arches MS has potential for being impacted at the moderate threshold of in-water dissolved hydrocarbons. Twelve Apostles and , Port Phillip Heads MNPs and Mushroom Reef MS were predicted to be exposed	Impacts to Bunurong Marine National Park values, such as abundant and diverse marine flora and fauna, important coastal habitat for threatened species, recreational activities, cultural places and objects of high traditional significance to indigenous people, and important maritime and heritage values, may be impacted by high threshold levels of entrained hydrocarbons. Point Addis Marine National Park values, such as the diverse invertebrates, underwater scenery, intertidal reefs, recreational activities, and potential traditional use of the area by indigenous people, may be impacted by high thresholds of in-water entrained hydrocarbons. The Twelve Apostles Marine National Park values, such as the wreck of the Loch Ard, underwater limestone formations of arches and canyons, diverse range of

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			above the low threshold of in water entrained and/or dissolved hydrocarbons..	encrusting invertebrates and dive sites are not predicted to be impacted by high thresholds of dissolved hydrocarbons, given impacts are only predicted within 0 – 10 m of the water column. The unique limestone rock formations, including the Twelve Apostles, marine habitats representative of the Otway marine bioregion and indigenous culture based on spiritual connection to sea country and a history of marine resource use, may be impacted by in water hydrocarbons at the high threshold. Consequently, the potential consequence to these State Marine Protected Areas is considered to be Serious (3) as they could be expected to result in localised minor short-term impacts to an area of recognised conservation value.
	Key Ecological Features	Change in ecosystem dynamics	The West Tasmanian Canyons KEF may be exposed to dissolved hydrocarbons at high thresholds and entrained hydrocarbons at the moderate threshold within the upper 0 - 10 m of the water column. Bonney Coast Upwelling KEF may be exposed to entrained hydrocarbons at low thresholds within the upper 0-10m of the water column and entrained hydrocarbons at low thresholds. Upwelling East of Eden was predicted to be exposed to low entrained threshold of in water hydrocarbons.	The West Tasmanian Canyons KEF is in water depths > 70 m and thus impacts from in-water hydrocarbons are not predicted. No impacts from the low threshold of in water hydrocarbons are predicted to the KEFs.
	Threatened Ecological Communities	Change in ecosystem dynamics	The following Threatened Ecological Communities may be exposed to dissolved and entrained hydrocarbons at the low threshold within the upper 0 -10 m of the water column. Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community. Giant Kelp Marine Forests of South East Australia.	Entrained hydrocarbons at the low threshold are not predicted to impact on the ecological function of the Threatened Ecological Communities.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			Subtropical and Temperate Coastal Saltmarsh.	
Benthic Habitat	Algae	Change in habitat	Video surveys confirmed the presence of high density macroalgae dominated epibenthos in waters shallower than 20 m, however, communities are typically limited to intertidal and shallow subtidal rocky substrates (Section 4.4.3). Dissolved hydrocarbons in the upper 0 – 10 m of the water column at the moderate threshold that could impact algae found within Victorian waters where waters may be shallower than 10 m. Entrained hydrocarbons in the upper 0 – 10 m of the water column at the high threshold that could impact algae are not predicted in Tasmanian waters or Victorian waters where waters may be shallower than 10 m.	Reported toxic responses to oils have included a variety of physiological changes to enzyme systems, photosynthesis, respiration, and nucleic acid synthesis (Lewis & Pryor 2013). A review of field studies conducted after spill events by Connell et al (1981) indicated a high degree of variability in the level of impact, but in all instances, the algae appeared to be able to recover rapidly from even very heavy oiling. Given the restricted range of exposure (shallow nearshore and intertidal waters only) and only the predicted moderate threshold concentrations of dissolved hydrocarbons predicted in shallow waters, any impact to algae is not expected to result in long-term or irreversible damage. Consequently, the potential consequence to algae are considered to be Minor (1), as they could be expected to result in localised low-level impacts.
	Soft Coral	Change in habitat	Corals do not occur as a dominant habitat type within the planning area, however their presence has been recorded around areas such as Wilsons Promontory National Park and Cape Otway where low threshold concentrations of dissolved or entrained hydrocarbons are predicted.	Exposure of entrained hydrocarbons to shallow subtidal corals has the potential to result in lethal or sublethal toxic effects, resulting in acute impacts or death at moderate to high exposure thresholds (Shigenaka, 2001). Contact with corals may lead to reduced growth rates, tissue decomposition, and poor resistance and mortality of sections of reef (NOAA, 2010). However, given the lack of coral reef formations, and the sporadic cover of hard or soft corals in mixed nearshore reef communities along the Otway coast, such impacts are considered to be limited to isolated corals. Also, only low exposure thresholds are predicted at known coral habitat sites. Consequently, the potential consequence to algae are considered to be Minor (1), as they could be expected to result in localised low-level impacts.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
	Seagrass	Change in habitat	In-water exposure (dissolved or entrained) is only predicted to occur within the upper 0 – 10 m of the water column; therefore, benthic habitat within intertidal or shallow nearshore waters has the potential to be exposed. Note that the greater wave action and water column mixing within the nearshore environment will also result in rapid weathering of the condensate. Seagrass may be present within the area predicted to be exposed to in-water hydrocarbons (e.g. seagrass is known to occur within Twelve Apostles Marine Park, and areas around Warrnambool) Exposure in nearshore and intertidal areas is predicted to only be at a low threshold for dissolved and entrained hydrocarbons.	There is the potential that exposure could result in sub-lethal impacts, more so than lethal impacts, possibly because much of seagrasses' biomass is underground in their rhizomes (Zieman et al., 1984). Exposure also can take place via uptake of hydrocarbons through plant membranes and seeds may be affected by contact with oil contained within sediments (NRDA 2012). When seagrass leaves are exposed to petroleum oil, sub-lethal quantities of the soluble fraction can be incorporated into the tissue, causing a reduction in tolerance to other stress factors (Zieman et al. 1984). The toxic components of petroleum oils are thought to be the PAH, which are lipophilic and therefore able to pass through lipid membranes and tend to accumulate in the thylakoid membranes of chloroplasts (Ren et al. 1994). Susceptibility of seagrasses to hydrocarbon spills will depend largely on distribution, with deeper communities protected from oiling under all but the most extreme weather conditions. Shallow seagrasses are more likely to be affected by dispersed oil droplets. Given the restricted range of exposure (shallow nearshore and intertidal waters only) and the predicted low concentrations of hydrocarbons predicted in these waters, any impact to seagrass is not expected to result in long-term or irreversible damage. Consequently, the potential consequence to seagrass are considered to be Moderate (2), as they could be expected to result in localised minor short-term impacts to habitat of recognised conservation value.
Marine fauna	Plankton	Injury / mortality to fauna	Plankton are likely to be exposed to in-water hydrocarbons within the upper 0 – 10 m of the water column. Effects will be greatest in the area close to the spill source where hydrocarbon concentrations are likely to be highest.	Relatively low concentrations of hydrocarbon are toxic to both plankton including zooplankton and ichthyoplankton (fish eggs and larvae). Plankton risk exposure through ingestion, inhalation, and dermal contact. Impacts would predominantly result from exposure to dissolved fractions, as larval fish and plankton are pelagic, and are moved by seawater currents. Potential impacts would largely be restricted to planktonic communities, which would be

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				expected to recover rapidly following a hydrocarbon spill. Plankton are numerous and widespread but do act as the basis for the marine food web, meaning that an oil spill in any one location is unlikely to have long-lasting impacts on plankton populations at a regional level. Once background water quality conditions have re-established, the plankton community may take weeks to months to recover (ITOPF, 2011a), allowing for seasonal influences on the assemblage characteristics. Additionally, with the elevated nutrient loading expected during seasonal upwelling events within the Otway region (November to April), plankton are likely to recover more rapidly than when upwelling of nutrient-rich waters is less prevalent. Consequently, given the limited area exposed by moderate levels of dissolved hydrocarbons, the potential consequence to plankton are considered to be Minor (1), as they could be expected to result in localised low-level short-term and recoverable impacts.
	Marine invertebrates	Injury / mortality to fauna	In-water invertebrates of value have been identified to include squid, crustaceans (rock lobster, crabs) and molluscs (scallops, abalone). Impact by direct contact of in-water hydrocarbons to benthic species in the deeper areas of potential exposure are not predicted as in-water exposure (dissolved or entrained) is only predicted to occur in the upper 0 – 10 m of the water column. Species located in shallow nearshore or intertidal waters may be exposed to in-water hydrocarbons low thresholds. Several commercial fisheries for marine invertebrates are within the area predicted to be exposed to moderate levels of entrained in-water hydrocarbons.	Acute or chronic exposure through contact and/or ingestion can result in toxicological risks. Larval or juvenile forms of invertebrates may be more prone to impacts (Suchanek, 1993). Localised impacts to larval stages may occur which could impact on population recruitment that year. Tainting of recreation or commercial species is considered unlikely to occur given exposure is limited to entrained hydrocarbons, however if it did it is expected to be localised and low level with recovery expected. Consequently, the potential consequence to invertebrates, including commercially fished invertebrates are considered to be Moderate (2) as they could be expected to result in localised short-term impacts to species of value.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
	Fish (including eels) [**PC294**]	Injury / mortality to fauna	In-water exposure (dissolved or entrained) is only predicted to occur in the upper 0 – 10 m of the water column the surface layers of the water column. Several fish communities in these areas are demersal and therefore more prevalent towards the seabed, as such, exposure to these species is not expected to occur. Any fish or shark species within the surface layers of the water column, may come into contact with the area of predicted exposure for in-water hydrocarbons. The Australian grayling spends most of its life in fresh water, with parts of the larval or juvenile stages spent in coastal marine waters, therefore it is not expected to be present in offshore waters in large numbers. There is distribution and foraging BIAs for the white shark are predicted to be overlapped by the hydrocarbon exposure, however, it is not expected that this species spends a large amount of time close to the surface where thresholds may be highest.	Pelagic free-swimming fish and sharks are unlikely to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons in water are not expected to be sufficient to cause harm (ITOPF, 2010). Subsurface hydrocarbons could potentially result in acute exposure to marine biota such as juvenile fish, larvae, and planktonic organisms, although impacts are not expected cause population-level impacts. Environmental monitoring of pelagic and demersal fishes immediately following the Montara oil spill indicated that fish were exposed to hydrocarbons, although no adverse effects were detected (Gagnon and Rawson 2012, 2011). Further sampling and testing over time indicated that fish captured in close proximity to the Montara wellhead were comparable to those collected from reference sites (Gagnon and Rawson 2012, 2011). [**PC282**] Consequently, the potential consequence to fish, including those commercially fished, are considered to be Moderate, as they could be expected to result in localised low-level short-term impacts to species of value. Impacts on eggs and larvae entrained in the upper water column are not expected to be significant given the temporary period of water quality impairment, and the limited geographical extent of the spill. As egg/larvae dispersal is extensive in the upper layers of the water column and it is expected that current induced drift will rapidly replace any oil affected populations. Impacts are assessed as temporary and localised, and therefore considered to be Moderate (2)
	Pinnipeds (seals and sea-lions)	Injury / mortality to fauna Change in fauna behaviour	Australian and New Zealand fur-seals may occur within the area of exposure. There are no identified BIAs for seals or sea lions within the area of exposure. No known breeding colonies of Australian or New Zealand fur-seals are exposed to moderate dissolved or high entrained exposure thresholds.	Exposure to moderate dissolved or high entrained exposure thresholds in the water column or consumption of prey affected by the oil may cause sub-lethal impacts to pinnipeds. Due to the temporary and localised nature of the spill, pinnipeds widespread nature, the low-level exposure zones and rapid loss of the volatile components of MDO in choppy and windy seas (such as that of the area exposed), the potential consequence to pinnipeds are considered

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			Given the mobility of pinnipeds, there may be small numbers of seals in the areas predicted to be temporarily exposed to moderate dissolved or high entrained exposure thresholds in the water column, noting that in-water exposure (dissolved or entrained) is only predicted to occur within the upper 0 - 10 m of the water column.	to be Moderate (2), as they could be expected to result in localised minor short-term impacts to species of recognised conservation value.
	Cetaceans (whales and dolphins)	Injury / mortality to fauna Change in fauna behaviour	Several threatened, migratory and/or listed marine cetacean species have the potential to be migrating, resting or foraging within the area predicted to be exposed to in-water hydrocarbons. BIAs for foraging for pygmy blue whales and the migration BIA for southern right whales are within the area predicted to be exposed to moderate or high exposure thresholds in the water column, noting that in-water exposure (dissolved or entrained) is only predicted to occur within the upper 0 - 10 m of the water column.	Cetacean exposure to entrained hydrocarbons can result in physical coating as well as ingestion (Geraci and St Aubin, 1988; Deepwater Horizon Natural Resource Damage Assessment Trustees 2016). Such impacts are associated with 'fresh' hydrocarbon; the risk of impact declines rapidly as the oil weathers. The potential for impacts to cetaceans and dolphins would be limited to a relatively short period following the release and would need to coincide with seasonal foraging or aggregation event to result in exposure to a large number of individuals, as may be the case during seasonal upwelling events within the Otway region. However, such exposure is not anticipated to result in long-term population viability effects. A proportion of the foraging or distributed population of whales could be affected in the relatively localised area and water depth of the total foraging BIA for pygmy blue whales and migration BIA for southern right whales. Consequently, the potential consequence is considered to be Serious (3), as they could be expected to result in serious impact on valued species or habitat.
	Birds [**PC284**]	Injury / mortality to fauna Change in fauna behaviour	The extent of in-water hydrocarbons at the moderate threshold from a LOWC overlaps foraging BIAs for several seabird species, including various albatross species (i.e. antipodean, black-browed, Bullers, Campbell, Indian-yellow-nosed, shy and wandering), petrels (common-diving), shearwaters (short-	Seabirds could be impacted by in-water hydrocarbon exposure directly (i.e., whilst diving through the water column foraging) or indirectly (i.e. by consuming hydrocarbon-tainted fish, resulting in sub-lethal or toxic impacts). Penguins may be especially vulnerable to oil because they spend a high portion of their time in the water and readily lose insulation and buoyancy if their feathers are oiled. The Iron Baron vessel spill, of

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			tailed and wedge-tailed), Australasian gannet, black-faced cormorant and little penguin.	325 tonnes of bunker fuel in Tasmania in 1995, is estimated to have resulted in the death of up to 20,000 penguins (Hook et al. 2016).
			In-water hydrocarbons at low threshold were predicted to overlap the breeding BIA for the little penguin (at Phillip Island and the buffer around Christmas Island).	As seabirds are top order predators, any impact on other marine life (e.g., pelagic fish) from hydrocarbon exposure may disrupt and limit food supply both for the maintenance of adults and the provisioning of young. Furthermore, the foraging BIAs are typical over relatively extensive areas, therefore, impacts are not anticipated at a population level due to the localised and temporary exposure of moderate levels of surface hydrocarbons. Breeding little penguins oiled by in-water hydrocarbons during foraging may contaminate nests and eggs from oil transfer by parent birds (Clarke 2010). Bird eggs may become damaged from oil contamination if an oiled adult sits on the nest. Fresh crude was found to be more toxic than weathered crude, which had a median lethal dose of 21.3 mg/egg (Clarke 2010). Studies of contamination of duck eggs by small quantities of crude oil, mimicking the effect of oil transfer by parent birds, have been shown to result in mortality of developing embryos (French-McCay 2009). Acute or chronic toxicity impacts (death or long-term poor health) to seabirds is possible, however, the presence of birds within areas exposed to moderate threshold levels is expected to be limited, due to the transitory nature of foraging individuals, and temporary presence of in-water hydrocarbons in waters surrounding breeding BIAs.. However, due to the anticipated hydrocarbon weathering and fate of the condensate, the majority is expected to have either evaporated or entrained during that time. Modelling predicted between approximately 69.4% to 82.5% of the volume to evaporate and up to approximately 22.1% to entrain within the first 24 hours, depending on the wind conditions (RPS 2024). Furthermore, tidal and wave action within the area is anticipated to breakdown any shoreline hydrocarbons.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				Consequently, the potential consequence to seabirds and shorebirds is considered to be Moderate (2), as they could be expected to result in minor, short-term impact to species of recognised conservation value.
Socio-economic	Commercial and recreational fisheries	Change in ecosystem dynamics Changes to the functions, interests or activities of other users	In-water exposure to hydrocarbons may result in a reduction in commercially targeted marine species, resulting in impacts to commercial fishing and aquaculture. Actual or potential contamination of seafood can affect commercial and recreational fishing and can impact seafood markets long after any actual risk to seafood from a spill has subsided (NOAA, 2002) which can have economic impacts to the industry. Several commercial fisheries operate in the planning area and overlap the spatial extent of the water column hydrocarbon predictions	Any acute impacts are expected to be limited to small numbers of juvenile fish, larvae, and planktonic organisms, which are not expected to affect population viability or recruitment. Impacts from entrained exposure are unlikely to manifest at a fish population viability level. Any exclusion zone established would be limited to the safety exclusion zone around the vicinity of the release point, and due to the rapid weathering of hydrocarbons would only be in place whilst well-control activities are enacted, therefore physical displacement to vessels is unlikely to be a significant impact. Consequently, the potential consequence to commercial and recreational fisheries are considered to be Moderate (2), as they could be expected to result in localised low-level short-term impacts.
	Recreation and tourism	Changes to the functions, interests or activities of other users Change in aesthetic value	Tourism and recreation are linked to the presence of marine fauna (e.g. whales), particular habitats and locations for recreational fishing. The area between Cape Otway and Port Campbell is frequented by tourists. It is a remote stretch of coastline dominated by cliffs with remote beaches subject to the high energy wave action. Access to the entire coastline is via a 7 to 8-day walking track from Apollo Bay ending at the Twelve Apostles. Recreation is also linked to the presence of marine fauna and direct impacts to marine fauna such as whales, birds, and pinnipeds can result in indirect impacts to recreational values. It is important to note that the	Any impact to receptors that provide nature-based tourism features (e.g. whales) may cause a subsequent negative impact to recreation and tourism activities. Any impact to receptors that provide nature-based tourism features (e.g. fish and cetaceans) may cause a subsequent negative impact to recreation and tourism activities. However, the relatively short duration, and distance from shore means there may be short-term and localised consequences, which are ranked as Moderate (2).

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			impact from a public perception perspective may be even more conservative. This may deter tourists and locals from undertaking recreational activities. If this occurs, the attraction is temporarily closed, economic losses to the business are likely to eventuate. The extent of these losses would be dependent on how long the attraction remains closed.	
	Seaweed Industry	Change in ecosystem dynamics Changes to the functions, interests or activities of other users	In-water exposure to hydrocarbons may result in a reduction in commercially targeted seaweed species. Areas along the west side of King Island where bull kelp is collected may be exposed to dissolved and entrained hydrocarbons at the low threshold within the upper 0 - 10 m of the water column.	Experiments verified the susceptibility of *Nereocystis luetkeana* (bull kelp – North America) tissue to the direct exposure to several petroleum types. Antrim et al (1995) showed that petroleum treatments resulted in visible tissue damage, with a distinct bleached line being the most visible indication of plant contact with the petroleum. Moderate to heavy colour loss, which was generally followed by rapid decay of tissue, was most pronounced in 24 h exposures to unweathered and weathered MDO. The study did not look at how this would affect the productivity of bull kelp. Consequently, the potential consequence is considered to be Serious (3), as they could be expected to result in serious impact on valued species or habitat.
First Nations	Sea Country Native Title Indigenous Protected Area	Change in aesthetic value Changes to the functions, interests or activities of other users	In-water exposure to hydrocarbons is predicted along coastal First Nations Sea Country including Victorian coastal waters stretching from Discovery Bay to the west to Hopkins River mouth/ Warnambool in the east. Sea Country predicted to be exposed to in-water exposure to hydrocarbons is adjacent to the Eastern Maar Native Title determination (Tribunal File No. VCD2023/001), Gunditjmara Native Title determination (Tribunal File No. VCD2007/001) and Preminghana Indigenous Protected Area. [**PC269**]	Section 4 details the connection First Nations people have to Sea Country which could be potentially impacted by in-water exposure to hydrocarbons. Although no long term or permanent changes to marine environment are expected the short-term contamination of Sea Country may result in impacts associated at a spiritual level (i.e. rituals, songlines, culturally important species) and could affect culturally important activities such as mutton birding or affect culturally important species including eels and whales. The potential short-term and localised consequences are ranked as Moderate (2). Refer also to fish (including eels) and cetaceans (whales) exposure and consequence evaluations above. [**PC274**].

7.4.4.3 Credible Scenario Risk Evaluation

Table 7-26 provides likelihood, consequence, and risk evaluations for each credible scenario for loss of containment – hydrocarbons and chemicals, supported by consequence evaluations detailed in Sections 7.4.4.1, 7.4.4.2 and 6.9 from exposure to MDO, condensate and MEG, respectively.

Table 7-26: Risk Evaluation for Each Credible Scenario for Loss of Containment – Hydrocarbons and Chemicals

Credible Scenario (Stage)		**Risk Evaluation**
Loss of well containment - gas and condensate (drilling and completions /decommissioning)	Consequence	An unplanned LOWC event has the potential for widespread exposure of hydrocarbons in the marine environment. Section 7.4.4.2 provides detailed consequence evaluations on receptors with the potential for sea surface, in-water and shoreline condensate exposure based on hydrocarbon spill modelling of a LOWC event (Section 7.4.3). This evaluation found the highest consequence ranking to be Serious (3) for the following receptors: • Seabirds • Cetaceans • State terrestrial protected areas • Seaweed industry • Australian Marine Parks • State marine protected areas. To encapsulate all potential consequences to the environment, the highest consequence ranking of Serious (3) has been assigned as the overall consequence level for unplanned LOWC event.
	Likelihood	The likelihood of a LOWC event occurring is Highly Unlikely. To date no incidents relating to LOWC events have occurred during Beach operations in Australia including in the Otway basin. Future spills from LOWC events are considered remote events based on history of no known condensate spills in southern Australia from LOWC events.
	Risk Rating	**Medium**
Umbilical or flowline loss of containment – MEG (installation and commissioning)	Consequence	An unplanned umbilical or flowline loss of containment – MEG has the potential for to result in temporary and localised changes to water quality, and plankton. This scenario was not modelled due to the relatively small volume (up to 400 m^3) and MEG being a category 'E' OCNS chemical, with no substitution warning, readily biodegradable with a low potential for bioaccumulation and a Minor potential impact consequence ranking. To encapsulate all potential consequences to the environment, the highest consequence ranking of Minor (1) has been assigned as the overall consequence level for unplanned umbilical or flowline loss of containment – MEG.
	Likelihood	The likelihood of an unplanned umbilical or flowline loss of containment – MEG event occurring is considered Unlikely. Marine pollution from offshore developments has occurred previously in the Australian oil and gas industry. An unplanned umbilical or flowline loss of containment – MEG may occur but is not anticipated.
	Risk Rating	**Low**
Flowline and/or pipeline loss of containment – gas and condensate (operations)	Consequence	An unplanned flowline and/or pipeline loss of containment – gas and condensate event has the potential for widespread exposure of hydrocarbons in the marine environment. Section 7.4.4.2 provides detailed consequence evaluations on receptors with the potential for sea surface, in-water and shoreline condensate exposure based on hydrocarbon spill modelling of a LOWC event (Section 7.4.3). This evaluation found the

Credible Scenario (Stage)		**Risk Evaluation**
		highest consequence ranking to be Serious (3). The use of LOWC consequence evaluations for a flowline and/or pipeline loss of containment event is considered a highly conservative but suitably representative estimate. However, to encapsulate all potential consequences to the environment, the highest consequence ranking of Serious (3) has been assigned as the overall consequence level for unplanned flowline and/or pipeline loss of containment – gas and condensate event.
	Likelihood	The likelihood of a flowline and/or pipeline loss of containment event occurring is Highly Unlikely. To date no incidents relating to flowline and/or pipeline loss of containment event have occurred during Beach operations in Australia including in the Otway basin. Future spills from a flowline and/or pipeline loss of containment event are considered remote events based on history of no known condensate spills in southern Australia from LOWC events.
	Risk Rating	**Medium**
Vessel Collision - Marine Diesel Oil (MDO) spill (support operations)	Consequence	An unplanned vessel collision event has the potential for receptors in the marine environment to be exposed to hydrocarbons. Section 7.4.4.1 provides detailed consequence evaluations on receptors with the potential for sea surface, in-water and shoreline MDO exposure based on hydrocarbon spill modelling of a vessel collision event (Section 7.4.3). This evaluation found the highest consequence ranking to be Serious (3) for seabirds and cetaceans. To encapsulate all potential consequences to the environment, the highest consequence ranking of Serious (3) has been assigned as the overall consequence level for unplanned vessel collision event.
	Likelihood	The likelihood of a vessel event occurring is Unlikely. Industry data (2005-2012) shows vessel collisions are rare (3% of marine incidents in Australian waters), and these incidents typically involve smaller, often double-lined forward tanks.
	Risk Rating	**Medium**
Loss of Containment – hazardous substances stored on drill MODU and vessels (support operations)	Consequence	An unplanned loss of containment – hazardous substances stored on drill MODU and vessels event has the potential for receptors in the marine environment to be exposed to hydrocarbons and chemicals of up to 1 m^3. Section 7.4.4.1 provides detailed consequence evaluations on receptors with the potential for sea surface, in-water and shoreline MDO exposure based on hydrocarbon spill modelling of a vessel collision event (Section 7.4.3). This evaluation found the highest consequence ranking to be Serious (3). The use of vessel collision consequence evaluations for loss of containment – hazardous substances stored on drill MODU and vessels event is considered a highly conservative but suitably representative estimate. However, to encapsulate all potential consequences to the environment, the highest consequence ranking of Serious (3) has been assigned as the overall consequence level for unplanned loss of containment – hazardous substances stored on drill MODU and vessels event.
	Likelihood	The likelihood of an unplanned loss of containment – hazardous substances stored on drill MODU and vessels event occurring is considered Unlikely. Marine pollution from offshore developments has occurred previously in the Australian oil and gas industry. An unplanned loss of containment – hazardous substances stored on drill MODU and vessels event may occur but is not anticipated.
	Risk Rating	**Medium**

7.4.5 Risk Evaluation Summary

The risk evaluation for the loss of containment of hydrocarbons and chemicals is summarised in Table 7-27.

Table 7-27: Risk Evaluation Summary for the Loss of Containment of Hydrocarbons and Chemicals

Summary		
Risk summary	Risk evaluations of potential unplanned loss of containment events identified the potential for Low to Medium risks to the environment. The consequence and likelihood levels to determine the Low to Medium risks are defined in Table 7-26. The highest consequence level for the loss of containment scenarios is Serious (3) as a result of potential hydrocarbon exposure to the following receptors: • Seabirds • Cetaceans • State terrestrial protected areas • Seaweed industry • Australian Marine Parks • State marine protected areas The likelihood unplanned loss of containment events occurring ranges from Unlikely to Highly Unlikely based on the frequency of these events occurring in the Australian oil and gas industry or during Beach operations in Australia including in the Otway basin. Future spills from LOWC or vessel collision events are considered remote and highly unlikely events based on history of no known MDO or condensate spills in southern Australia from LOWC or vessel collision events. [**PC275**]	
Extent of risks	The greatest extent of risks results from the loss of containment of condensate and MDO from a loss of well containment event and vessel collision event, respectively, will result in widespread exposure of hydrocarbon to the environment.	
Duration of risks	The unplanned loss of containment events anticipated to result in the longest duration of risks are from loss of containment of condensate and MDO from a loss of well containment event and vessel collision event, respectively. Condensate and MDO are non-persistent hydrocarbons. Worst case spills are not considered to result in long-term or irreversible environmental damage or affect ecosystem functioning. Due to the volatility of the hydrocarbons released (condensate and MDO), once on the water surface most of the hydrocarbon volume will evaporate within several days of release.	
Level of certainty	Beach has a high level of certainty about the risks of the unplanned loss of containment events. The threats posed by loss of containment events including loss of well control and vessel collision are well known and strict regulatory requirements are in place to control the risk. With these regulatory controls in place, Beach have a high level of certainty that Project activities will not result in a loss of containment event.	
Is the impact considered lower-order or higher-order?	The highest risk ratings for unplanned loss of containment events are Medium risks (Table 7-26). Medium risks are considered lower-order risks that are acceptable with the application of good industry practice.	
Risk Assessment		
Loss of well containment - gas and condensate		
Consequence	**Likelihood**	**Risk rating**
Serious	**Highly Unlikely**	**Medium**
Umbilical loss of containment – MEG		

Consequence	Likelihood	Risk rating
Minor	**Unlikely**	**Low**
Flowline and/or pipeline loss of containment – gas and condensate		
Consequence	**Likelihood**	**Risk rating**
Serious	**Highly Unlikely**	**Medium**
Vessel Collision -Marine Diesel Oil (MDO) spill		
Consequence	**Likelihood**	**Risk rating**
Serious	**Unlikely**	**Medium**
Loss of Containment – hazardous substances stored on drill MODU and vessels		
Consequence	**Likelihood**	**Risk rating**
Serious	**Unlikely**	**Medium**

7.4.6 Demonstration of Acceptability

Table 7-28 demonstrates how and why environmental risks from loss of containment of hydrocarbons and chemicals meets the defined acceptable levels (Table 5-4).

Table 7-28: Demonstration of Acceptability – Loss of Containment – Hydrocarbons and Chemicals

Demonstration of Acceptability		
Impact and risk comparison with relevant defined acceptable levels	Acceptable level 5 addresses the risks of unplanned loss of containment – hydrocarbons and chemicals, as outlined in Table 5-4. These risks were evaluated, resulting in Low to Medium risk ratings based on the combination of Minor (1) to Serious (3) potential consequences and Unlikely to Highly Unlikely event likelihoods. By implementing control measures that satisfy legislative and other requirements, the occurrence of a loss of containment – hydrocarbons and chemicals event will be prevented, thereby ensuring that Acceptable level 5 is met and achieved. Refer below to list of control measures to be implemented to prevent such an event from occurring.	
ESD Principles	Integration principle	Section 7.4.4 identifies and evaluates environmental risks associated with the loss of containment of hydrocarbons and chemicals. As part of identifying the potential risks; conservation values and sensitivities, physical environment, ecological environment, socio-economic values, and First Nations values and sensitivities described in Section 4 were reviewed to determine potential interactions of the aspect against each of these receptors they may result in environmental risk. As a result, consideration of economic, environmental, social and equitable receptors was conducted as part of identifying the impacts and risks. For Phase 1: Initial Project Consultation (Section 10.2.3), Beach consulted with relevant stakeholders on the Project and associated activities. No objections or claims were raised in Phase 1: Initial Project Consultation For Phase 2: Project OPP Public Comment Period (Section 10.2.4), the public had the opportunity to provide further comment to this OPP during the period (18/3/2024 – 20/5/2024). Beach prepared the public comment report summarising all comments, an assessment of the merits of each comment, a

		statement of the response to each comment, and an outline of any changes made to the OPP as a result of the comment (Appendix P). The impact assessment for this aspect has been updated to reflect the merit provided by public comment reference number PC232, PC269, PC270, PC274, PC275, PC282, PC284, and PC294. As a result, the impact assessment now integrates responses to public comments of merit and therefore is of an acceptable level. The potential environmental risk against this aspect was assessed as having a Medium risk level which is considered a lower-order environmental risk. Lower-order environmental risks are considered 'broadly acceptable' and considered managed to an acceptable level by meeting relevant requirements (adopted controls as listed below).
	Precautionary principle	The potential environmental risks against this aspect were assessed as having a Medium risk level which is considered a lower-order environmental risk and below the defined acceptable levels detailed in Table 5-4, except for acceptable level 5. Lower-order environmental risks cannot result in serious or irreversible environmental damage. There is high confidence in the potential environmental impacts and risks and effectiveness of controls against this aspect. Beach has significant experience operating in the Otway and Bass based on their existing offshore developments and associated activities including the Beach Otway Drilling Campaign in 2021/2022.
	Intergenerational principle	The defined acceptable levels were developed to meet the principles of ESD (Section 5.8.5). Given predicted environmental impacts due to the loss of containment of hydrocarbons and chemicals is lower than the defined acceptable levels detailed in Table 5-4, except for acceptable level 5; the health, diversity, or productivity of the environment for future generations is expected to be maintained.
	Biodiversity principle	Section 7.4.3 identifies and evaluates environmental risks associated with the loss of containment of hydrocarbons and chemicals As part of identifying the potential impacts; conservation values and sensitivities including MNES in Section 4 were reviewed. The potential risks against this aspect were assessed as having Low to Medium risk rankings which are considered lower-order environmental risks that can be management to meet the defined acceptable level 5. Lower-order environmental risks cannot result in affects to biological diversity or ecological integrity.
Internal context	Policy compliance	The defined acceptable levels, EPOs and controls proposed for this aspect are consistent with Beach Environmental Policy objectives. As a result, potential environmental impacts and risks from Project can be managed to align with Beach Environmental Policy objectives.
External context	Stakeholder engagement is being carried out as part of this OPP process. Beach operates the existing Otway project and has established good relations with both onshore and offshore stakeholders. Engagement with stakeholders will continue throughout all aspects of the Project to build and maintain trust with stakeholders and the local community and minimise community and stakeholders concern and impacts where practicable. During Phase 1: Initial Project Consultation (Section 10.2.3), no objections or claims were raised against this aspect. During Phase 2: Project OPP Public Comment Period (Section 10.2.4), comments were raised against this aspect. The assessment of merit for these comments found this aspect to require updates. Changes to the OPP to address PC232, PC269, PC270, PC274, PC275, PC282, PC284, and PC294 have been integrated into the impact evaluation for this aspect.	

	Any new guidance or advice in relation to this aspect will be assessed and incorporated into adaptive management plans prepared for activity specific EPs.	
Other requirements	Requirement	Demonstration
	OPGGS Act 2006 (Cth) A Well Operations Management Plan (WOMP) must be in place for all wells.	**CM 01 Navigation Safety** All vessels operating within the project area will adhere to the navigation safety requirements including: • International Regulations for Preventing Collisions at Sea 1972 • Chapter 5 of International Convention for the Safety of Life at Sea 1974 • International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 • Navigation Act 2012 and any subsequent Marine Orders that specify standards for crew training and competency, navigation, communication, and safety measures. **CM02 Notifications** The Australian Hydrographic Office will be notified of the Project activities and installed subsea infrastructure prior to commencement to facilitate the issuing of Notice to Mariners and maintain nautical charts. Relevant stakeholders are notified prior to the activity so that third party marine users are aware of vessel location and timing **CM03 Fair Ocean Access Procedure** Beach's Fair Ocean Access Procedure was developed with input from commercial fishing industry organisations. The procedure details the process whereby a commercial fishers can claim compensation for an economic loss associated with Beach's offshore activities where impacts cannot be avoided, including in the event of an oil spill. **CM05 Petroleum safety zones** The Project will comply with OPGGS Act – Section 616 (2) petroleum safety zones, which includes establishment and maintenance of petroleum safety zones around wells, offshore structures or equipment which prohibits vessels entering without written consent. **CM06 Temporary exclusion/cautionary zones** 500 m temporary exclusion and 2 km cautionary zones will be established and maintained around drilling and installation activities. **CM40 WOMP** The Well Operations Management Plan (WOMP) is a regulatory requirement under the Offshore Petroleum and Greenhouse Gas Storage Act 2006 and the associated Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011. It is the primary approval document for ensuring a high standard of well integrity and details the risk assessment, critical procedures and safety mechanisms to be implemented throughout the duration of the relevant petroleum activity.
	OPGGS (Resource Management and Administration) Regulations 2011 A WOMP will be prepared and detail well design and detail safety measures to prevent a spill. This must be accepted by NOPSEMA.	
	OPGGS (Environment) Regulations 2023 Part 3 (Incidents, reports and records).	
	OPGGS Act 2006 (Cth) Section 460(2) - a person carrying on activities in an offshore area under the permit must carry out those activities in a manner that does not interfere with the conservation of the resources of the sea and seabed to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.	
	The following management plans identify loss of containment (pollution, habitat degradation or chemical discharge) as a threat: • South-east Marine Parks Network Management Plan 2025 • Wildlife Conservation Plan for Seabirds (CoA, 2020a) • Wildlife Conservation Plan for Migratory Shorebirds (CoA, 2015a) • National Recovery Plan for Albatrosses and Petrels 2022 (CoA, 2022) • Approved Conservation Advice for *Sternula nereis nereis* (Australian Fairy Tern) (TSSC, 2011) • National Recovery Plan for the Australian Fairy Tern (*Sternula nereis nereis)* (CoA, 2020)	

	• Conservation Advice for *Numenius madagascariensis* (Far Eastern Curlew) (DCCEEW, 2023f) • Conservation Advice for *Limosa lapponica baueri* (Bar-tailed Godwit (Western Alaskan)) (DCCEEW, 2024e) • Conservation Advice for *Limosa limosa* (black-tailed godwit) (DCCEEW, 2024f) • Approved Conservation Advice for *Calidris acuminata* (sharp-tailed sandpiper) (DCCEEW, 2024i) • Conservation Advice for *Calidris tenuirostris* (great knot) (DCCEEW, 2024l) • Approved Conservation Advice for *Pluvialis squatarola* (grey plover) (DCCEEW, 2024k) • Approved Conservation Advice for *Xenus cinereus* (Terek sandpiper) (DCCEEW, 2024i) • National Recovery Plan for *Rostratula australis* (Australian Painted Snipe) (DSEWPaC, 2013a) • Conservation Advice for *Charadrius leschenaultia* (Greater Sand Plover) (TSSC, 2016b) • Conservation Advice *Calidris ferruginea* (Curlew Sandpiper) (DoE, 2015f) • Approved Conservation Advice for *Calidris canutus* (Red Knot) (DCCEEW, 2024m) • National Recovery Plan for the Australiasian Bittern (*Botaurus poiciloptilus*) (DCCEEW, 2022x). • Approved Conservation Advice for *Botaurus poiciloptilus* (Australasian Bittern) (TSSC, 2019) • National Recovery Plan for the Orange-bellied Parrot (*Neophema chrysogaster*) (DELWP, 2016) • Approved Conservation Advice for the Blue Petrel (*Halobaena caerulea*) (TSSC, 2015c) • National Recovery Plan for the Australian Grayling (*Prototroctes	**CM41 MODU Safety Case** The Safety Case for the MODU is a regulatory requirement under the OPGGS Act and the associated Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011. The Safety Case identifies hazards and risks specific to drilling wells, describes how the risks are controlled and describes the safety management system in place to ensure the controls are effectively and consistently applied. This includes the subsea control system configured for all wells to fail-safe in the event of loss of communication and/or hydraulics. Prevention of loss of well control and subsequent release of hydrocarbons is a key focus as this is the source of major accident events. **CM42 Well Engineering and Construction Management System (WECS)** Beach Well Engineering and Construction Management System (WECS) that ensures well activities are fit for purpose with operational risks managed to a level that is as low as reasonably practicable. It also ensures that changes are made in a controlled manner, that appropriate standards are adhered to, and that a sufficiently resourced and competent organisation is in place. The Beach Operations Excellence Management System consists of Well Integrity Standard and WECS. **CM43 Workforce capability** Beach Workforce Capability Requirements Matrix to ensure Operations personnel are qualified, trained and certified as competent to operate and maintain Beach facilities. **CM44 Crisis and Emergency Management** Beach's Crisis and Emergency Management Standard requires Beach to have plans, procedures and resources in place to effectively respond to crisis and emergency situations, including hydrocarbon spills. **CM45 Preventative maintenance** Computerised Maintenance Management System to ensure all wells and subsea infrastructure is maintained to schedule. **CM46: SMPEP or SOPEP (appropriate to class)** In accordance with MARPOL Annex I and AMSA's MO 91 [Marine Pollution Prevention – oil], a SMPEP or SOPEP (according to class) is required to be developed based upon the Guidelines for the Development of Shipboard Oil Pollution Emergency Plans, adopted by IMO as Resolution MEPC.54(32) and approved by AMSA. To prepare for a spill event, the SMPEP/SOPEP details: • response equipment available to control a spill event; • review cycle to ensure that the SMPEP/SOPEP is kept up to date; and

	maraena) (Backhouse et al., 2008) - Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013c) - Recovery Plan for Marine Turtles in Australia, 2017-2027 (CoA, 2017) - Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (DEWHA, 2008) - Conservation Management Plan for the Blue Whale, 2015-2025 (CoA, 2015b) - National Recovery Plan for the Southern Right Whale *Eubalaena australis* (DCCEEW, 2024o) - Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC, 2015e) - Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale) (TSSC, 2015d) - Conservation Advice *Neophoca cinerea* Australian sea lion (TSSC, 2020) - Recovery Plan for the Australian sea lion (*Neophoca cinerea*) (DSEWPaC, 2013d)	- testing requirements, including the frequency and nature of these tests. - reporting requirements and a list of authorities to be contacted; - activities to be undertaken to control the discharge of hydrocarbon; and - procedures for coordinating with local officials. Specifically, the SMPEP/SOPEP contains procedures to stop or reduce the flow of hydrocarbons to be considered in the event of tank rupture. **CM47 Bunkering procedure** Bunkering procedures to manage fuel transfers that include: - Weather limits on bunkering operations - Bunkering equipment specifications and inspection - Visual observations during transfers - Emergency shutdowns **CM48 EP, OPEP and OSMP** Accepted Environment Plans (EP) Oil Pollution Emergency Plans (OPEP) and Operational and Scientific Monitoring Plans (OSMP) in place for all relevant Project activities and oil spills responded to in accordance with the plans **CM49 Oil spill modelling** Oil spill modelling and environmental risk assessments for the Project EPs and OPEPs will consider the full range of worst-case scenario LOWC consequences. **CM50 Source control** Source Control Emergency Response Plans in place for all drilling activities.

7.4.7 Environmental Performance

In accordance with NOPSEMA's OPP Decision Making Guideline (NOPSEMA 2024), the EPO for this aspect (Table 7-29) has been developed to be relevant to identified environmental impacts and risks, consistent with the principles of ESD and equivalent to or better than the defined acceptable level of impact. Control measures listed in Table 7-28 provides detail on how each control measure will be implemented for the Project to ensure the acceptable levels and EPOs, defined in Table 7-29 are met

Table 7-29: Environmental Performance Outcomes – Loss of Containment of Hydrocarbons and Chemicals

Defined Acceptable Level	Environmental Performance Outcomes	
Acceptable level 5: Unplanned loss of containment – hydrocarbons and chemicals is unacceptable	EPO27:	No unplanned loss of containment of hydrocarbons or chemicals to the marine environment during Project activities.
	EPO7:	No death or injury to listed threatened or migratory species from Project activities.

Defined Acceptable Level	Environmental Performance Outcomes	
	EPO28:	In event of an unplanned release of chemicals or hydrocarbons, spill response control measures will be implemented in accordance with accepted EP, OPEP and OSMP (CM48 EP, OPEP and OSMP).

8 Cumulative Impact Assessment

8.1 Overview

Cumulative environmental impacts in the context of offshore petroleum activities are successive, additive, or synergistic impacts of collectively significant activities or projects with material impacts on the environment that have the potential to accumulate over temporal and spatial scales (NOPSEMA Environment Plan Decision Making Guideline, N-04750-GL1721 A524696, Dec 2022).

The effects of past projects and activities, and currently operating projects, are captured when describing the existing condition of and any pressure or threats affecting the environment (see Section 4). This baseline condition and understanding of the capacity of the receiving environment and receptors to accommodate changes, in light of existing pressures and threats, informs the environmental impact and risk assessments conducted in Sections 6 and 7 of this OPP.

The focus of this cumulative impact assessment (CIA) is to further build on these assessments by considering the impacts of the proposed activity on key matters in conjunction with the impacts from other reasonably foreseeable future projects.

The types of activities and projects typically considered in CIA are large in scale and are of relevance in terms of potentially contributing to or compounding material impacts in the relevant project area. While an environmental value is at the centre of the CIA this doesn’t mean that every potential impact of regional concern to that value needs to be addressed. For example, while loss of habitat to a threatened species may be of regional concern, there may be no reason to incorporate those potential impacts into a project-initiated cumulative impact assessment (CIA) if the project under assessment does not contribute to long term habitat reduction (Minerals Council of Australia 2015).

8.2 Methodology

Guidance from the United Kingdom (UK) National Infrastructure Planning Advice Note Seventeen: Cumulative effect assessment relevant to nationally significant infrastructure programs (UK 2019) and the New South Wales (NSW) Cumulative Impact Assessment Guidelines for State Significant Projects (NSW 2022), form the basis of this assessment.

Both the UK and NSW guidelines are intended to apply to large-scale national and state significant projects, respectively, with greater potential for cumulative impacts into the long-term. Consequently, the assessment process applied here has been adapted to the nature and scale of the activities associated with the Project.

8.2.1 Identifying Reasonably Foreseeable Future Projects and Activities CIA Scoping

CIA considers projects and activities that are reasonably foreseeable within the spatial and temporal extent of the assessment. This defines the boundaries of the assessment by including projects and activities that have a realistic likelihood of occurring and could contribute to cumulative impacts.

To identify reasonably foreseeable future projects and activities a search was conducted of the NOPSEMA, DEECA (Vic) Environment Plan and The Offshore Infrastructure Registrar websites to identify any relevant projects and activities. In addition, petroleum titleholders within the Otway Basin have been meeting regularly to discuss environmental management in the region, including processes for improved CIA, focusing on reasonably foreseeable activities. This has provided a more accurate representation of projects and activities and the potential for cumulative impacts, ensuring that relevant impacts are appropriately assessed and managed.

Reasonably foreseeable future projects and activities identified to date, within the life of the Project, are detailed in Table 8-1 and Figure 8-1.

In addition, as the existing Beach Otway Development (Beach's current production operations at the Geographe and Thylacine gas fields) is the baseline condition, a review was undertaken to identify how the impacts associated with existing operations are anticipated to change (cumulative spatial and temporal impacts) as the Project is developed over the life of the Otway operations.

Projects and activities that are not reasonably foreseeable or speculative have been excluded from the assessment scope to maintain practicality and relevance in decision-making processes. The Cumulative Environmental Impact Assessment Industry Guide (Minerals Council of Australia 2015) suggests that speculative projects should not be included which includes projects which have been referred and/or announced but are not under assessment. Despite this, wind farm projects have been considered in brief as a conservative approach.

Information on identified projects and activities are typically accessible once consultation commences and relevant technical supporting information is submitted for public comment or assessment. In addition, information relevant to this CIA has been discussed at the ongoing Otway Basin Petroleum Titleholder meetings. Where project/activity-specific data is not yet available, data from similar projects has been used as a proxy prior to technical information being made available. Given the similarity of impacts, there is a high level of certainty in the prediction of cumulative impacts in most cases.

Some assumptions around specific timings for projects or activities have been made. Whilst there is some level of uncertainty in schedule and timing of approvals to support activities, in general schedules are relatively well known due to titleholders sharing similar resources (i.e. rig consortium utilising a single MODU for all drilling activities).

8.2.1.1 CIA Scoping

Scoping is undertaken to identify the key environmental matters that could be materially affected by the cumulative impacts of the Project and other reasonably foreseeable future projects and require a detailed CIA.

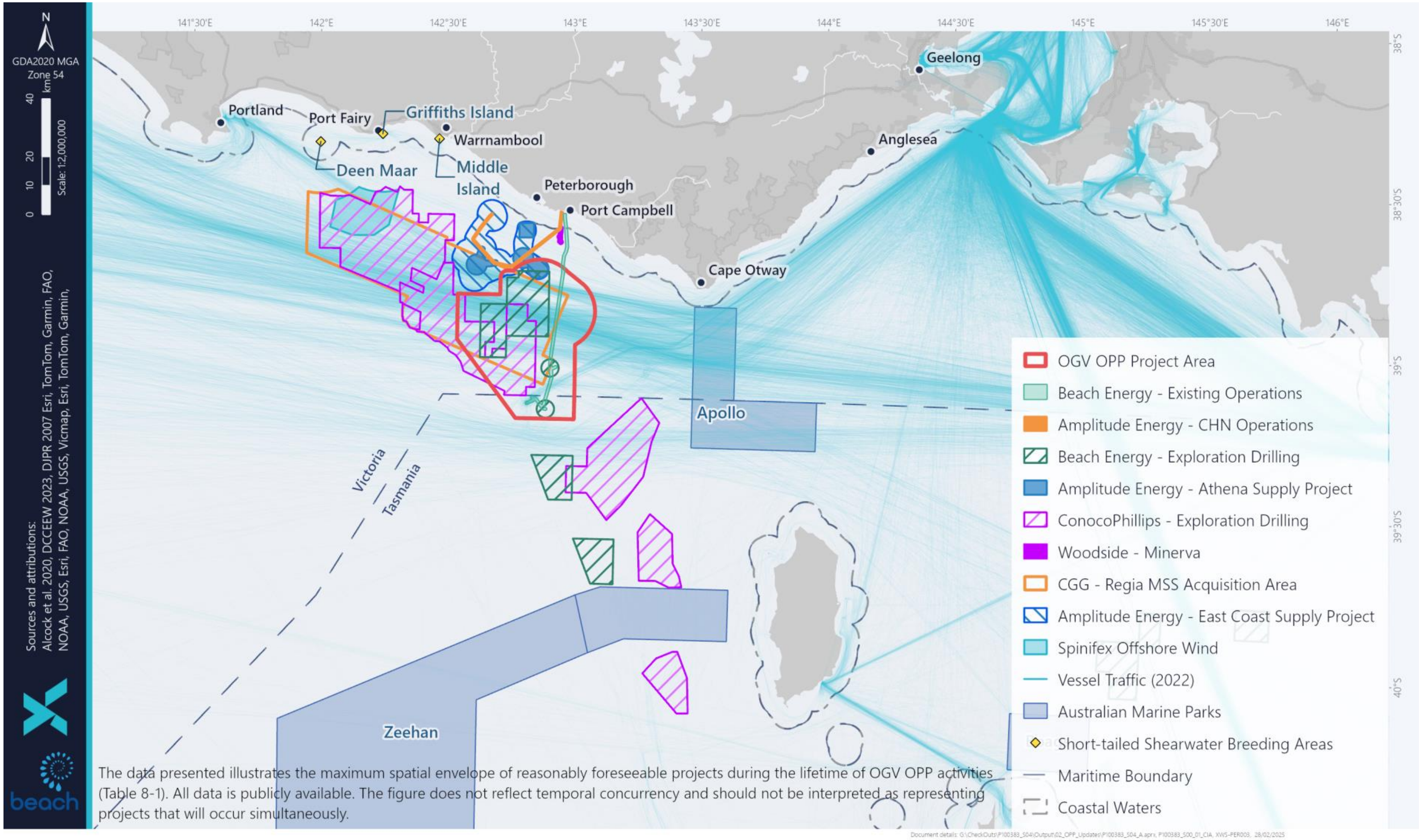
Scoping considerations identified for CIA include:

- **Successive impacts** - those that occur one after the other.
- **Additive impacts** - those where the combined impact is the sum of the separate impacts.
- **Synergistic impacts** - those where the combined impact is greater than the sum of the separate impacts.
- **Key environmental matters** - features of the environment (ecological, socio-economic, and cultural values and sensitivities) that are valued because of their rarity or importance, including the critical role they play in supporting systems which are essential for the environment, people and /

or the economy (NSW 2022), for example, commercial fisheries and threatened species undertaking biologically important behaviours.

- **Material impacts** - impacts of the project and other reasonably foreseeable future projects and activities that may not align with the defined acceptable levels, for example, threats of wide-scale, serious or irreversible damage due to cumulative impacts.
- **Temporal extent** - depends on the key matter and the scale and nature of potential impacts on the matter (NSW 2022) but aligned to reasonably foreseeable timeframes associated with the project and other reasonably foreseeable projects and activities within the Planning Area.
- **Spatial Extent** – depends on the key matter. NSW (2022) recommends that while the area chosen for each key matter must be broad enough to capture all relevant cumulative impacts, it should not be unnecessarily large or include areas where the cumulative impacts are likely to be negligible relative to the baseline condition of the relevant matter.

The scoping steps are detailed below, and the outcomes are in Table 8-2.



The data presented illustrates the maximum spatial envelope of reasonably foreseeable projects during the lifetime of OGV OPP activities (Table 8-1). All data is publicly available. The figure does not reflect temporal concurrency and should not be interpreted as representing projects that will occur simultaneously.

Document details: G:\CheckOuts\P100383_S04\Output\02_OPP_Updates\P100383_S04_A.aprx, P100383_S00_01_CIA, XWS-PER003, 28/02/2025

Figure 8-1: Reasonably Foreseeable Future Projects and Activities in the Offshore Otway Basin

- Step 1: Receptors identified as part of the Risk Evaluation (Section 7) are not subject to the cumulative impact assessment process.
- Step 2: Identify the relevant acceptable levels (as listed in Section 5.8.5) for each receptor. It is noted that the acceptable levels for the Project are derived from legal requirements, management plans and principles of ESD. These acceptable levels reiterate legal mandates to prevent unacceptable impacts to receptors. Reasonably foreseeable future projects and activities and potential of cumulative impacts must also meet these acceptable levels to ensure legal compliance.
- Step 3: Identify whether the Project's spatial extent of impacts overlap with those of other current and reasonably foreseeable projects affecting the same receptor.
- Step 4: Identify whether the Project's temporal extent of impacts overlap with those of other current and reasonably foreseeable projects affecting the same receptor.
- Step 5: If temporal and spatial overlaps are identified (in steps 3 and 4), a scoping assessment is conducted. This assessment determines whether the combined overlaps could cause the acceptable level to be exceeded, resulting in a potential cumulative impact from identified potential cumulative-cause-effect pathways.
- Step 6: Identify the level of certainty of the scoping assessment. The level of certainty of the assessment is deemed to be high if:
    - Impacts are well understood
    - Impacts are relatively easy to predict using standard methods
    - Impacts are capable of being mitigated to comply with relevant standards and to meet the acceptable level as previously detailed Table 5-4.

If one of the points is not met, then there is a moderate level of certainty for the scoping assessment. To ensure thoroughness, a cautious approach is taken. Receptors with scoping assessments of moderate certainty proceed to detailed CIA. However, if a scoping assessment demonstrates a high level of certainty that there are no significant cumulative impact pathways, the receptor is not considered further for detailed CIA.

- Step 7: Confirm if the receptor is considered or not considered for detailed CIA based on potential cumulative-cause-effect pathways and certainty of the scoping assessment.

8.2.2 Detailed CIA

For those receptors and aspects where a potential cumulative cause-effect pathway and material impact was identified in the scoping, a detailed CIA assessment was applied in general alignment with the project-specific methodology described in Section 5. The outcomes of this detailed assessment are detailed in

Table 8-3 to Table 8-5.

The CIA process applied to each aspect and component of the environment are:

- Identification of:
    - Receptor conservation values or values relevant to CIA e.g. EPBC Listed Threatened Species, MNES, commercial or cultural significance.
    - Legislative or other requirements relevant to the assessment.
    - Relevant threatening processes.
    - Relevant spatial extent such as BIAs, and temporal extent when receptor present including any biologically important features such as behaviours or critical life-cycle stages, timings.
    - Relevant actions from legislative or other requirements.
- Detail the baseline existing environment.
- Define the acceptable level to the receptor.
- Identification of other reasonably foreseeable future projects where the aspect overlaps the identified relevant spatial extent.
- Assessment of potential for cumulative impacts:
    - Description of potential cumulative impact.
    - Detail the level of certainty of the assessment.
    - Detail the existing control measures to meet the defined acceptable level. It is noted that Project control measures, developed to meet defined acceptable levels, are directly applicable to reducing the potential consequences of cumulative impacts. These control measures are Beach's primary means of mitigating cumulative impacts. Beach has no direct authority over the planning, implementation, or management of other reasonably foreseeable projects and activities that may potentially contribute to cumulative impacts.
    - Comparison to acceptable level(s), and where required (reiterative process):
    - Identification of additional control measures and demonstration that cumulative impacts are acceptable.
- Detailing any additional actions.

All potential cumulative impacts to the key receptors were evaluated as being Minor (1). No additional controls were identified however Beach will continue to work with other titleholders undertaking activities within the Otway Basin with the aim of identifying and minimising the potential for cumulative impacts, in addition to cooperation on monitoring and management to increase effectiveness.

Table 8-1: Reasonably Foreseeable Future Projects and Activities in the Offshore Otway Basin

Titleholder	Activity	Status	Expected Timing Window	Potential Temporal Overlap with all OGV Project activities (as detailed in Section 3)	Potential Spatial Overlap with relevant OGV Project activities
Beach Energy	Otway Offshore Operations	Existing Operations	Otway Offshore Operations Ongoing, end of field life ~2037	Otway Offshore Operations may involve IMR campaigns and platform resupply for the duration of its operational life. Potential temporal overlap with OGV OPP activities identified as: **Platform Resupply (helicopter) –** ~2 days every 3 months, ~6 hours per day, daylight hours only. **Standby vessel during IMR** - ~2 days every 6 months, ~6 hours per day, daylight hours only. **ROV inspection** - ~30 days every 5 years **Diver inspection** - ~15 days every 10 years **P&A** – not detailed but expected to be 40 to 60 days	Otway Offshore Operations may involve IMR campaigns and platform resupply. Spatial overlap with this OGV OPP activities identified as: **Operational Area** - Otway Offshore Operations OA consists of a 500 m buffer around all subsea infrastructure and wells, including the Otway Pipeline System which is partially overlapped by the OGV OPP Project Area. **Light EMBA** – Light EMBA resulting from Otway Offshore Operations vessels (navigation, safety and working lights) may overlap those of the OGV OPPs Light (20 km) EMBA and Flaring (63 km) EMBA. **Noise EMBA -** Noise EMBA (up to 7.5 km marine mammal behaviour criteria during resupply) resulting from Otway Offshore Operations vessels may overlap those of the OGV OPP (7.97 km non-shelf and 19.6 km shelf areas marine mammal behaviour criteria, drilling phase).
Amplitude Energy (Cooper Energy)	Casino-Henry-Netherby (CHN) Operations	Existing Operations	Ongoing Ongoing, end of filed life ~2030	CHN Operations may involve IMR campaigns for the duration of its operational life. Potential temporal overlap with OGV OPP activities identified as: **Support vessel during IMR** - 2 – 4 weeks at sea for an entire inspection program including mobilisation and demobilisation expected every 2 years. **P&A** – not detailed but expected to be 40 to 60 days	CHN Operations may involve IMR campaigns and platform resupply. Closest distance between projects is ~1 km. Spatial overlap with this OPP activities identified as: **Light EMBA** – 20 km Light EMBA resulting from CHN Operation vessels (navigation, safety and working lights) may overlap with this OPPs Light (20 km) and Flaring (63 km) EMBA. **Noise EMBA** - Noise EMBAs (5.97 km marine mammal behaviour criteria during resupply) resulting from CHN Operation vessels may overlap with those of this OPP (7.97 km non-shelf and 19.6 km shelf areas marine mammal behaviour criteria, drilling phase).
Beach Energy	Offshore Gas Victoria Drilling Program (Drilling, Decommissioning (P&A))	Proposed	2025-2027 Up to 5 new wells (~30-40 days per well), up to 5 wells P&A (~ 15-20 days per well Surveys per well ~7 days Anchor handling per well ~4-6 days	Activities for all 3 projects may involve geophysical and geotechnical surveys, exploration drilling with P&A activities. Potential temporal overlap with this OPP activities identified as: **Survey and support vessels** - ~7 days per survey and ~4 to 6 days anchor handing days per well. 3 hours per resupply. **Drilling Activities –** range of approximately 30 to 60 days per well **P&A** - ~15-20 days per well Note, titleholders in the region are part of a rig consortium which has signed an agreement with Transocean to bring a semi-submersible MODU to the offshore Otway Basin in 2025 and beyond. Due to the financial and logistical implications of operating a semi-submersible MODU, the presence of multiple rigs in the area for future operations (i.e. planned P&A activities), is not considered a credible scenario. Therefore, concurrent drilling and P&A activities are not considered.	Activities for all 3 projects may involve geophysical and geotechnical surveys plus support, drilling and P&A activities. Spatial overlap with this OPP activities identified as (noting simultaneous drilling activities are not possible): **Operational Area:** 3 x projects overlap OGV OPP Project area. **Light EMBA** – Light EMBA (20 km) resulting from 3 listed project's vessels (navigation, safety and working lights) may overlap the OGV OPP's Light (20 km) and Flaring (63 km) EMBA during the OGV drilling phase. **Noise EMBA (non-drilling phases)#** - Noise EMBAs (up to 0.5 km non-shelf marine mammal behaviour criteria, prelay (ConocoPhillips); up to 0.44 km marine mammal behaviour criteria AHTS prelay activity, Amplitude Energy); up to 2.98 km non-shelf and 6.5 km shelf areas marine mammal behaviour criteria, IMR (Beach Energy) resulting from 3 x listed projects vessels may overlap with those of OGV OPP (7.97 km non-shelf and 19.6 km shelf areas marine mammal behaviour criteria, drilling phase). **Noise EMBA (3 x project's drilling phases)#** - Noise EMBAs for marine mammal behaviour criteria up to 12.6/22.8 km non-shelf/shelf (ConocoPhillips); up to 2.72/5.97 km, Amplitude Energy); up to 6.23/19.6 km (Beach Energy) resulting from 3 x listed projects vessels may overlap with those of OGV OPP (2.9 km non-shelf and 6.5 km shelf areas marine mammal behaviour criteria, non-drilling phase. #As concurrent drilling not possible, noise EMBAs for both drilling and non-drilling phases for all projects are detailed (i.e. OGV drilling phase may occur during non-drilling phases of other projects and vice versa).
Amplitude Energy (Cooper Energy)	Athena Supply Project (Exploration Drilling)	Proposed	2024-2026 (~60 days per well, max 3 wells)		
ConocoPhillips	Otway Exploration Drilling Program (Exploration Drilling)	Proposed	2024-2026 (~30-40 days per well, max 6 wells)		
Woodside Energy	Minerva P&A and decommissioning	Proposed	2024-2025 (< 2 months) Equipment removal activities restricted to between September and April inclusive.	Decommission activities may involve MODU plus support and survey vessel activities. Potential temporal overlap with Beach OPP activities identified as: **Survey and support vessels** – 44 to 160 days P&A scope, 45 – 60 days decommission scope. **P&A** - ~44 - 160 days **Decommissioning** – 46 to 60 days Note, Woodside are part of a rig consortium which has signed an agreement with Transocean to bring a semi-submersible MODU to the offshore Otway Basin in 2025. Therefore, additive or synergistic	Decommission activities may involve MODU plus support and survey vessel activities. Closest distance between projects is ~6 km. Spatial overlap with this OPP activities identified as: **Light EMBA** – Light EMBA (20 km) resulting from Minerva project's vessels (navigation, safety and working lights) may overlap with this OPPs Light (20 km) and Flaring (63 km) EMBA. **Noise EMBA** - Noise EMBAs (up to 2.4 km marine mammal behaviour criteria, MPSV Subsea infrastructure removal) resulting from Minerva vessels and ~10.2 km drilling phase) may overlap with those of the OGV OPP (7.97 km non-shelf and 19.6 km shelf areas marine mammal behaviour criteria, drilling phase).

				impacts with other planned drilling or P&A activities are not are not considered credible.	
CGG Services Australia	Regia Marine Seismic Survey (MSS) (Seismic Survey)	Proposed	2024-2028 60 days acquisition 90 days in field One survey between November – May or Two separate surveys April – June, and or September – November.	Regia MSS may involve support vessel and survey activities. Potential temporal overlap with Beach OPP activities identified as: **Survey and support vessels** - up to a maximum of 90 days.	Spatial overlap with this OPP activities and identified as: **Operational Area** – Regia MSS OA overlays the entire Project Area of this OPP. **Light EMBA** – Light EMBA resulting from Regia MSS vessel's (navigation, safety and working lights) may overlap with this OPPs Light (20 km) and Flaring (63 km) EMBA. **Noise EMBA -** Noise EMBA[α] (44 km) resulting from the Regia MSS survey and vessels overlap those of the OGV OPP (7.97 km non-shelf and 19.6 km shelf areas marine mammal behaviour criteria). [α] ~44 km marine mammal behaviour criteria PTS and TTS per pulse effect criteria reached between 410 – 820 m PTS 24hr cumulative effect criteria is reached within 70 m and the TTS 24hr cumulative effect criteria is reached within 190-350 m. Note - not feasible that a cetacean would be within that distance of the moving vessel for 24 hrs, thus impacts are not predicted
Amplitude Energy (Cooper Energy)	East Coast Supply Project (Development and operation of subsea wells)	Proposed	Surveys – 7 to 21 days per campaign Up to 15 wells drilled, ~60 days per well, 30 to 60 days subsea installation per well. Operations, end of field life ~2045 Decommissioning expected ~2050	East Coast Supply Project activities may involve geophysical and geotechnical surveys, drilling, completions, operations and decommissioning activities. Potential temporal overlap with OGV OPP activities identified as: **Survey and support vessels** - ~7 days to 21 days per campaign **Subsea installation vessels** – 30 – 60 days per well. **Drilling Activities** – range of approximately 30 to 60 days per well **Completions** - ~30 to 60 days per well **P&A** - ~15-20 days per well Note, titleholders in the region are part of a rig consortium which has signed an agreement with Transocean to bring a semi-submersible MODU to the offshore Otway Basin in 2025 and beyond. Due to the financial and logistical implications of operating a semi-submersible MODU, the presence of multiple rigs in the area for future operations (i.e. planned P&A activities), is not considered a credible scenario. Therefore, concurrent drilling and P&A activities are not considered.	East Coast Supply Project activities may involve geophysical and geotechnical surveys, drilling, completions, operations and decommissioning activities. Spatial overlap with the OGV OPP activities identified as: **Operational Area**: East Coast Supply Project Area overlaps OGV OPP Project area. **Light EMBA** – Light EMBA (20 km) resulting from East Coast Supply Project's vessels (navigation, safety and working lights) may overlap with this OPPs Light (20 km) and Flaring (63 km) EMBA. **Noise EMBA** - Noise EMBAs (2.72 to 5.97 km marine mammal behaviour criteria, up to 410 m km PTS and) resulting from support phases from the East Coast Supply Project and 7.87 km from drilling phase, may overlap with those of the OGV OPP (7.97 km non-shelf and 19.6 km shelf areas marine mammal behaviour criteria).
Alinta Energy and JERA Nex (Spinifex Offshore Wind)	Spinifex Offshore Wind (Offshore wind installation)	Announced	Surveys – ~2025 - 2028 Turbine Installation – ~2031 Operations, ~2032 to 2057* Decommissioning, ~2058*	Spinifex Offshore Wind Project activities may involve geophysical and geotechnical surveys, piling, installation, IMR and operations and decommissioning activities. The project is in the pre-planning phase and as such no specific details are currently publicly available for the Spinifex Offshore Wind Installation. However, from limited available data, a potential temporal overlap with this OPP activities are identified as: **Survey vessels** – various fauna, geotechnical and geophysical surveys are required to support approval documentation expected to be conducted between 2025 to 2028. Likely to consist of single vessels for short term surveys (up to 3 weeks). **Installation activities** – turbine Installation not expected to begin until ~2031	The Spinifex Offshore Wind Project proposed project area is located ~34 km from the OGV OPP Project Area. Spatial overlap with the OGV OPP activities identified as: **Light EMBA** – Light EMBA (20 km) resulting from Spinifex Offshore Wind Project's vessels (navigation, safety and working lights) may overlap with this OPPs Light (20 km) and Flaring (63 km) EMBA. **Noise EMBA** - Noise EMBA (~20 km‡ marine mammal behaviour criteria during construction and IMR) resulting from the Spinifex Offshore Wind Project's vessels may overlap with those of the OGV OPP (7.97 km non-shelf and 19.6 km shelf areas marine mammal behaviour criteria).
N/A	Shipping / vessel traffic	Existing	All year round	Shipping activities in the area involve vessels (e.g., cargo and tankers) travelling between major Australian and foreign ports. The south-east marine region and Bass Strait is one of Australia's busiest shipping routes, where shipping/vessel traffic operate all year-round. For the life of the Project, shipping/vessel traffic will be excluded within 500 m Safe Navigation Areas, 500 m exclusion zones, 2 km cautionary zones and 500 m petroleum safety zones during Project activities.	Shipping/vessel traffic operations will be excluded within of 500 m Safe Navigation Areas, 500 m exclusion zones, 2 km cautionary zones and 500 m petroleum safety zones during Project activities. This will ensure no spatial overlap of shipping/vessel traffic operations and Project vessel activities within these safety areas/zones. Shipping/vessel traffic transiting outside of Project safety areas/zones will generate light and sound emissions to extents dependant on the type of vessel. Shipping/vessel traffic transiting close to Project safety areas/zones will have moving sound/light EMBAs that may temporarily overlap with Project sound/light EMBAs.

	Temporal overlap of shipping/vessel traffic with the Project will be restricted to those transiting outside of these safety areas/zones. There will be no temporal overlap of shipping/vessel traffic operations within these safety areas/zones.	**Operational Area** – An average of 9 vessels per day may pass through the OGV Project Area. However there will be no spatial overlap of shipping/vessel traffic operations and Project activities because of implemented Project safety areas/zones. **Light EMBA** – Light emissions (navigation, safety and working lights) from transiting shipping outside of Project safety areas/zones may overlap with OGV Project Light (20 km) and Flaring (63 km) EMBAs. An average of 11 and 15 vessels per day may pass through the OGV OPPs Light and Flaring EMBA respectively. **Noise EMBA** – Typical noise emissions (0.38 km marine mammal behaviour criteria (taken from OSV standby/transit modelling) resulting from transiting shipping outside of Project safety areas/zones may overlap with those of the OGV OPP (7.97 km non-shelf and 19.6 km shelf areas marine mammal behaviour criteria). An average of 10.5 vessels per day may pass through the combined shelf and non-shelf OGV OPPs noise EMBA.

*assuming typical 25-year lifespan (DCCEEW 2025a)

‡ Noise modelling for the installation of monopole or jacket design foundation has yet to be completed for this project. Large scale pilling installations within Australian waters are limited, therefore proxy values taken from:

- ConocoPhillips Australia, (2018) Modelling conducted on multiple large diameter piles (similar to monopile installation), however, in depths of ~250 m. Values expected to be highly conservative.
- Norro et al (2013). Details of measurements for both monopile and jacket installations in similar hard substrate as expected in the Otway, but in slightly shower depths (37 m). However, values expected to be comparable..

Table 8-2: CIA Scoping Outcome

Receptors	Planned Environmental Aspects Considered	Acceptable Level	Potential for Cumulative Impact (Spatial Extent)	Potential for Cumulative Impact (Temporal Extent)	Scoping Assessment Outcome	Level of Certainty of Scoping Assessment	Cumulative Cause-effect Pathway
Australian Marine Parks	Emissions – Light	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species. Acceptable level 4: Unplanned establishment of invasive marine species is unacceptable. **Acceptable level 5:** Unplanned loss of containment – hydrocarbons and chemicals is unacceptable	Yes OGV OPP's Flaring EMBA overlaps: • Zeehan AMP • Apollo AMP. OGV OPP's Light EMBA does not overlap any AMPs. Other projects with potential overlap with AMP: • ConocoPhillips	Yes Activities planned to be undertaken during periods of biologically important behaviours for conservation values	The Zeehan Marine Park lists the black-browed (foraging BIA), wandering and shy albatrosses (foraging / foraging likely BIAs) and great-winged and cape petrels as major conservation values. Apollo AMP lists black-browed (foraging BIA) and shy albatross (foraging likely BIA), Australasian gannet (foraging BIA), short-tailed shearwater (foraging BIA) and crested tern as conservation values. Worst case light levels resulting from OGV OPP flaring at the Zeehan and Apollo marine parks are 0.001 and 0.003 Lux respectively (0.01 is equal to a clear moonless night sky). Modelling in Section 6.3 predicted the level of impact from MODU facility lighting to be within 10 km of the MODU. Closest AMP is situated ~35 km from Project Area. Therefore, as detailed in Section 6.3 Impacts from light emissions have been evaluated to result in Minor (1) consequences. OGV OPP flaring EMBA may overlap Light EMBAs of ConocoPhillips activities. As a single MODU is being used for all reasonably foreseeable drilling activities (Table 8-1) additive or synergistic cumulative impacts resulting from flaring is not considered credible. ConocoPhillips proposed support activities in T49P consists of one survey and prelay for one exploration well. The overlap of the OGV Flaring EMBA and those from ConocoPhillips activities with the Apollo and Zeehan marine park and its associated Lux values would be negligible. Lux levels from concurrent actives (as detailed above) would have no impact on light sensitive species. In addition, bird species which are considered values of the AMPs and those that have defined BIAs, are unlikely to have biological important behaviours impacted by the cumulative light emissions resulting from OGV OPP and other reasonably foreseeable future projects as all detailed species are known to forage in daylight. Considering other reasonably foreseeable activities over temporal and spatial scales, the assessment outcomes found there was limited potential for successive, additive or synergistic impacts as the result of light emissions to bird species which are considered values of the Zeehan or Apollo AMPs. However, short-tailed shearwater fledglings are known to be susceptible to light emission. Whilst the fledglings are highly unlikely to be present in the AMP, due to the range from known nesting sites (Figure 8-1), they are considered for further assessment due to their cultural value as detailed in First Nations Cultural Values and Sensitivities section of this table.	High – Light modelling conducted, impacts to sensitive species well understood	Identified for values of the AMPs (short-tailed shearwater), with further assessment required to determine if impacts are material.
Key Ecological Features	Emissions – Underwater Sound	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery	No OGV OPP's sound EMBAs do not overlap any KEFs.	No No periods of biologically important behaviours for KEF values	Value of the Bonney Coast Upwelling KEF is one of 12 widely recognised and well-known areas worldwide where blue whales are known to feed in relatively high numbers. Values of the West Tasmania Canyons include sponges concentrated near the canyon heads and fish species. Whilst the noise EMBAs do not overlap either KEF, as blue whales are listed as a value of the Bonney Coast Upwelling KEF, they are carried forward for further assessment for reasons as detailed in Section - Marine Mammals of this table.	Moderate - noise modelling conducted, impacts to sensitive species well understood. However, no literature on the cumulative impacts to whale species.	None identified

		plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species. **Acceptable level 4:** Unplanned establishment of invasive marine species is unacceptable**.** **Acceptable level 5:** Unplanned loss of containment – hydrocarbons and chemicals is unacceptable.					
Maritime Archaeological Heritage	Physical Presence – Seabed Disturbance Discharges – Drill Cuttings and Cement	**Acceptable level 15**: No impacts on underwater cultural heritage with values as conferred by the *Underwater Cultural Heritage Act 2018* (Cth).	No Limited to individual activity area	Yes Continual presence	The OGV Project Area overlaps only one known shipwreck. OGV OPP activities that could result in the disturbance of maritime archaeological heritage are assessed in Section 6.2 (Seabed Disturbance), Section 6.7 (Planned Discharge – Drill Cuttings and Fluids) and Section 6.8 (Planned Discharges – Cement). Seabed disturbance is limited to individual activity areas and has been assessed as Minor (1). Seabed disturbance for all other reasonably foreseeable projects, detailed in Table 8-1, will also be limited to individual activity areas. Whilst other reasonably foreseeable projects (Table 8 1) may overlap known maritime archaeological heritage and potentially unknown maritime archaeological heritage, cumulative impacts from OGV OPP activities are not considered credible. as impacts are confined to a relatively small area as previously detailed. Impacts to maritime archaeological heritage are not predicted from seismic surveys. All drilling and infrastructure installation activities are required to undertake seabed surveys prior to seabed disturbance however as seabed disturbance and discharges are localised cumulative impacts are not predicted. CM10 (Seabed assessments) and CM11 (Cultural heritage assessments) will provide the opportunity for appropriately qualified persons to identify ecological, maritime, archaeological or submerged cultural heritage, landscapes and inform protection priorities ensuring a high level of certainty prior to drilling and installation activities.	High – OGV activities limited to individual activity areas, impacts well understood with additional control measures in place to detect and avoid sensitive areas.	None identified
Benthic Habitats and Communities	Physical Presence – Seabed Disturbance Discharges – Drill Cuttings and Cement	**Acceptable level 10:** No impacts on unique seafloor habitats[1] to the south-east region, including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests. **Acceptable level 11:** Impacts on benthic habitats and communities within the Project Area that are highly represented throughout the region and are not unique seafloor habitats is acceptable.	No Limited to individual activity area	Yes Continual presence	Beach OGV Project area does not impact any areas considered sensitive or communities of value (Key Ecological Features, AMP or threatened ecological communities). Thus, cumulative impacts to these values are not predicted from the Beach OGV Project. OGV OPP activities that could result in the disturbance of benthic habitats and communities are assessed in Section 6.2 (Seabed Disturbance), Section 6.7 (Planned Discharge – Drill Cuttings and Fluids) and Section 6.8 (Planned Discharges – Cement). Seabed disturbance is limited to isolated individual activity areas and has been assessed as Minor (1). No seabed disturbance, inclusive of drill cuttings and cement discharges, will occur within the Beach existing OGV Development or the future development area from other reasonably foreseeable future projects in the Otway Basin based on their location and activities. There is the potential for a cumulative increase in seabed disturbance, inclusive of drill cuttings and cement discharges, from the existing and planned developments within the Otway Basin (Beach, Cooper Energy and Woodside), however, these will be in isolated locations and impacts to areas where benthic habitat and communities are a value (Key Ecological Features, AMPs or threatened ecological communities) are not predicted. In addition, seabed surveys of the shelf area where Cooper Energy, Woodside and Beach's existing development are located have	High – OGV activities limited to individual activity areas with additional control measures in place to detect and avoid sensitive areas.	Identified but impacts not material no further assessment required.

		[1] Unique seafloor habitats of the south-east region including deep-sea reefs, continental shelf habitats, seamounts canyons and kelp forests (DNP, 2025).			identified that the seabed is highly mobile making it difficult for filter feeders and soft body invertebrates to survive and establish in significant populations. CM10 (Seabed assessments) and CM11 (Cultural heritage assessments) will provide the opportunity for appropriately qualified persons to identify ecological, maritime, archaeological or submerged cultural heritage, landscapes and inform protection priorities ensuring a high level of certainty prior to drilling and installation activities.		
Plankton	Emissions – Underwater Sound Discharges – Drill Cuttings and Cement Discharges – Commissioning and Operations Discharges - Vessels	**Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline.	Yes Limited to individual activity area with exception of seismic operations	Yes Continual presence of plankton	Emissions from underwater sound as a result of OGV OPP activities have been assessed as having a Minor (1) impact on plankton (Section 6.4). Impacts will be localised and well below natural mortality rates. Impacts from other reasonably foreseeable projects are predicted to be similar with no material cumulative impacts. OGV OPP planned discharges that could impact plankton are assessed in Section 6.7 (Planned Discharge – Drill Cuttings and Fluids), Section 6.8 (Planned Discharges – Cement), Section 6.9 (Planned Discharge – Commissioning and Operational Fluids) and Section 6.10 (Planned Discharge – Routine Operational Wastes from Vessels). Impacts where found to be local and temporary with Minor (1) consequences. Discharges to the water column are not predicted to impact water quality at a cumulative scale and therefore will not impact plankton at an ecological integrity level.	High - noise modelling conducted, impacts to sensitive species from discharges well understood	None identified
Invertebrates	Physical Presence – Seabed Disturbance Emissions – Underwater Sound Discharges – Drill Cuttings and Cement	**Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline.	Yes Limited to individual activity area with exception of seismic operations	Yes Continual presence of invertebrates	Emissions from underwater sound as a result of OGV OPP activities have been assessed as having a Minor (1) impact on invertebrate (Section 6.4). Impacts will be short term and localised as detailed in Section 3. Impacts from other reasonably foreseeable projects are predicted to be similar with no material cumulative impacts identified. Continuous noise from drilling, vessel and installation operations are not predicted to impact invertebrates as per previous impact assessment (Section 6.4) with no cumulative impact pathway identified. Impacts from geophysical surveys to benthic invertebrates are not predicted and impacts from VSP are predicted to result in impacts at very small scale (185 m), this is not predicted to be material to contribute to cumulative impacts. Behavioural impacts to squid are predicted to occur up to 3.9 km of the VSP (up to 24 hrs) and 90 m for seabed surveys, this is not predicted to be material to contribute to cumulative impacts even within areas where squid fishing occurs. Impacts to benthic invertebrates from seabed disturbance including drill cuttings and cement discharge are covered in Benthic Habitats and Communities.	High – noise modelling conducted, impacts to sensitive species from discharges well understood	None identified
Fish and Sharks	Emissions – Underwater Sound	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed	Yes Limited to individual activity with exception of seismic operations	Yes Continual presence of fish and sharks likely, however, no periods of biologically important behaviours for sensitive species	Emissions from underwater sound as a result of OGV OPP activities are assessed as having Minor (1) consequences to fish and sharks (Section 6.4). Impacts will be short term and highly localised. Impacts from other reasonably foreseeable drilling and IMR projects are predicted to be similar with no material cumulative impacts identified. CGG's Regia MSS shows a TTS threshold of 8.35 km for a cumulative sound exposure level (SELcum) for fish species (Popper et al. 2014). Popper et al. (2005) reports that fish showing a TTS recovered to normal hearing levels within 18-24 hours. Therefore, any hearing loss and subsequent decrease in fitness would be temporary with recovery taking place in a relatively short timeframe after the seismic source has moved away from the exposed fish. Due to the temporary and isolated nature of noise emissions from OGV OPP activities and other reasonably foreseeable activities plus rapid recovery from any impacts, no cumulative impact pathway was identified.	High - noise modelling conducted, impacts to sensitive species well understood	None identified

		threatened, migratory or cetacean species.					
Birds	Emissions – Light	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species.	Yes BIAs for sensitive species overlapped by light EMBAs from OGV and other foreseeable future activities.	Yes Periods of biologically important behaviours for sensitive species	Light emissions as a result of OGV OPP activities have been assessed as having a Minor (1) impact on birds (Section 6.3.3.2). Considering other reasonable future activities over temporal and spatial scales, the assessment outcomes found there was limited potential for successive, additive or synergistic impacts as the result of light emissions to bird species listed within the light EMBAs. Light emissions from all activities will be temporary. Overlapping light intensity levels are of negligible values which have previously been shown to below those to cause a behavioural response. However due to the sensitivity of certain species, the following are carried forward for further assessment: • orange bellied parrot - listed as Critically Endangered and Marine under the EPBC Act and noted as a species of cultural significance. The National Recovery Plan for the Orange-bellied Parrot lists barriers to migration and movement as a threat. • short-tailed shearwaters - light pollution, including from gas flaring, is listed as a threat to seabirds in the Wildlife Conservation Plan plus one of few Australian native birds that is harvested. • common diving-petrel - listed as a conservation value in the south-east and temperate east plus light emissions are identified as a threat in the National Recovery Plan for Albatrosses and Petrels and the species is known to forage at night where cumulative light emissions could impact foraging behaviour. For other bird species, important biological activities are unlikely to be impacted by light emissions as species known to forage during daylight hours.	High – Light modelling conducted, impacts to sensitive species well understood	Identified for the orange bellied parrot, short-tailed shearwater and the common diving-petrel with further assessment required to determine if impacts are material.
Marine Reptiles	Emissions – Light Emissions – Underwater Sound	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species.	No No BIAs or critical habitat overlapped by noise EMBAs from OGV or other foreseeable future activities.	No No periods of biologically important behaviours for sensitive species	No cumulative effect pathway identified. Individuals in the area are expected to be transient, with no BIAs, critical habitat, or biologically important behaviours within the Otway Basin. Lighting doesn't impact in water navigation or behaviours and impacts from noise will be temporary and recoverable. Although sound impacts are restricted to within typically 20 km around individual activities, activities may be occurring consecutively over a period of time and seismic and drilling at one location have the potential to occur concurrently. However, Section 6.4 (Underwater Sound) found impacts to turtles are likely to be restricted to short term and highly localised behavioural avoidance from the VSP sources with Minor (1) consequences to low numbers present in the Otway region.	High – Light and noise modelling conducted, impacts to sensitive species well understood	None identified
Marine Mammals	Emissions – Underwater Sound	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed	Yes BIAs for sensitive species overlapped by noise EMBAs from OGV and other foreseeable future activities.	Yes Periods of biologically important behaviours for sensitive species overlapped by OGV and other foreseeable future activities.	There is potential for cumulative impacts associated with underwater sound depending on location of activities and sensitive receptors, i.e. foraging and migrating endangered species. Although sound impacts are restricted to within typically 10s of kms around individual activities, activities may be occurring consecutively over a period of time and seismic and drilling at one location have the potential to occur concurrently. Marine mammal species considered for further assessment are the:	Moderate - noise modelling conducted, impacts to sensitive species well understood. However, no literature on the cumulative impacts to whale species.	Identified the sensitive marine mammals including the blue, southern right, fin, sei and pygmy right whales for further assessment and to determine if

		threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species.			• blue whale - listed as Endangered under the EPBC Act with foraging, feeding or related behaviour known to occur within the noise EMBAs with anthropogenic noise interference listed as a threat. • southern right whale - listed as Endangered under the EPBC Act and noted as a species of cultural significance with noise interference listed as a threat. • fin whale - listed as Vulnerable under the EPBC Act, with foraging, feeding or related behaviour likely to occur within the noise EMBAs with anthropogenic noise and acoustic disturbance listed as a minor threat. • sei whale - listed as Vulnerable under the EPBC Act with foraging, feeding or related behaviour likely to occur within the noise EMBAs with anthropogenic noise and acoustic disturbance listed as a minor threat. • pygmy right - listed as foraging may or is likely to occur within the noise EMBAs. Considering other significant activities or projects over temporal and spatial scales, the assessment outcomes found there was limited potential for successive, additive or synergistic impacts other marine mammal species from noise emissions as no BIAs or biologically important behaviour were identified within the noise EMBAs as detailed within Section 6.4 (Underwater Sound).		impacts are material.
Coastal Communities and Onshore Tourism Activities	Emissions – Light	**Acceptable level 14:** No interference with other marine users to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties as conferred by the titles granted to Beach.	No Not predicted to see multiple activities from single vantage point (i.e. King Island, Victorian coast)	Yes May be able to see different activities over time from single vantage point (King Island, Victorian coast)	Section 6.3.3.4 (Emissions – Light) details the highest level of illuminance from short-term flaring is Port Campbell National Park at 0.0111 lux, which is approximately the same as a quarter moon (0.01 lux). As flaring is short term and temporary (as detailed in (Section 3.8 (Description of Activities) impact from light emissions is likely to result in Minor (1) consequences. Cumulative effect pathway identified, associated with visibility of different activities over time, but impacts not material. The likelihood of visibility of multiple activities from a single vantage point is considered low given the distances offshore it is not predicted that a MODU and vessels would be distinguishable from other existing vessel traffic.	High – Light modelling conducted, impacts to sensitive communities well understood	Identified but impacts not material no further assessment required
Offshore Petroleum Activities	Physical Presence - Interaction with Other Users	**Acceptable level 14:** No interference with other marine users to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties as conferred by the titles granted to Beach.	Yes Non-Beach activities restricted to own Project Area outside of OGV OPP project Area. Beach Energy's activities and the Regia MSS overlap.	No Beach's OGV OPP activities and Regia MSS are unlikely to co-occur.	No cumulative impact effect pathway identified. At most, avoidance of a single seismic survey vessel and towed equipment, and a single drilling location at any given time with minimal interaction between activities. All activities are scheduled and or operate within their own exclusion zones/petroleum titles. Notice to mariners will provide advanced warning and opportunity to plan transit route.	High - impacts by offshore petroleum activities well understood	Identified but impacts not material, no further assessment required
Offshore Renewable Energy Activities	Physical Presence - Interaction with Other Users	**Acceptable level 14:** No interference with other marine users to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties as conferred by the titles granted to Beach.	No Non-Beach activities restricted to own Project Area outside of OGV OPP project Area.	Yes IMR activities may overlap with wind farm installation (expected 2031).	No cumulative impact effect pathway identified. Non-Beach activities restricted to own Project Area outside of OGV OPP project Area.	High – displacement by offshore renewable energy activities well understood.	None identified
Defence Activities	Physical Presence - Interaction with Other Users Physical Presence – Seabed Disturbance	**Acceptable level 14:** No interference with other marine users to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties as conferred by the titles granted to Beach.	Yes Potential displacement of military vessels that could be operating in the area as a result of concurrent and consecutive activities	Yes Potential displacement of military vessels that could be operating in the area as a result of concurrent and consecutive activities	Section 6.1.3.2 (Defence Activities) shows that OGV OPP activities will have negligible impacts to Defence operations. Whilst cumulative effect pathway identified from other foreseeably reasonable projects identified, impacts are not considered material. Industry standard controls in place such as notice to mariners will provide advanced warning and opportunity to plan transit route. At most avoiding a single seismic survey vessel and towed equipment, and a single drilling location at any given time with minimal interaction between activities. Impacts to UXO are not predicted from seismic surveys.	High - impacts to defence activities well understood	Identified but impacts not material, no further assessment required

					Drilling and installation activities are required to undertake seabed surveys prior to seabed disturbance which include techniques to identify UXO. Impacts to UXO are not planned event and therefore cumulative impacts not predicted.		
Shipping	Physical Presence - Interaction with Other Users	**Acceptable level 14:** No interference with other marine users to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties as conferred by the titles granted to Beach.	Yes Potential displacement of shipping as a result of concurrent and consecutive activities	Yes Potential displacement of shipping as a result of concurrent and consecutive activities	Section 6.1.3.3 (Shipping) shows that OGV OPP activities will have Minor (1) consequences to existing and future shipping activity. Whilst cumulative effect pathway identified from other foreseeably reasonable projects identified, impacts are not considered material. The area of impact is small compared to the area available for shipping. Industry standard controls in place such as notice to mariners will provide advanced warning and opportunity to plan transit route. At most avoiding a single seismic survey vessel and towed equipment, and a single drilling location at any given time will have minimal interaction between activities.	High - impacts to shipping activities well understood	Identified but impacts not material, no further assessment required
Marine Tourism	Physical Presence - Interaction with Other Users	**Acceptable level 14:** No interference with other marine users to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties as conferred by the titles granted to Beach.	Yes Potential displacement of marine tourists as a result of concurrent and consecutive activities	Yes Potential displacement of marine tourists as a result of concurrent and consecutive activities	Section 6.1.3.4 (Tourism and Recreational Diving and Fishing) shows that OGV OPP activities are unlikely to impact tourism activities. Whilst cumulative effect pathway identified from other foreseeably reasonable projects identified, impacts are not considered material. Diving and recreational fishing are most likely to occur in coastal areas. The area of displacement is small compared to area available for tourism. Industry standard controls in place such as notice to mariners will provide advanced warning and opportunity to plan transit route. At most avoiding a single seismic survey vessel and towed equipment, and a single drilling location at any given time with minimal impact.	High - impacts to marine tourism activities well understood	Identified but impacts not material, no further assessment required
Recreational Fishing	Physical Presence - Interaction with Other Users	**Acceptable level 14:** No interference with other marine users to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties as conferred by the titles granted to Beach.	Yes Potential displacement of recreational fishers as a result of concurrent and consecutive activities	Yes Potential displacement of recreational fishers as a result of concurrent and consecutive activities	Section 6.1.3.4 (Tourism and Recreational Diving and Fishing) shows that OGV OPP activities are unlikely to impact tourism activities. Whilst cumulative effect pathway identified from other foreseeably reasonable projects identified, impacts are not considered material. Diving and recreational fishing are most likely to occur in coastal areas. The area of displacement is small compared to area available for recreational fishing. Industry standard controls in place such as notice to mariners will provide advanced warning and opportunity to plan transit route. At most avoiding a single seismic survey vessel and towed equipment, and a single drilling location at any given time with minimal interaction between activities.	High - impacts to recreational fishing well understood	Identified but impacts not material, no further assessment required
Commercial Fisheries	Physical Presence - Interaction with Other Users Physical Presence – Seabed Disturbance Emissions – Greenhouse Gas Discharges – Drill Cuttings and Cement	**Acceptable level 14:** No interference with other marine users to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties as conferred by the titles granted to Beach.	Yes Potential displacement of commercial fishers as a result of concurrent and consecutive activities	Yes Potential displacement of commercial fishers as a result of concurrent and consecutive activities	Cumulative effect pathway identified. Displacement of fishers operating in fisheries with spatial extent that may be overlapped by a number of offshore activities, i.e. displaced by multiple exclusion zones (MODU and seismic survey) or different exclusion zone over time. Although displacement impacts are restricted to within typically 2-3 kms around individual activities (see Section 6.1.3.1 (Commonwealth and State Managed Fisheries), drilling may be occurring consecutively over a period of time and seismic and drilling at one location have the potential to occur concurrently. Whilst Minor (1) behavioural disturbances are predicted to commercial fish species from underwater sound, cumulative impacts are not predicted.	High – areas of fishing activity known with impacts to commercial fishing well understood	Identified and further assessment required to determine if impacts are material.
First Nations Cultural Values and Sensitivities	Physical Presence – Interaction with Other Users Physical Presence – Seabed Disturbance Emissions – Light Emissions – Underwater Sound	**Acceptable level 16**: No impacts on declared areas or objects of particular significance with values as conferred by the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth).	Yes Potential overlap with Sea Country a result of concurrent and consecutive activities	Yes Potential overlap with Sea Country a result of concurrent and consecutive activities	All cultural values and First Nations sensitivities have been reviewed, and cumulative effect pathways for receptors with cultural intangible values have been identified. It is considered that the potential for cumulative impacts to whales (blue and southern right whales) and birds (orange-bellied parrot, short-tailed shearwater) may prevent First Nations people's obligations to maintain spiritual connections and care for culturally significant species. Impacts from the drilling and P&A activities to other cultural values identified such as fish, eels, dolphins, and seals are at a very small scale, which is not predicted to be material to contribute to cumulative impacts.	High - impacts well understood with the addition of control measures to avoid sensitive submerged cultural heritage	Identified for the blue and southern right whale and the orange-bellied parrot and short-tailed shearwater with further assessment required to determine if impacts are material

	Emissions – Greenhouse Gas Discharges – Drill Cuttings and Cement Discharges – Commissioning and Operations Discharges - Vessels	Impacts to submerged cultural heritage are not predicted from the drilling and P&A activities based on a seabed survey will be undertaken to identify any cultural heritage and if identified Beach will consult with the relevant First Nations groups and determine any exclusion areas or further cultural heritage management procedures that may be required.	and results in cumulative impacts at a population level.

Table 8-3: Cumulative Impact Assessment Outcomes for Interaction with Other Users

Aspect	**Interaction with Other Users**
Receptor	**Commercial fishers**
Conservation (or other) value and Status	Socio-economic value to local communities and national economy. The Project Area overlaps where there is fishing intensity for: • Commonwealth Bass Strait Central Zone Scallop Fishery - < 5 vessels • Commonwealth Eastern Tuna and Billfish Fishery - < 5 vessels • Commonwealth Southern and Eastern Scalefish and Shark Fishery (SESSF) ◦ Commonwealth Trawl Sector ▪ Otter-board trawl – Low intensity ▪ Danish-seine – < 5 vessels ◦ Gillnet, Hook and Trap Sector ▪ Scalefish Hook - < 5 vessels ▪ Shark Gillnet – Medium intensity ▪ Shark Hook - < 5 vessels • Commonwealth Southern Bluefin Tuna Fishery - < 5 vessels • Commonwealth Southern Squid Jig Fishery – Low intensity • Victorian Giant Crab – up to 84 days fished • Victorian Rock Lobster Fishery - up to 139 days fished • Victorian Wrasse (Ocean) Fishery – up to 1 day fished
Legislative or Other requirements	*OPGGS Act 2006 (Cth).* Southern and Eastern Scalefish and Shark Fishery (SESSF) Species Summaries (AFMA 2023)
Threatening Processes Relevant to Aspect	None, other than fishing pressure for school shark
Relevant OGV OPP Spatial and Temporal Extent	Fishery Management Areas for the duration of the Project.
Relevant Actions from Legislative or Other Requirements	OPGGS Act 2006 (Cth) Section 280 – requires that a person carrying on activities in an offshore area under the permit, lease, licence, authority, or consent must carry out those activities in a manner that does not interfere with navigation or fishing (among others).
Baseline Environment Condition	Listed fisheries that overlap the Project Area may also interact or be displaced by with: • existing oil and gas activity (Section 4.5.2) • existing shipping (see Section 4.5.6) Current fisheries in the area historically have sustainable stock status (Sections 4.5.10, 4.5.11, 4.5.12).
Acceptable Level	**Acceptable level 14:** No interference with other marine users to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties as conferred by the titles granted to Beach.
Other Reasonably Foreseeable Projects/ Activities Relevant to Aspect	SESSF: Commonwealth Trawl Sector Otter Board, SESSF: Commonwealth Trawl Sector Danish-seine and Southern Squid Jig Fishery potential cumulative impact from exclusion zones associated with reasonably foreseeable projects as detailed in Table 8-1 : • One seismic survey occurring concurrently with drilling/P&A activities and/or Project installation activities. • Consecutive drilling/P&A activities and/or Project installation activities (including those over several seasons / years). • Concurrent drilling and installation activities (including those over several seasons / years). • Project infrastructure / IMR. Victorian Giant Crab and Southern Rock Lobster Fisheries potential cumulative impact from exclusion zones associated with: • One seismic survey occurring concurrently with drilling/P&A activities and/or Project installation activities. • Consecutive drilling/P&A activities and/or Project installation activities (including those over several seasons / years). • Concurrent drilling and installation activities (including those over several seasons / years).

Aspect	Interaction with Other Users
Receptor	**Commercial fishers**
	• Project infrastructure / IMR. Tasmanian Rock Lobster Fishery potential cumulative impact from exclusion zones associated with: • One seismic survey occurring concurrently with drilling/P&A activities and/or Project installation activities. • Consecutive drilling/P&A activities and/or Project installation activities (including those over several seasons / years). • Concurrent drilling and installation activities (including those over several seasons / years). Project infrastructure / IMR.
Description of Cumulative Impact (including spatial/temporal extent)	**Successive impacts -** Commercial fishers may potentially be displaced within relevant Fishery Management Areas in the offshore Otway Basin by the proposed Project and other reasonably foreseeable seismic surveys, drilling, installation, IMR and P&A activities. Drilling, seismic, installation and IMR activity exclusions will only apply while the activity is being undertaken (typically 2 to 3 km) with limited permanent exclusion zones (500 m) to apply to wells and subsea infrastructure present for the duration of production. Drilling, seismic, installation and IMR activities within the OGV OPP (Section 3.3) and other reasonably foreseeable projects (Table 8-1) are conducted over relatively short periods (drilling phases typically 30 to 40 days). **Additive impacts –** as above **Synergistic impacts –** none identified Beach has undertaken previous drilling, installation, IMR and Operations in the area with little displacement to commercial fishers based on the consultation and notification controls implemented that will also be applied to the Project.
Certainty of Assessment	Given the intensity of fishing in the area, and the overlap of fishery management areas with the proposed activities of multiple titleholders, the assessment of cumulative impacts is made with a high level of predictability and certainty.
Existing Control Measures to Meet Acceptable Levels	OGV Project control measures, developed to meet defined acceptable levels, are directly applicable to reducing the potential consequences of cumulative impacts. These control measures are Beach's primary means of mitigating cumulative impacts. Beach has no direct authority over the planning, implementation, or management of other reasonably foreseeable projects and activities that may potentially contribute to cumulative impacts. A single MODU has been contracted to conduct drilling/P&A activities in the region, mitigating the potential for concurrent impacts from these activities. Titleholders overlapping fishery management areas with recorded fishing intensity are required to consult with affect parties and typically have ongoing notifications processes and a compensation protocol in place to ensure fishers are no worse off as a result of their proposed activity. Existing control measures (as listed below) to meet defined acceptable levels are fully detailed in Table 6-2. • CM03 Fair Ocean Access Procedure • CM04 Stakeholder consultation • CM05 Petroleum safety zones • CM06 Temporary exclusion/cautionary zones
Additional Control Measures	Recognising the shared responsibility for managing cumulative impacts, Beach will actively collaborate with other petroleum titleholders, share relevant data and promote coordinated efforts to ensure that all reasonably foreseeable projects and activities adhere to acceptable environmental standards to mitigate cumulative impacts. **Additional Controls:** Observation, incidents, and opportunities for improvement regarding the interaction with other users will be reported to other petroleum titleholders. This additional control has been adopted and included against CM04: Stakeholder consultation, as updated in ES Table 0-4. CM51 Each future EP resulting from the OGV OPP will undertake a review for additional or significantly revised reasonably foreseeable projects. Additional or significantly revised projects will be assessed as per CIA methodology (Section 8.2). Any cumulative impacts from new, significantly revised or currently unknown activities that results in an unacceptable level of impact to receptors, will be subject to new or revised control measures within the appropriate EP to reduce cumulative impacts to ALARP.
Residual Cumulative Consequence	**Minor (1)**
Acceptable Level Achieved	Yes – Following completion of the CIA process, the residual lower order – Minor (1) consequence is considered acceptable because: • The nature and scale of displacement is considered acceptable. • Good practice controls are defined and will be implemented. • The activities will be managed in accordance with relevant company, Commonwealth, international, and Industry standards, guidelines, and requirements.

Table 8-4: Cumulative Impact Assessment Outcomes for Light Sensitive Species

Aspect	**Light Sensitive Species**		
Receptor	Orange-bellied parrot (OBP)	Short-tailed shearwaters (fledglings)	Common diving-petrel
Conservation (or other) value and Status	Listed as Critically Endangered and Marine under the EPBC Act and noted as a species of cultural significance.	Not listed as threatened under the EPBC Act. Listed as Marine and Migratory. Foraging BIAs within flaring EMBA (September to May) The short-tailed shearwater is one of few Australian native birds that is harvested to this day (DNRET 2019).	Not listed as threatened under the EPBC Act. Listed as Marine. Listed as a conservation value in the south-east and temperate east. Does not have a recovery plan or conservation advice.
Legislative or Other requirements	National Recovery Plan for the Orange-bellied Parrot (DoE 2016) National Light Pollution Guidelines for Wildlife (DCCEEW 2023a).	National Recovery Plan for Albatrosses and Petrels (CoA 2022). Wildlife Conservation Plan for Seabirds (CoA 2020). National Light Pollution Guidelines for Wildlife (DCCEEW 2023a).	National Recovery Plan for Albatrosses and Petrels (CoA 2022). Wildlife Conservation Plan for Seabirds (CoA 2020). National Light Pollution Guidelines for Wildlife (DCCEEW 2023a).
Threatening Processes Relevant to Aspect	The National Recovery Plan for the Orange-bellied Parrot lists barriers to migration and movement as a threat. It is suggested that illuminated boats and structures within the migration route could act as a barrier to migration (weak evidence for impact, moderate risk rating). Only barriers within the migration route are considered a threat. Overlap with other light sources (Light and Flaring EMBAs) are not detailed as a threat.	Light pollution, including from gas flaring, is listed as a threat to seabirds in the Wildlife Conservation Plan, with potential for consequences affecting individuals but not whole populations. The recommended management action is to implement measures to reduce the impact of light pollution near breeding colonies. It also states that adult seabirds are less impacted by artificial lighting than fledglings and while vessels may directly affect seabirds through their activities, the Plan only lists those close to colonies or roost sites. The National Recovery Plan for Albatrosses and Petrels also states that light associated with coastal developments at or adjacent to breeding sites represents a moderate threat to short-tailed shearwater.	Light emissions are identified as a threat in the National Recovery Plan for Albatrosses and Petrels but marine infrastructure interactions, including those associated with artificial light, are classified as having no risk category priority and affecting 'Nil' species in Australian jurisdiction. Light pollution, including from gas flaring, is listed as a threat to seabirds in the Wildlife Conservation Plan for Seabirds, with potential for consequences affecting individuals but not whole populations. Potential for light emissions from the activity to overlap with the nocturnal foraging.
Relevant OGV OPP Spatial and Temporal Extent	The probable migration route is detailed in Figure 4-42 and Figure 4-64. OGV Project Area overlaps the OBP probable migration route by ~0.075% Probable Migration Route September-November (Southward); February-mid-March (northwards).	Short-tailed shearwater BIAs are detailed in Figure 4-41 and Figure 6-2. The OGV Light and Flaring EMBA overlap the short-tailed shearwater's foraging BIAs by 0.77% and 2.91% respectively. The OGV Light EMBA does not overlap any short-tailed shearwater Breeding BIAs The OGV Flaring EMBA overlaps the known fledgling areas at Middle and Griffith Islands. Worst case light levels from OGV OPP flaring activities have been calculated as ~0.001 Lux for both sites (illuminance equivalent to ambient light on a moonless clear night sky/new moon). Changes in ambient light at these levels are not known to cause behavioural disturbance as per those described in DCCEEW (2023a). The OGV Flaring EMBA does not overlap the known fledgling area at Deen Maar. Fledging period end of April to beginning of May.	The common-diving petrel are detailed in Figure 4-40 and Figure 6-2. The OGV OPP light and flaring EMBA overlaps the common-diving petrel foraging BIA by ~1.47% and ~4.68% respectively. Present year round. Common diving-petrels are thought to be fairly sedentary, remaining more or less in the area of their breeding colony year-round, however, there are instances where individuals have been recorded venturing into the open ocean to forage outside of the breeding season and may migrate to more tropical climates (Brooke 2004). Within the Bass Strait the common diving-petrels has shown high foraging efforts compared to other populations (with foraging trips averaging 71 ± 3 km). This is believed to potentially be due to the sparse distribution of prey such as krill (Formant et al. 2021).
Relevant Actions from Legislative or Other Requirements	Assess the risk of barriers, being illuminated structures or boats, on the probable migration route. Manage threat if the risk rating warrants action. National Light Pollution Guidelines for Wildlife recommend: 1. Always using Best Practice Lighting Design to reduce light pollution and minimise the effect on wildlife. 2. Undertaking an Environmental Impact Assessment for effects of artificial light on listed species for which artificial light has been demonstrated to affect behaviour, survivorship or reproduction.	Wildlife Conservation Plan for Seabirds: Mitigate against impacts of light pollution around breeding colonies. National Light Pollution Guidelines for Wildlife recommend: 1. Always using Best Practice Lighting Design to reduce light pollution and minimise the effect on wildlife. 2. Undertaking an Environmental Impact Assessment for effects of artificial light on listed species for which artificial light has been demonstrated to affect behaviour, survivorship or reproduction.	Wildlife Conservation Plan for Seabirds: Mitigate against impacts of light pollution around breeding colonies. National Light Pollution Guidelines for Wildlife recommend: 1. Always using Best Practice Lighting Design to reduce light pollution and minimise the effect on wildlife. 2. Undertaking an Environmental Impact Assessment for effects of artificial light on listed species for which artificial light has been demonstrated to affect behaviour, survivorship or reproduction.

Aspect	**Light Sensitive Species**		
Receptor	Orange-bellied parrot (OBP)	Short-tailed shearwaters (fledglings)	Common diving-petrel
Baseline Environment Condition	Ambient light within the Project Area is detailed within Section 4.3.6. The OBP migration route may also be impacted by light sources from: • existing oil and gas activity (Section 4.5.2) • existing shipping (Section 4.5.6). • current commercial fishing effort (Section 4.5.10, 4.5.11, 4.5.12) Note on average ~121 individual vessels pass through the OBP probable migration route area per day.	Ambient light within the Project Area is detailed within Section 4.3.6. The short-tailed shearwater may also be impacted by light sources from: • existing oil and gas activities (Section 4.5.2) • existing shipping (Section 4.5.6) • current commercial fishing effort (Section 4.5.10, 4.5.11, 4.5.12). Note on average ~15 individual vessels pass through the OGV Flaring EMBA per day. On average ~2.5 vessels operate within 20 km of Middle and Griffith Islands plus Deen Maar breeding areas per day. Additional anthropogenic light sources within the vicinity of breeding sites include streetlights, building lights, façade lights, and vehicular. Beach expects that seabirds within the area are highly habituated to light emissions from continuous and long-term exposure to shipping vessels, existing oil and gas activities plus Additional anthropogenic light sources.	Ambient light within the Project Area is detailed within Section 4.3.6. The common-diving petrel may also be impacted by light sources from: • existing oil and gas activities (Section 4.5.2) • existing shipping (Section 4.5.6) • current commercial fishing effort (Section 4.5.10, 4.5.11, 4.5.12). Note on average ~430 individual vessels pass through the common-diving petrel foraging BIA per day. Beach expects that seabirds within the foraging area are highly habituated to light emissions from continuous and long-term exposure to shipping vessels and existing oil and gas activities as per other species (Dunlop and Rippey 2001). Additional anthropogenic light sources within the vicinity of coastal areas include streetlights, building lights, façade lights, vehicular.
Acceptable Level	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species.	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species.	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species.
Other Reasonably Foreseeable Projects/ Activities Relevant to Aspect	Potential scenarios for other reasonably foreseeable projects / activities relevant to have potential cumulative impacts: • One seismic survey occurring concurrently with drilling/P&A activities and/or Project installation activities. • Consecutive drilling/P&A activities and/or Project installation activities (including those over several seasons / years). • Concurrent drilling and installation activities (including those over several seasons / years). • Concurrent project infrastructure / IMR activities (including those over several seasons / years). • Consecutive project infrastructure / IMR activities. (including those over several seasons / years). Drilling, seismic, installation and IMR activities within the OGV OPP (Section 3.3) and other reasonably foreseeable projects (Table 8 1) are conducted over relatively short periods (drilling phases typically 30 to 40 days). Other reasonably foreseeable future projects areas within the OBP probable migration route consist of: • Amplitude Energy CHN operations (~0.025% overlap) • Amplitude Energy East Coast Supply Project (~0.007% overlap)	Potential scenarios for other reasonably foreseeable projects / activities relevant to have potential cumulative impacts: • One seismic survey occurring concurrently with drilling/P&A activities and/or Project installation activities. • Consecutive drilling/P&A activities and/or Project installation activities (including those over several seasons / years). • Concurrent drilling and installation activities (including those over several seasons / years). • Concurrent project infrastructure / IMR activities (including those over several seasons / years). • Consecutive project infrastructure / IMR activities. (including those over several seasons / years). Other reasonably foreseeable future projects areas with light EMBAs that overlap Middle and Griffith Islands plus Deen Maar breeding areas: • Alinta Energy and JERA Nex - Spinifex Offshore Wind. 3 x breeding areas between 20 and 23 km from operational area therefore outside expected vessel light EMBA). • Amplitude Energy - Athena Supply Project (Flaring EMBA (49 km) overlaps Middle Island only). Approximate distance to closest flare site is 41 km which has a calculated light intensity of <0.002 Lux.	Potential scenarios for other reasonably foreseeable projects / activities relevant to have potential cumulative impacts: • One seismic survey occurring concurrently with drilling/P&A activities and/or Project installation activities. • Consecutive drilling/P&A activities and/or Project installation activities (including those over several seasons / years). • Concurrent drilling and installation activities (including those over several seasons / years). • Concurrent project infrastructure / IMR activities (including those over several seasons / years). • Consecutive project infrastructure / IMR activities. (including those over several seasons / years). Other reasonably foreseeable future projects areas within the common-diving petrel foraging BIA consist of: • Alinta Energy and JERA Nex - Spinifex Offshore Wind – light EMBA (~0.07% overlap) • Amplitude Energy - Casino-Henry-Netherby (CHN) Operations – Light EMBA (~0.58% overlap) • Amplitude Energy - Athena Supply Project – Flaring EMBA (~1.78% overlap), light EMBA (~0.64% overlap)

Aspect	**Light Sensitive Species**		
Receptor	Orange-bellied parrot (OBP)	Short-tailed shearwaters (fledglings)	Common diving-petrel
	• CGG Regia MSS (~0.181% operational overlap. No overlap with acquisition or line turn areas) • Woodside Minerva P&A (~0.026% overlap) Temporal: Consecutive and concurrent operations over the lifetime of OGV OPP activities (see Section 3.8) may result in multiple vessels within the probable migration route.	• Amplitude Energy - East Coast Supply Project (Flaring EMBA (49 km) overlaps Middle and Griffiths Island only). Approximate distance to closest flare site is 32 km which has a calculated light intensity of ~0.004 Lux. • CGG Services Australia - Regia Marine Seismic Survey (MSS) – Acquisition Area and line turns are within 20 km of Deen Maar. Nearest line turn is ~1 km to Deen Maar which has a calculated light intensity of <0.001 Lux. • ConocoPhillips - Otway Exploration Drilling Program. 3 x breeding areas between 17 and 20 km from operational area. Calculated light intensity of <0.001 Lux. 3 x breeding areas between 19 and 22 km from closest flare site which has a calculated light intensity of <0.007 Lux. Temporal: Consecutive and concurrent operations over an extended period of time may have vessels within the probable migration route.	• Amplitude Energy - East Coast Supply Project - Flaring EMBA (~2.15% overlap), light EMBA (~0.79% overlap) • Beach Energy - Otway Offshore Operations - light EMBA (~0.83% overlap) • Beach Energy - Offshore Gas Victoria Drilling Program - light EMBA (~3.03% overlap) • CGG Services Australia - Regia Marine Seismic Survey (MSS) - light EMBA (~3.29% overlap) • ConocoPhillips - Otway Exploration Drilling Program Flaring EMBA (~7.5% overlap), light EMBA (~3.7% overlap) • Woodside Energy - Minerva P&A and decommissioning - light EMBA (~0.25% overlap) Temporal: Consecutive drilling operations over an extended period of time may have light EMBAs that overlap the foraging BIA.
Description of Cumulative Impact (including spatial/temporal extent)	With the OGV OPP Project Area minimal overlap (~0.075%) with the OBP probable migration route the likelihood of a vessel or MODU acting as a barrier to the OBP is considered negligible. Potential OGV OPP well sites are situated outside of the OBP probable migration route. Section 6.3.3.2 (Emissions – Light) assessed the impacts to all bird species by OGV OPP activities as having Minor (1) consequences. **Successive and Additive impacts** - Due to the location of potential drilling sites, a MODU (acting as a barrier) will only be present in the OBP probably migration route for activities under Woodside's approved Minerva Decommissioning and Field Management Environment Plan (Woodside 2025). Only activity areas associated with the approved Woodside Minerva decommissioning activities (Woodside 2025) and Amplitudes CHN operations EP (Cooper 2024) overlap the OBP probable migration route. Neither EP identifies any long-term population viability to the OBP or impacts resulting from cumulative impacts. Whilst Regia MSS operational area is within the probable migration route, there is no overlap with acquisition or line turn areas. The likelihood of vessels (barriers) from the Regia MSS being within the OBP probable migration route are considered negligible. With the minimal overlap of all reasonably foreseeable future projects vessels, being within the OBP probable migration route, the likelihood of additional vessels acting as barriers to the OBP are considered negligible. The presence of all vessels will be temporary with no permanent illuminated structures within the OBP probably migration route. In addition, any vessel present will not bisect the probable migration route area restricting migration. Consideration should be given that ~121 vessels are present within the OBP probable migration route each day. Cumulative impacts resulting from the temporary presence of 1 to 3 additional OGV vessels and those from other reasonably foreseeable projects within the small portion of the OBP probable migration route are not of a concern considering the nature and scale of the existing environment. In addition, Beach has been operating in the Otway Basin and undertaking similar activities to the Project activities with no evidence of	Impact assessment of light emissions (Section 6.3.3.2) found that for short-tailed shearwaters, the behavioural response threshold range for fledgling shearwaters against flaring light emissions excludes the breeding locations (Middle Island and Griffiths Island). Due to its distance from OGV OPP activities, fledglings at Deen Maar were not considered. **Successive and Additive impacts** - Potential impacts to short-tailed shearwaters from OGV activities are expected to be limited to foraging individuals and therefore no impacts to short-tailed shearwater fledglings will occur. Short-tailed shearwaters are not known to forage at night therefore the impact from light emissions form OGV operations on foraging short-tailed shearwaters is considered negligible. In addition, modelling by Pendoley (2022) showed that light levels from a large pipelay vessel fell below those know to impact hatchling behaviour at 14.8 km from the vessel. The only project known to have vessels that will be within 14.8 km is CGG's Regia MSS. Approximately 40 km of acquisition lines and run-ins are within 14.8 km of the fledgling sites at Deen Maar. At an estimated 4 knots the equates to a total of 5.5 hours that the CGG vessels may impact fledging sites. Calculated levels for other reasonably foreseeable projects show negligible increases in light intensity levels at the Middle and Griffiths Island and Deen Maar breeding sites which are well below those known to cause behavioural disturbance to short-tailed shearwater fledglings (Section6.3.3.2, DCCEEW 2023a). Existing conditions show that on average ~2.5 vessels not connected with either OGV OPP activities or other reasonably foreseeable activities, operate within 20 km of the breeding sites. The presence of all vessels connected to OGV OPP and other reasonably foreseeable activities will be temporary with no permanent fixed structures. Light intensity from flaring has been shown to be negligible at the breeding sites and are all short-term (1 – 2 days) with possible impacts unlikely during daylight hours. **Synergistic impacts** – none identified with the presence of a MODU and additional vessels.	Section 6.3 (Emission - Light) found that impacts from temporary OGV Project light emissions are expected to be limited to individuals and therefore no impacts to petrels will occur at a population level with Minor (1) consequences. **Successive and Additive impacts** – Light EMBAs for the OGV OPP and other reasonably foreseeable projects have been shown to have limited overlap with the common diving-petrel foraging BIA. Light EMBAs for non-flaring activities are based on conservative thresholds to provides a precautionary limit based on observed effects (20 km) (DCCEEW 2023). Modelling (Appendix O, Pendoley 2022) and observed effects (Rodriguez et al 2017) show area of behavioural impact to be significantly smaller. Therefore, the area of influence, as detailed by percentage overlap of the foraging BIA above, will be negligible considering the nature and scale of the foraging area. In addition, any vessel present will not bisect the BIA restricting critical behaviour .Successive and additive impacts to foraging activities of the common diving-petrel are considered unlikely Light EMBAs for flaring activities are based a change in ambient light levels (0.001 Lux). Behavioural response of bird species at these light intensity levels are not expected which have been calculated to be significantly less (0.18 Lux, adapted from Rodriguez et al 2017). At 63 MMscfd, 0.18 Lux is reached at <10 km from flare source. The successive and additive cumulative impact of light emissions from OGV OPP activities and other reasonably foreseeable projects would be very low in comparison to the light emissions associated with existing shipping and fishing operations within the foraging BIA. The addition of limited vessels to the ~430 vessels already passing through the foraging BIA daily would not significantly increase light intensity levels in the area. With the high level of shipping, the current environment is not considered pristine. The area covered by the foraging BIA is not a habitat that encourages site-fidelity (i.e. seabirds are not

Aspect	Light Sensitive Species		
Receptor	Orange-bellied parrot (OBP)	Short-tailed shearwaters (fledglings)	Common diving-petrel
	OBP presence recorded. Other operators including previous seismic surveys have also not had evidence of OBP presence recorded. OBP numbers continue to increase. **Synergistic impacts** – none identified with the presence of a MODU and additional vessels.		permanently present, are typically transiting whilst opportunistically foraging over wide areas). Beach expects that seabirds within the foraging area are highly habituated to light emissions from continuous and long-term exposure to shipping vessels and existing oil and gas activities. In addition, all vessels connected to OGV OPP and other reasonably foreseeable activities will be temporary with no permanent fixed structures as detailed in Section 3.8 and Table 8-1. Light intensity from flaring is expected to have limited successive cumulative impacts as flaring per project is limited (1-2 days each) with each program expected to take 30 to 60 days. The time between flaring events is expected to be >1 month with the MODU typically 30 to 60 days on site plus the time taken to reposition to the next well site. In addition, not all wells from OGV OPP and other reasonably foreseeable projects will be undertaking flaring activities. Additive or synergistic cumulative impacts from flaring at not possible as a single MODU is being used by operators in the area. **Synergistic impacts** – none identified with the presence of a MODU and additional vessels.
Certainty of Assessment	There is no published information available on the sensitivity of the orange-bellied parrot to light, and only anecdotal evidence exists regarding the impact of barriers to migration (DELWP 2016a). However, light modelling (Appendix O) and impacts on other bird species is well understood (Section 6.3.3.2).	Beach has been operating in the Otway Basin and undertaking similar activities to the Project activities without incident to date of birds being attracted to MODUs or vessels. Other operators including previous seismic surveys have also not had incidents of bird attraction. Light modelling (Appendix O) and impacts on bird species is well understood (Section 6.3.3.2). The assessment of cumulative impacts is made with a high level of predictability and certainty due to the consistent negligible light intensity levels at the breeding sites from OGV activities and other reasonably foreseeable activities.	Beach has been operating in the Otway Basin and undertaking similar activities to the Project activities without incident to date of birds being attracted to MODUs or vessels. Other operators including previous seismic surveys have also not had incidents of bird attraction. Light modelling (Appendix O) and impacts on bird species is well understood (Section 6.3.3.2) as well as modelling conducted for other reasonably foreseeable projects (Table 8-1) and similar offshore construction projects (Pendoley 2022) The assessment of cumulative impacts is made with a high level of predictability and certainty from current modelling.
Existing Control Measures to Meet Acceptable Levels	OGV Project control measures, developed to meet defined acceptable levels, are directly applicable to reducing the potential consequences of cumulative impacts. These control measures are Beach's primary means of mitigating cumulative impacts. Beach has no direct authority over the planning, implementation, or management of other reasonably foreseeable projects and activities that may potentially contribute to cumulative impacts. A single MODU has been contracted to conduct drilling/P&A activities in the region, mitigating the potential for concurrent impacts from these activities. Beach will conduct drilling activities at one location at a time and abide by relevant activity exclusion zones in place for other activities in the offshore Otway Basin, which will minimise the potential for successive and additive cumulative impacts from light emissions. Existing control measures to meet defined acceptable levels (as listed below) are fully detailed in Table 6-3. • CM05 Petroleum safety zones • CM06 Temporary exclusion/cautionary zones	OGV Project control measures, developed to meet defined acceptable levels, are directly applicable to reducing the potential consequences of cumulative impacts. These control measures are Beach's primary means of mitigating cumulative impacts. Beach has no direct authority over the planning, implementation, or management of other reasonably foreseeable projects and activities that may potentially contribute to cumulative impacts. A single MODU has been contracted to conduct drilling/P&A activities in the region, mitigating the potential for concurrent impacts from these activities. Beach will conduct drilling activities at one location at a time and abide by relevant activity exclusion zones in place for other activities in the offshore Otway Basin, which will minimise the potential for successive and additive cumulative impacts from light emissions. Existing control measures to meet defined acceptable levels (as listed below) are fully detailed in Table 6-3. • CM05 Petroleum safety zones • CM06 Temporary exclusion/cautionary zones	OGV Project control measures, developed to meet defined acceptable levels, are directly applicable to reducing the potential consequences of cumulative impacts. These control measures are Beach's primary means of mitigating cumulative impacts. Beach has no direct authority over the planning, implementation, or management of other reasonably foreseeable projects and activities that may potentially contribute to cumulative impacts. A single MODU has been contracted to conduct drilling/P&A activities in the region, mitigating the potential for concurrent impacts from these activities. Beach will conduct drilling activities at one location at a time and abide by relevant activity exclusion zones in place for other activities in the offshore Otway Basin, which will minimise the potential for successive and additive cumulative impacts from light emissions. Existing control measures to meet defined acceptable levels (as listed below) are fully detailed in Table 6-3.

Aspect	**Light Sensitive Species**		
Receptor	Orange-bellied parrot (OBP)	Short-tailed shearwaters (fledglings)	Common diving-petrel
	Titleholders with Light EMBAs overlapping or adjacent to the OBP migration route are required to have a light management plan that meets the requirements of the National Light Pollution Guidelines. Existing control measures to meet defined acceptable levels (as listed below) are fully detailed in Table 6-15. - CM12 MODU and vessel lighting CM13 Lighting Management Procedure	Titleholders with Light EMBAs overlapping or adjacent to the breeding sites are required to have a light management plan that meets the requirements of the National Light Pollution Guidelines. Existing control measures to meet defined acceptable levels (as listed below) are fully detailed in Table 6-15. - CM12 MODU and vessel lighting - CM13 Lighting Management Procedure	- CM05 Petroleum safety zones - CM06 Temporary exclusion/cautionary zones Titleholders with Light EMBAs overlapping or adjacent to the common-diving petrel foraging BIA are required to have a light management plan that meets the requirements of the National Light Pollution Guidelines. Existing control measures to meet defined acceptable levels (as listed below) are fully detailed in Table 6-15. - CM12 MODU and vessel lighting CM13 Lighting Management Procedure
Additional Control Measures	Recognising the shared responsibility for managing cumulative impacts, Beach will actively collaborate with other petroleum titleholders, share relevant data and promote coordinated efforts to ensure that all reasonably foreseeable projects and activities adhere to acceptable environmental standards to mitigate cumulative impacts. **Additional Controls:** Observation, incidents, and opportunities for improvement regarding the interaction with other users will be reported to other petroleum titleholders. This commitment has been adopted and included against CM04: Stakeholder consultation, as updated in ES Table 0-4. CM51 Each future EP resulting from the OGV OPP will undertake a review for additional or significantly revised reasonably foreseeable projects. Additional or significantly revised projects will be assessed as per CIA methodology (Section 8.2). Any cumulative impacts from new, significantly revised or currently unknown activities that results in an unacceptable level of impact to receptors, will be subject to new or revised control measures within the appropriate EP to reduce cumulative impacts to ALARP.	Recognising the shared responsibility for managing cumulative impacts, Beach will actively collaborate with other petroleum titleholders, share relevant data and promote coordinated efforts to ensure that all reasonably foreseeable projects and activities adhere to acceptable environmental standards to mitigate cumulative impacts. **Additional Controls:** Observation, incidents, and opportunities for improvement regarding the interaction with other users will be reported to other petroleum titleholders. This commitment has been adopted and included against CM04: Stakeholder consultation, as updated in ES Table 0-4. CM51 Each future EP resulting from the OGV OPP will undertake a review for additional or significantly revised reasonably foreseeable projects. Additional or significantly revised projects will be assessed as per CIA methodology (Section 8.2). Any cumulative impacts from new, significantly revised or currently unknown activities that results in an unacceptable level of impact to receptors, will be subject to new or revised control measures within the appropriate EP to reduce cumulative impacts to ALARP.	Recognising the shared responsibility for managing cumulative impacts, Beach will actively collaborate with other petroleum titleholders, share relevant data and promote coordinated efforts to ensure that all reasonably foreseeable projects and activities adhere to acceptable environmental standards to mitigate cumulative impacts. **Additional Controls:** Observation, incidents, and opportunities for improvement regarding the interaction with other users will be reported to other petroleum titleholders. This commitment has been adopted and included against CM04: Stakeholder consultation, as updated in ES Table 0-4. CM51 Each future EP resulting from the OGV OPP will undertake a review for additional or significantly revised reasonably foreseeable projects. Additional or significantly revised projects will be assessed as per CIA methodology (Section 8.2). Any cumulative impacts from new, significantly revised or currently unknown activities that results in an unacceptable level of impact to receptors, will be subject to new or revised control measures within the appropriate EP to reduce cumulative impacts to ALARP.
Residual Cumulative Consequence	**Minor (1)**	**Minor (1)**	**Minor (1)**
Acceptable Level Achieved	Yes – Following completion of the CIA process, the residual lower order – Minor (1) consequence is considered acceptable because: - Cumulative light emissions will not result in interference with the recovery of EPBC Act listed threatened species - Cumulative light emissions will not result in modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline - Cumulative light emissions will not result in inconsistencies with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species. - Light from drilling activities (including flaring) will only occur from a single location within the OBP probable migration route (no concurrent activities due the use of a single MODU between titleholders) and do not represent a permanent illuminated structure (or barrier) within the probable migration route.	Yes – Following completion of the CIA process, the residual lower order – Minor (1) consequence is considered acceptable because: - Cumulative light emissions will not result in interference with the recovery of EPBC Act listed threatened species - Cumulative light emissions will not result in modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline - Cumulative light emissions will not result in inconsistencies with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species. - Light from all drilling activities (including flaring) will only occur from a single location with no concurrent flaring activities due the use of a single MODU between titleholders. - Identified breeding areas for the short-tailed shearwater would only be overlapped by the OGV OPP and other reasonably foreseeable flaring EMBAs for short periods while flaring occurred.	Yes – Following completion of the CIA process, the residual lower order – Minor (1) consequence is considered acceptable because: - Cumulative light emissions will not result in interference with the recovery of EPBC Act listed threatened species - Cumulative light emissions will not result in modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline - Cumulative light emissions will not result in inconsistencies with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species. - Light from drilling activities (including flaring) will only occur from a single location (no concurrent activities due the use of a single MODU between titleholders), with

Aspect	**Light Sensitive Species**		
Receptor	Orange-bellied parrot (OBP)	Short-tailed shearwaters (fledglings)	Common diving-petrel
	• The presence of vessels / barriers from other reasonably foreseeable projects within the OBP probable migration route are short term and have minimal overlap. They do not bisect the probable migration route of the OBP and will not prevent migration. • Existing environment is not considered pristine in respect of light emissions with multiple vessels (~121 per day) operating within the OBP probable migration route. • Good existing and additional control measures are defined and will be implemented including MODU and vessels requirement to implement a Light Management Plan which will restrict light emissions. • The activities will be managed in accordance with relevant company, Commonwealth, international, and Industry standards, guidelines and requirements. • Due to the minimal cumulative impacts described, seasonal and restricted area controls are not considered necessary.	• OGV Flaring EMBA overlaps the known fledgling areas at Middle and Griffith Islands but with worst case light levels calculated as ~0.001 Lux, below levels known to cause behavioural disturbance in fledglings. • Existing environment is not considered pristine in respect of light emissions with additional anthropogenic light sources within the vicinity of breeding sites include streetlights, building lights, façade lights, and vehicular. • This species is not listed as threatened and periodic changes in ambient light at the predicted levels are unlikely to cause behavioural changes or result in injury/mortality to this species. • The impact of light emissions from other reasonably foreseeable projects overlapping the light emission from a MODU are predicted to result in increases in ambient light that are negligible (short-term, fully recoverable and do not represent permanent illuminated structures or boats within the close vicinity of the breeding sites). • Good existing and additional control measures are defined and will be implemented including MODU and vessels requirement to implement a Light Management Plan which will restrict light emissions. • The activities will be managed in accordance with relevant company, Commonwealth, international, and Industry standards, guidelines and requirements. • Due to the minimal cumulative impacts, seasonal and restricted area controls are not considered necessary.	limited overlap with the foraging BIA and do not represent permanent illuminated structures within the foraging area. • The impact of light emissions from other reasonably foreseeable projects overlapping the light emission from a MODU are predicted to result in increases in ambient light that are negligible (short-term, fully recoverable and do not represent permanent illuminated structures or boats within the foraging BIA). Light emissions do not bisect the foraging BIA and will not prevent critical behaviour. • Limited spatial extent of effect compared to area available for foraging. The National Recovery Plan states that marine infrastructure interactions, including those associated with artificial light, are classified as having no risk category priority and affecting 'Nil' species in Australian jurisdiction. • The common-diving petrel is known to forage over wide areas. • Good existing and additional control measures are defined and will be implemented including MODU and vessels requirement to implement a Light Management Plan which will restrict light emissions. • The activities will be managed in accordance with relevant company, Commonwealth, international, and Industry standards, guidelines and requirements. • Existing environment is not considered pristine in respect of light emissions Light emissions from OGV OPP activities and other reasonably foreseeable projects will be insignificant to the estimated 430 individual vessels that pass through the common-diving petrel foraging BIA per day. Additional anthropogenic light sources within the vicinity of coastal areas include streetlights, building lights, façade lights, vehicular also exist. • Beach expects that seabirds within the foraging area are highly habituated to light emissions from continuous and long-term exposure to shipping vessels and existing oil and gas activities. • Due to the minimal cumulative impacts, seasonal and restricted area controls are not considered necessary.

Table 8-5: Cumulative Impact Assessment Summary for Identified Cetaceans

Aspect	Cetaceans
Receptor	**Blue whale (BW), southern right whale (SRW) and other cetacean species with biologically important behaviours**
Conservation (or other) value and Status	Blue whale listed as Endangered under the EPBC Act Southern right whale listed as Endangered under the EPBC Act and noted as a species of cultural significance in the National Recovery Plan for the Southern Right Whale (DCCEEW 2024o). Fin whale (FW) listed as vulnerable under the EPBC Act Sei whale (SW) listed as vulnerable under the EPBC Act Pygmy right whale (PRW) no Listing Advice for this species
Legislative or Other requirements	Conservation Management Plan for the Blue Whale (DoE 2015) Guidance on key terms within the Blue Whale Conservation Management Plan (DAWE 2021a) National Recovery Plan for the Southern Right Whale (DCCEEW 2024o) Conservation Advice Balaenoptera physalus (fin whale) (TSSC 2015d). Conservation Advice Balaenoptera borealis (sei whale) (TSSC 2015e). No management plan or conservation advice for Caperea marginata (pygmy right whale).
Threatening Processes Relevant to Aspect	Conservation Management Plan for the Blue Whale identifies anthropogenic noise interference as a threat. National Recovery Plan for the Southern Right Whale identify noise interference as a threat. Conservation advice Balaenoptera physalus (fin whale) identifies anthropogenic noise and acoustic disturbance as a minor threat. Conservation advice Balaenoptera borealis (sei whale) identifies anthropogenic noise and acoustic disturbance as a minor threat.
Relevant OGV OPP Activities Spatial and Temporal Extent	BIAs for the BW are detailed in Figure 4-44 and Figure 6-6. BIAs for the SRW are detailed in Figure 4-60 and Figure 6-7. Underwater sound EMBAs for OGV Project Area overlap foraging and annual high use foraging BIAs for the BW (~2.06%), (presence is between November to June, peaking in February and March). Note a typical operational area (3 km radius + 7.98 km Noise EMBA) would overlap foraging and annual high use foraging BIAs by <0.2%. Underwater sound EMBAs for OGV Project Area overlap the migration BIA for the SRW (~0.18%) with SRW migrating through the area between approximately April to October. Note a typical operational area (3 km radius + 7.98 km Noise EMBA) would overlap migration BIA by <0.15%. Note, no OGV OPP underwater sound EMBAs overlap the SRW reproductive BIA. No BIAs or habitat critical to the survival of the FW, SW or PRW identified within the OGV underwater sound EMBAs. PMST report shows presence within EMBAs for FW, SW as listed as foraging, feeding or related behaviour known to occur within area, with PRW foraging, feeding or related behaviour may occur. Whilst there are no defined foraging areas for FW, SW or PRW off the coast of Victoria, it is likely foraging occurs in the same areas identified as the foraging BIAs for BW as they are often recorded foraging in the same areas (Gill et al. 2008; Gill et al. 2015; McCauley et al 2018). FW whale migrations are from higher latitude summer feeding grounds to lower latitude winter breeding grounds. SW seasonal migrations are from subpolar summer feeding grounds to lower latitude winter breeding grounds. Young PRW appear to be restricted to shallower coastal waters (Kemper 2002), possibly moving between areas of coastal upwelling. Weaned juveniles head south of 41° latitude into waters with higher prey abundance (Kemper 2002).
Relevant Actions from Legislative or Other Requirements	Conservation Management Plan for the Blue Whale states that anthropogenic noise in BIAs must be managed so that blue whales can continue to utilise the area without injury and [are] not displaced from a foraging area. DAWE (2021a) details that underwater anthropogenic noise should not: • Stop or prevent any blue whale from foraging • Cause any blue whale to move on when foraging, or • Stop or prevent any blue whale from entering a foraging area The National Recovery Plan for the Southern Right Whale identifies actions within and adjacent to SRW BIAs and habitat critical to the survival of SRWs should demonstrate that it does not prevent any southern right whale from utilising the area or cause auditory impairment and that the risk of behavioural disturbance is minimised. The Conservation Advice for *Balaenoptera physalus* (fin whale) and for *Balaenoptera borealis* (sei whale) identify anthropogenic noise and acoustic disturbance as a minor threat.
Baseline Environment Condition	Ambient sound within the Project Area is detailed within Section 4.3.7. Listed species identified may also be impacted by noise sources from: • existing oil and gas activities (Section 4.5.2) • existing shipping (Section 4.5.6) including current commercial fishing effort (Section 4.5.10, 4.5.11, 4.5.12). On average ~225 vessels operate within the BW combined foraging and foraging (annual high use area) (Otway region) BIAs per day with associated continuous noise emissions. On average ~1663 vessels operate within the SRW migration BIA per day with associated continuous noise emissions.

Aspect	Cetaceans
Receptor	**Blue whale (BW), southern right whale (SRW) and other cetacean species with biologically important behaviours**
Acceptable Level	**Acceptable level 1:** No interference with the recovery of EPBC Act listed threatened species. **Acceptable level 2:** No modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline. **Acceptable level 3:** Impacts will not be inconsistent with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species.
Other Reasonably Foreseeable Projects/ Activities Relevant to Aspect	Potential scenarios for other reasonably foreseeable projects / activities relevant to have potential cumulative impacts: • One seismic survey occurring concurrently with drilling/P&A activities and/or Project installation activities. • Consecutive drilling/P&A activities and/or Project installation activities (including those over several seasons / years). • Concurrent drilling and installation activities (including those over several seasons / years). • Concurrent project infrastructure / IMR activities (including those over several seasons / years). • Consecutive project infrastructure / IMR activities. (including those over several seasons / years). Other reasonably foreseeable projects underwater sound EMBAs that overlap the combined BW foraging and annual high use foraging BIAs and the SRW migration and reproductive BIAs are detailed below. Alinta Energy and JERA Nex - Spinifex Offshore Wind: • Estimated underwater sound EMBAs overlap foraging and annual high use foraging BIAs for the BW <1.4%. • Estimated underwater sound EMBAs overlap migration and reproduction BIA for the SRW <0.5% and <0.5% respectively • Project is in the pre-planning phase and as such no specific details are currently publicly available. However, if future underwater sound modelling predicts an overlap with the SRW reproductive BIA, seasonal controls would be likely be based on similar approved developments in the area (Woodside 2025). Amplitude Energy - Casino-Henry-Netherby (CHN) Operations: • Underwater sound EMBAs overlap foraging and annual high use foraging BIAs for the BW <0.5% • Underwater sound EMBAs overlap migration and reproduction BIA for the SRW <0.05% and <0.5% respectively • Approved EP shows no seasonal controls to restrict activities Amplitude Energy - Athena Supply Project: • Underwater sound EMBAs overlap foraging and annual high use foraging BIAs for the BW (<0.5%) • Underwater sound EMBAs overlap migration BIA for the SRW (<0.05%) • No overlap with SRW reproductive BIA • EP under assessment, shows no seasonal controls proposed to restrict activities Amplitude Energy - East Coast Supply Project • Underwater sound EMBAs overlap foraging and annual high use foraging BIAs for the BW (<0.8%) • Underwater sound EMBAs overlap migration and reproduction BIA for the SRW <0.2% and <2% respectively • Under assessment, shows no seasonal controls proposed to restrict activities Beach Energy - Otway Offshore Operations • Underwater sound EMBAs overlap foraging and annual high use foraging BIAs for the BW <1% • Estimated underwater sound EMBAs overlap migration and reproduction BIA for the SRW <0.1% and <0.5% respectively • Approved EP shows no seasonal controls to restrict activities Beach Energy - Offshore Gas Victoria Drilling Program • Underwater sound EMBAs overlap foraging and annual high use foraging BIAs for the BW <3.3% • Underwater sound EMBAs overlap migration BIA for the SRW <0.5% • Approved EP shows no seasonal controls CGG Services Australia - Regia Marine Seismic Survey (MSS) • Underwater sound EMBAs overlap foraging and annual high use foraging BIAs for the BW <8% • Estimated underwater sound EMBAs overlap migration and reproduction BIA for the SRW <1% and <2% respectively • Under assessment showing seasonal controls in place to avoid behavioural disturbance to SRW and BW. ConocoPhillips - Otway Exploration Drilling Program

Aspect	Cetaceans
Receptor	**Blue whale (BW), southern right whale (SRW) and other cetacean species with biologically important behaviours**
	• Underwater sound EMBAs overlap foraging and annual high use foraging BIAs for the BW <6.4% • Underwater sound EMBAs overlap migration BIA for the SRW <1% • No overlap with SRW reproductive BIA • Under assessment with no proposed seasonal controls to restrict activities Woodside Energy - Minerva P&A and decommissioning • Underwater sound EMBAs overlap foraging and annual high use foraging BIAs for the BW <0.05% • Estimated underwater sound EMBAs overlap migration and reproduction BIA for the SRW <0.01% and <0.01% respectively • Approved EP shows seasonal controls to reduce the likelihood of behavioural disturbance to SRW. No BIAs or habitat critical to the survival of the FW, SW or PRW identified within the OGV underwater sound EMBAs. Whilst there are no defined foraging areas for FW, SW or PRW off the coast of Victoria, it is likely foraging occurs in the same areas identified as the foraging BIAs for BW as they are often recorded foraging in the same areas (Gill et al. 2008; Gill et al. 2015; McCauley et al 2018).
Description of Cumulative Impact (including spatial/temporal extent)	The potential impacts from both impulsive and continuous underwater sound to SRW and BW is assessed as having Moderate (2) consequences (Section 6.4). For the FW, SW and PRW consequences were assessed as Minor (1) as there are no BIAs identified within the sound EMBAs. **Successive and Additive impacts –** As a single MODU will be used within the Otway region by multiple titleholders, concurrent drilling activities will not occur. Therefore, additive cumulative impacts by concurrent drilling operations are not possible. Additive impacts are only possible between a single drilling operation, other support or IMR operations, seismic surveys or general shipping. However, these will be limited due to the relatively short time drilling and support activities take compared with the lifetime of the OGV OPP (Section 3) and other reasonably foreseeable projects (Table 8-1, Figure 8-1). Successive impacts are possible throughout the lifetime of the OGV Project (Section 3). However, drilling and support activities are conducted over relatively short durations compared with the lifetime of the OGV OPP and other reasonably foreseeable projects (Table 8-1). In addition, the presence of all vessels connected to OGV OPP and other reasonably foreseeable activities will be temporary (Section 3). The locations of OGV OPP and other reasonably foreseeable activities are isolated and separated such that areas of behavioural impact would not form barriers to the migration of whale species or other biological important behaviours. The spatial extent of underwater sound EMBAs (Behavioural) for the OGV OPP and most other reasonably foreseeable projects have been shown to have very limited overlap with habitat critical to the survival for BW and SRW. Underwater sound EMBAs for projects involved in drilling operations are based on underwater noise modelling associated resupply vessels on DP as well as MODU operations (Table 8-1). These are significantly larger than those associated with support and IMR activities. Therefore, percentage overlaps previously detailed, while minimal are still conservative. The drilling phase of the OGV OPP and other reasonably foreseeable projects is relative short compared to the lifetime of the OGV Project. In addition, successive cumulative impacts resulting in an increase in the likelihood of PTS and TTS for foraging BW, migrating SRW or FW, SW or PRW are not predicted. Distances to the PTS and TTS thresholds are well understood (as detailed in Section 6.4 and Appendices F, G, H, I and J). Due to the isolated nature of OPP OGV and other reasonably foreseeable activities PTS and TTS EMBAs are not expected to overlap (both spatially and temporally) and therefore there acceptable levels will be achieved. Both OGV OPP and other reasonably foreseeable activities have been shown to have a small overlap with underwater sound EMBAs and the BW foraging and annual high use foraging BIAs. Spatial data for the BW BIAs does not identify any areas within the BIA of specific importance for critical behaviour. Therefore, with the isolated and temporary nature of OGV OPP and other reasonably foreseeable activities, no barriers within the BIAs preventing BW migration activities will occur. The Bonney Coast Upwelling KEF (Section 4.2.12.1) is an area where blue whales are known to feed in relatively high numbers. However, this BIA is situated ~60 km from the OGV OPP Project Area with no impacts from underwater noise EMBAs from OGV OPP activities. Behavioural underwater noise EMBAs from ConocoPhillips exploration drilling activities may overlap this KEF but as previously stated, concurrent drilling operation will not occur with successive activities also not expected to cause a cumulative impact. Whilst CGG's Regia MSS underwater noise emissions will overlap the KEF, seasonal controls are proposed to avoid behavioural disturbance to BW. Whilst piling activities from the Spinifex wind farm installation may overlap the BW BIAs and Bonney Coast Upwelling KEF no details are currently available on mitigation measures, but seasonal controls would be expected in line with other operators in the area preventing cumulative impacts from noise emissions. Other reasonably foreseeable projects with underwater sound EMBAs shown to have an overlap with the SRW reproductive area BIA, may have or propose seasonal controls to avoid disturbance to SRW when present. Underwater sound EMBAs from the OGV OPP do not to overlap the SRW reproductive area BIA (Figure 6-7, Figure 6-9). As no underwater sound EMBAs are predicted to overlap the SRW reproductive BIA when the SRW are present, successive or additive cumulative impacts to SRW reproductive activity are not predicted to occur. Major SRW calving areas have been identified in Western Australia and South Australia with females regularly seen in Victoria at Warrnambool. The OGV OPP Project Area is >50 km from this breeding site, which is well beyond any OGV Project underwater sound EMBAs. Only the CGG Regia MSS has noise EMBAs that overlap this breeding site but has seasonal controls to prevent disturbance. Therefore, no successive or additive impacts are predicted for this breeding area when SRW are present. The SRW migration BIA is not intended to reflect entire species occurrence or distribution of the SRW but are areas identified as important by using reliable information on occurrence and behaviour (DCCEEW 2025b). No specific areas of importance of critical behaviour are identified within the SRW migration BIA from spatial data. Therefore, with the isolated and temporary nature of OGV OPP and other reasonably foreseeable activities, no barriers within the BIA preventing SRW migration activities will occur. It is important to note existing conditions show that on average ~225 vessels not connected with either OGV OPP activities or other reasonably foreseeable activities, operate within the BW combined foraging and foraging (annual high use area) (Otway region) BIAs per day with associated continuous noise emissions. In addition, existing conditions show that on average ~1663 vessels not connected with either OGV OPP activities or other reasonably foreseeable activities, operate within the SRW migration BIA per day with associated continuous noise emissions. McPherson et al. (2021) as detailed in Section 4.3.7 (Ambient Sound) showed that shipping traffic in the Otway are strong drivers of the ambient noise. Woodside (2003) details recorded broadband underwater noise levels in the order of 93 to 97 dB re 1 µPa with shipping raising the averaged noise level above 105 dB re 1 µPa. The Otway region should not be considered a pristine environment due to the underwater sound generated by existing shipping. However, despite the presence of existing vessel noise there is a population growth estimate for the BW of 12.6 %, consistent with growth rates in waters off the south of Australia (McCauley et al. 2018). In addition, the eastern Australian SRW population is estimated to have increased at 4.7% p.a. between 1996 and 2017 for all individuals (Stamation et al., 2020). Whilst this increase does not include reproductive females and is lower than seen in some other areas worldwide, the lower rate of increase (recorded at the Head of the Bight) is likely to be reflective of an open population with regular movement of individuals into and out of the area and the expansion

Aspect	**Cetaceans**
Receptor	**Blue whale (BW), southern right whale (SRW) and other cetacean species with biologically important behaviours**
	into former calving grounds (Charlton et al., 2019) suggesting unimpeded migration in the area despite existing vessel movements. Vessel activity from the OGV Project and other reasonably foreseeable projects will present a negligible increase in underwater sound emissions and will not restrict migration. **Synergistic impacts** – none identified with the presence of a MODU and additional vessels.
Certainty of Assessment	There are no studies on the cumulative impacts of underwater noise on marine mammals (pers comm JASCO 2025). However, there is a high level of predictability and certainty in the limited potential for impacts, given the underwater noise modelling data available for the OGV OPP and other reasonably foreseeable projects. In addition, OGV OPP activities and all other reasonably foreseeable projects, as listed in Table 8-1, have controls in place for each activity to prevent / limit impacts.
Existing Control Measures to Meet Acceptable Levels	OGV Project control measures, developed to meet defined acceptable levels, are directly applicable to reducing the potential consequences of cumulative impacts. These control measures are Beach's primary means of mitigating cumulative impacts. Beach has no direct authority over the planning, implementation, or management of other reasonably foreseeable projects and activities that may potentially contribute to cumulative impacts. A single MODU has been contracted to conduct drilling/P&A activities in the region, mitigating the potential for concurrent impacts from these activities. Beach will conduct drilling activities at one location at a time and abide by relevant activity exclusion zones in place for other activities in the offshore Otway Basin, which will minimise the potential for successive and additive cumulative impacts from underwater sound emissions. Existing control measures (as detailed below) to meet defined acceptable levels are fully detailed in Table 6-30. • CM14 EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans • CM15 Geophysical Survey Whale Management Procedure • CM16 VSP Whale Management Procedure • CM17 Drilling Whale Management Procedure • CM18 Vessel Whale Management Procedure • CM19 Noise Assessments
Additional Control Measures	Recognising the shared responsibility for managing cumulative impacts, Beach will actively collaborate with other petroleum titleholders, share relevant data and promote coordinated efforts to ensure that all reasonably foreseeable projects and activities adhere to acceptable environmental standards to mitigate cumulative impacts. **Additional Controls:** Observation, incidents, and opportunities for improvement regarding the interaction with other users will be reported to other petroleum titleholders. This commitment has been adopted and included against CM04: Stakeholder consultation, as updated in ES Table 0-4. CM51 Each future EP resulting from the OGV OPP will undertake a review for additional or significantly revised reasonably foreseeable projects. Additional or significantly revised projects will be assessed as per CIA methodology (Section 8.2). Any cumulative impacts from new, significantly revised or currently unknown activities that results in an unacceptable level of impact to receptors, will be subject to new or revised control measures within the appropriate EP to reduce cumulative impacts to ALARP.
Residual Cumulative Consequence	**Minor** (1)
Acceptable Level Achieved	Yes – Following completion of the CIA process, the residual lower order – Minor (1) consequence is considered acceptable because: • Underwater sound emissions will not result in interference with the recovery of EPBC Act listed threatened species • Underwater sound emissions will not result in the modification, isolation or decrease in the availability or quality of habitat to the extent that EPBC Act listed threatened, migratory or cetacean species are likely to decline • Underwater sound emissions will not result in inconsistencies with conservation advice, recovery plans and threat abatement plans for EPBC Act listed threatened, migratory or cetacean species • Titleholders are required to undertake their activity in a manner that is not inconsistent with the in-force Conservation Management Plan for the Blue Whale. • Titleholders are required to undertake their activity in a manner that is not inconsistent with the in-force Conservation Management Plan for the Southern Right Whale. • Impact areas from OGV Project activities and those for other reasonably foreseeable projects have been shown to be minimal compared with BIAs or habitat critical to the survival of BW and SRW.Good existing and additional control measures are defined and will be implemented including MODU and vessels requirement to implement a Light Management Plan which will restrict light emissions. • The activities will be managed in accordance with relevant company, Commonwealth, international, and Industry standards, guidelines and requirements. • Elevated ambient underwater noise by existing large volumes of shipping is present within the existing environment. • Seasonal and restricted area controls are not considered necessary as OGV OPP activities nor other reasonably foreseeable projects will individually or cumulatively restrict biologically important behaviour as defined in conservation management plans for the BW and SRW.

9 Environmental Management Implementation Approach

9.1 Implementing Requirements of the OPP in Future EPs

Future Project activities that are within the scope of this OPP will be undertaken in accordance with activity specific EPs that have been accepted by NOPSEMA.

The future EPs within the scope of this OPP will demonstrate environmental impacts and risks will be reduced to ALARP and will be of an acceptable level. The acceptable level defined in future EPs will be equivalent or greater than the acceptable levels defined in this OPP. The future EPs will define EPOs and EPSs, measurement criteria and an implementation strategy based on the implementation approach described in this section to ensure potential environmental impacts and risks are of an acceptable level.

The implementation approach described in this section provides a summary of the systems, practices and procedures used to ensure implementation of activities in accordance with this OPP, and that emergency preparedness and environmental monitoring is applied to manage the Project's risks and impacts. This will ensure the Project's environmental performance outcomes (EPOs) are achieved. Specifically, this section describes Beach's:

- Operations Excellence Management System
- Arrangements for monitoring, review and reporting of environmental performance
- Preparedness for emergencies

9.2 Operations Excellence Management System

Beach's Operations Excellence Management System (OEMS) is the company's framework to define, align, standardise and implement company processes to manage risks and ensure successful outcomes in its operations.

The OEMS defines the minimum standards, expectations and behaviours that ensure the company operates successfully (operations excellence in all core business processes including Health & Safety, Production & Reliability, Financial & Stakeholder Management and Project Delivery). The OEMS applies to all personnel performing work within the company's jurisdiction. The OEMS will be used to implement the Project.

The OEMS provides guidance on how Beach will meet the requirements of its Environmental Policy (Figure 9-1). Beach's OEMS has been developed considering Australian/New Zealand Standard ISO 14001:2016 Environmental Management Systems. The OEMS is an integrated management system and includes all HSE management elements and procedures. The OEMS is aligned with the requirements of recognised international and national standards including:

- ISO 14001 (Environmental Management)
- OHSAS 18001 (Occupational Health and Safety)
- ISO 31000 (Risk Management)
- AS 4801 (Occupational Health and Safety Management Systems)

At the core of the OEMS are 11 elements and associated standards that detail specific performance requirements that incorporate all the requirements for the implementation of the Environment Policy (Figure 9-3) and management of potential HSE impacts and risks (Figure 9-2). The Elements, via the nominated expectations, sponsor 30 Beach OEMS Standards, which provide more granular minimum compliance rule sets under which the company operates.

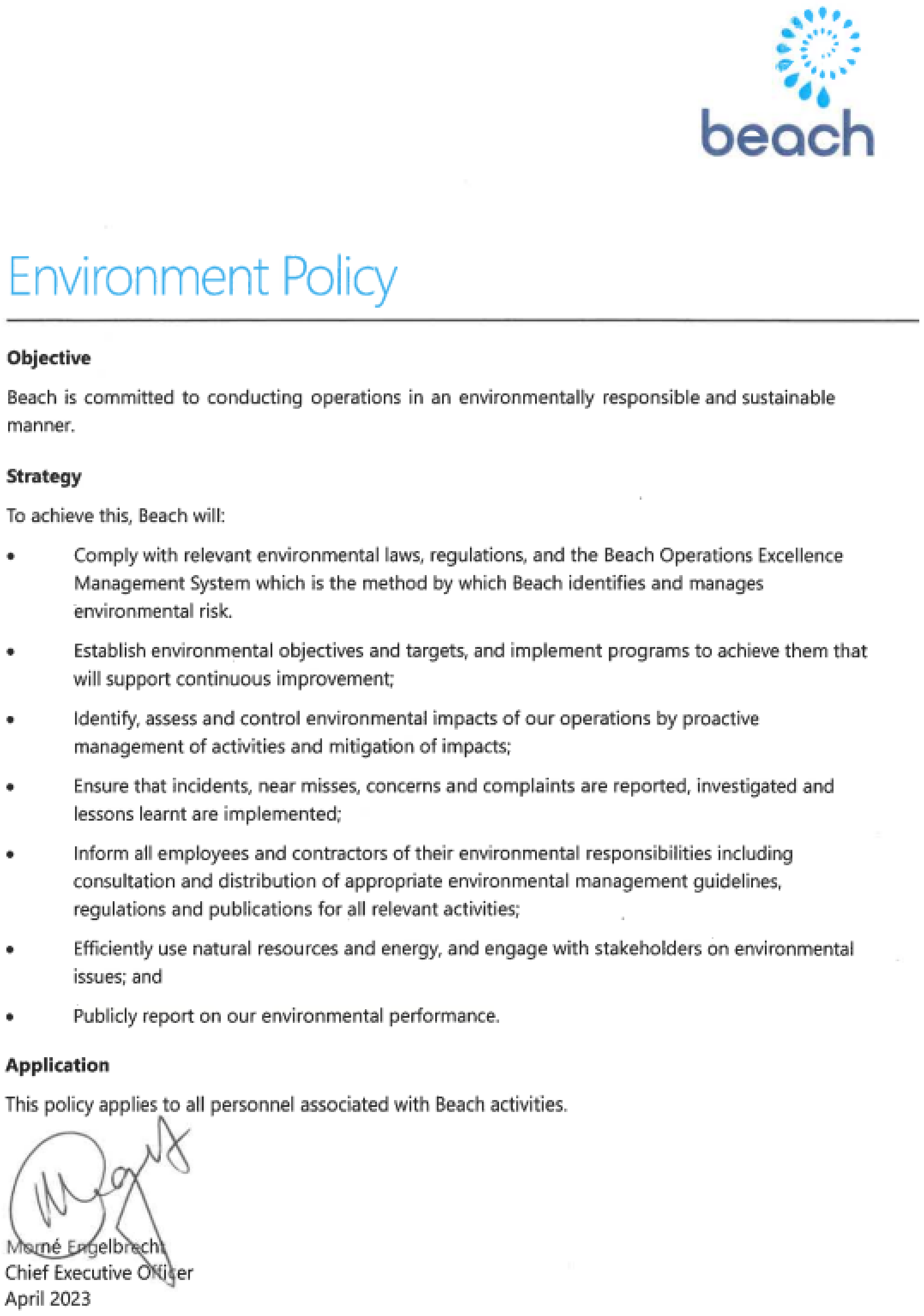
A core design feature of the OEMS is that every Standard is assigned to a General Manager/Functional Head or Executive with experience in the subject matter and/or accountability to ensure delivery of expected outcomes. OEMS Standard Owners ensure the effectiveness of their respective Standard(s) in addressing applicable risks and facilitate continuous improvement of performance and practices.

In the context of the OPP and the Project, the key Elements of the OEMS are summarised in this Section.

Figure 9-1: Beach Operations Excellence Management Standard (OEMS)

Element		Standard
1	Partners, Leadership and Authority	Leadership Standard
		Technical Authority Standard
		Joint Venture Management Standard
2	Financial Management and Business Planning	Integrated Planning Standard
		Phase Gate Standard
		Hydrocarbon Resource Estimation and Reporting Standard
		Financial Management Standard
3	Information Management and Legal Requirements	Regulatory Compliance Standard
		Document Management Standard
		Information Management Standard
4	People, Capability and Health	Training and Competency Standard
		Health Management Standard
5	Contracts and Procurement	Contracts and Procurement Standard
		Transport and Logistics Standard
6	Asset Management	Asset Management Standard
		Maintenance Management Standard
		Well Integrity Management Standard
		Well Construction Management Standard
		Project Management Standard
7	Operational Control	Operational Integrity Standard
		Process Safety Standard
		Management of Change Standard
8	Risk Management and Hazard Control	Risk Management Standard
		Safe Systems of Work
		Emergency and Security Management Standard
9	Incident Management	Incident Management Standard
10	Environment and Community	Environment Management Standard
		Community Engagement Standard
11	Assurance and Reporting	Sustainability Standard
		Assurance Standard

Figure 9-2: OEMS Elements and Standards



beach

Environment Policy

Objective

Beach is committed to conducting operations in an environmentally responsible and sustainable manner.

Strategy

To achieve this, Beach will:

- Comply with relevant environmental laws, regulations, and the Beach Operations Excellence Management System which is the method by which Beach identifies and manages environmental risk.
- Establish environmental objectives and targets, and implement programs to achieve them that will support continuous improvement;
- Identify, assess and control environmental impacts of our operations by proactive management of activities and mitigation of impacts;
- Ensure that incidents, near misses, concerns and complaints are reported, investigated and lessons learnt are implemented;
- Inform all employees and contractors of their environmental responsibilities including consultation and distribution of appropriate environmental management guidelines, regulations and publications for all relevant activities;
- Efficiently use natural resources and energy, and engage with stakeholders on environmental issues; and
- Publicly report on our environmental performance.

Application

This policy applies to all personnel associated with Beach activities.

Morné Engelbrecht
Chief Executive Officer
April 2023

Figure 9-3: Beach's Environment Policy

9.2.1 Partners, Leadership and Authority – OEMS Element 1

Element 1 focuses on ensuring the organisation is equipped, structured and supported to ensure a healthy, efficient and successful company. A summary of the roles and responsibilities under this OEMS Standard is provided in Table 9-1. Further roles and responsibilities will be provided in future EPs for the relevant activities.

Table 9-1: Key Roles and Responsibilities for the OEMS and OPP Implementation

Role	Responsibilities
OEMS Standard Owner	• Each Standard is assigned to a General Manager/Functional Head or Executive with experience in the subject matter and/or accountability to ensure delivery of expected outcomes. This role is designated as an "OEMS Standard Owner" and is critical to the success of the OEMS. • The Standard Owner has overall accountability for performance of their assigned Standard
OEMS Governance Committee	• The OEMS Governance Committee will ensure periodic assessment of system performance. The Committee will support continuous improvement initiatives and assess the need for system changes, such as, additional standards and new company tools/systems. The Committee will include nominated member(s) of the Company Executive as well as Representatives from Operations and Technical divisions, as a minimum.
Executive Management	• The Chief Executive Officer (CEO) is the designated owner of this standard. The Executive Vice President (EVP) Technical supports the CEO for implementation aspects of the Standard. • All EVPs are responsible for ensuring the understanding and application of this standard within their areas of responsibility, and for managing any deviations and gap closure activities.
General Manager or Equivalent	• Responsible for ensuring resources, including assets, facilities, and teams, under their control have understood the requirements and developed and implemented suitable procedures and tools to satisfy the requirements of this standard
Manager or Superintendent	• Responsible for ensuring their area of the business for which they are accountable, has understood and implemented the requirements of this standard. • Upholding and ensuring suitable discipline with respect to this standard. • Implementing or supporting an annual assurance program to report on compliance to this standard and to identify and address gaps or areas for continuous improvement.
All employees	• Responsible for understanding and following the respective procedure and requirements defined within this standard. • Responsible for escalating areas of non-conformance or areas where local practices do not meet the requirements of this standard the OPP requirements are communicated to the Project team.

9.2.2 Information Management and Legal – OEMS Element 3

Element 3 describes the measures Beach must take to ensure ongoing compliance with regulatory and legal obligations in order to protect the Company's value and reputation, and to maintain Beach's licences to operate. Beach's ability to safely perform its duties in line with its legal obligations relies on robust management of documents and information.

Standard 3.1 (Regulatory Compliance) describes the responsibilities of each stakeholder and the processes for identifying, maintaining, managing and reporting Beach's regulatory compliance obligations. The Standard details the minimum requirements of a system to ensure effective regulatory engagement can be maintained across all its activities including permissions, project execution, operating and reporting.

Section 2 of this OPP details the key environmental requirements applicable to the activity. The acceptability discussion for each aspect is assessed in Sections 6 and 7 and specifically details the environmental requirements pertaining to each aspect.

9.2.3 People, Capability and Health – OEMS Element 4

Element 4 focuses on ensuring the people within the business are fully equipped with the competencies required to perform their assigned duties and are physically and mentally prepared. This element is important in protecting workers' health and is closely aligned with Standard 8.1 (Risk Management) and Standard 8.2 (Safe Systems of Work).

Standard 4.1 (Training and Competency) describes the minimum company requirements to ensure peoples training requirements are identified and meet the tasks they are required to perform, and that verification of competency is carried out where necessary. The Standard defines the responsibilities for ensuring suitable training programmes are available and for ensuring peoples levels of capability are maintained at the required level.

Each employee or contractor with responsibilities pertaining to the implementation of this OPP and subsequent EPs shall have the appropriate competencies to fulfil their designated role.

To ensure that personnel are aware of the environmental requirements for the activity all offshore personnel will complete an induction, as a minimum. Records of completion of the induction will be recorded and maintained. The induction will at a minimum cover:

- Description of the environmental sensitivities and conservation values of the area and surrounding waters.
- Controls to be implemented to ensure impacts and risks are ALARP and of an acceptable level.
- Requirement to follow procedures and use risk assessments/ job hazard assessments to identify environmental impacts and risks and appropriate controls.
- Requirements for interactions with fishers and/or fishing equipment.
- Requirement for responding to and reporting environmental hazards or incidents.
- Overview of emergency response and spill management plans.

- Fauna sighting and vessel interaction procedures.
- Relevant Whale Management Procedure.

In addition to the activity-specific induction, each employee or contractor with specific responsibilities pertaining to the implementation of this OPP and future EPs shall be made aware of their responsibilities, and the specific control measures required to maintain environmental performance and legislative compliance.

9.2.4 Contracts and Procurement – OEMS Element 5

Element 5 addresses the acquiring of external services and materials, and the transportation of those materials. It ensures Beach's business interests are met while maintaining compliance with all legal obligations and retaining HSE performance as the top priority. Element 5 also documents requirements for management of land transport risks.

In accordance with Standard 5.1 (Contracts and Procurement), Beach undertakes a pre-qualification of all contractors in which their HSE systems are reviewed to ensure that the contractor's HSE management system (HSEMS) is adequate for meeting their legal obligations and has identified the significant risks and control measures related to the scope of work being undertaken for Beach. This process includes verifying evidence of HSEMS implementation.

Training and competency of contractor personal engaged to work on the activity shall be managed in accordance with the contractor's HSEMS (or equivalent).

Contractors will be assessed to ensure they have the capabilities and competencies to implement the control measures identified in Sections 6 and 7.

9.2.5 Asset Management – OEMS Element 6

The focus of Element 6 is the design, build and operation of assets. The underpinning standards reflect the importance of inherent safety in design, recognising that hazards and risks are to be reduced to ALARP in the design phase of an asset. The standards define the minimum requirement for the monitoring and assurance processes that support the ongoing safe and reliable management of an asset throughout its lifecycle. Element 6 draws heavily on the principles of process safety and is closely aligned with Elements 7 (Operational Control) and Element 8 (Risk Management).

Equipment that has been identified as a control measure for the purpose of managing potential environmental impacts and risks from activities described in future EPs and have an associated EPS that details the performance required.

9.2.6 Operational Control - Element 7

Element 7 focuses on the definition of parameters, practices and procedures required to ensure adequate controls and safe execution of work at operating assets. It deals with the ongoing management of barrier integrity throughout asset lifecycle, ensuring good process safety practices are consistently deployed, and that facility changes manage holistic risk.

Standard 7.3 (Management of Change) defines the minimum planning and implementation requirements for technical and organisational change at Beach. It details the requirement for holistic assessment of the change, the requirement for consultation with stakeholder's dependent upon the nature of the change, and the need for clear accountability for the change. Risk associated with change is mitigated by ensuring change is appropriately approved, effectively implemented, formally assured and closed out upon completion. Any changes must be classified as either temporary or permanent.

The intent of the Management of Change (MoC) Standard is that all temporary and permanent changes to the organisation, personnel, systems, procedures, equipment, products and materials are identified and managed to ensure HSE risks arising from these changes remain at an acceptable level.

Changes to equipment, systems and documentation are managed in accordance with the MoC Standard to ensure that all proposed changes are adequately defined, implemented, reviewed and documented by suitably competent persons. This process is tracked to provide assurance that all engineering and regulatory requirements have both been considered and met before any change is operational. The MoC process includes not just plant and equipment changes, but also documented procedures where there is an HSE impact, regulatory documents and organisational changes that impact personnel in safety critical roles.

Not all changes require a MoC review. Each change is assessed on a case-by-case basis. The potential environmental impacts and/or risks are reviewed by a member of the Beach Environment Team to determine whether the MoC review process is triggered.

Where risk and hazard review processes nominated in Section 9.2.7 identify a change in impacts, risks or controls (compared to those described and assessed in in future EPs), and triggers a regulatory requirement to revise the EP, the revision shall be defined, endorsed, completed and communicated in accordance with the MoC Standard.

9.2.7 Risk Management and Hazard Control – OEMS Element 8

The identification, assessment and treatment of risk is central to maintaining control of assets. Element 8 defines the means by which Beach manages all types of risk to the business. This element includes general risk management, the Safe Systems of Work by which site activities are controlled and executed, and the emergency and security arrangements in place to protect the Company from unplanned events or the attempts of others to do harm to the business.

9.2.7.1 Standard 8.1 - Risk Management

Standard 8.1 defines Beach’s requirements to mitigate and manage risk at all levels within the business. It defines the Risk Management Framework for identifying, understanding, managing and reporting risks. The framework defines the documents, training, tools and templates to be used, and the accountabilities to be applied in support of effective risk management. Risks to people, the environment, Beach’s reputation, financial position and any legal risks are assessed through the framework. The Standard defines the purpose and use of risk assessments and risk registers. The environmental risk management framework applied to the Development is described in Section 5 and applied to all the aspects assessed in Sections 6 and 7 of this OPP.

Beach will undertake a review of future EPs if required in order to ensure that any changes to the activity, controls, regulatory requirements and information from research, stakeholders, industry bodies or any other sources to inform the future EPs are assessed using the risk management tools nominated. The review will ensure that the environmental impacts and risks of the activity continue to be reduced to ALARP and an acceptable level.

If revision of future EPs is trigged though a change in risk or controls, the revision process shall be managed in accordance with the MoC process.

Additional, or increased, impacts or risks, are identified, outside of the management of change process by the assurance process.

9.2.7.2 Standard 8.3 -Emergency and Security Management

Standard 8.3 defines the minimum performance requirements to effectively manage credible emergency and security events, and to enable an efficient recovery to normal operations following such an event. The Standard defines the prevention, preparedness, response and recovery principles to be applied, the organisational structures to support emergency and security measures, and the training and testing protocols that must be in place to assure Beach maintains a state of readiness.

1. Emergency Response Framework

The Beach Emergency and Security Management Framework consists of a tiered structure whereby the severity of the emergency triggers the activation of emergency management levels. The emergency response framework contains three tiers based on the severity of the potential impact (Emergency Response Team, Emergency Management Team and Crisis Management Team). This framework is described in the Beach Emergency Management Plan (EMP).

2. Beach Emergency Management Plan

The Beach EMP provides the standard mechanism for the Emergency Management Team (EMT) to operate from and includes guidance on effective decision-making for emergency events, identification, assessment and escalation of events and provides training and exercise requirements. The EMP provides information on reporting relationships for command, control and communications, together with interfaces to emergency services specialist response groups, statutory authorities and other external bodies. The roles and responsibilities are detailed for onshore and offshore personnel involved in an emergency, including the response teams, onshore support teams, visitors, contractors and employees. The EMP details the emergency escalation protocol depending on the nature of the emergency.

Associated with the EMP are the Emergency Response Duty Roster and Contact Lists. These documents constitute a suite of emergency response documents that form the basis for Beach's response to an emergency situation.

3. Oil Pollution Emergency Plan

Any future EPs are required to have an accepted Offshore Oil Pollution Emergency Plan (OPEP) as per Section 14(8) of the OPGGS (Environment) Regulations. Regulation 14(8AA) provides a framework for the control measures and arrangements for responding to and monitoring oil pollution. Oil spill response arrangements associated with the Project will be detailed in the relevant OPEP.

4. Operational and Scientific Monitoring Plan

Operational and scientific monitoring arrangement associated with the Project will be detailed within the relevant Operational and Scientific Monitoring Plan (OSMP).

5. Testing of Spill Response Arrangements

The relevant OPEP details the oil spill response testing arrangements.

9.2.8 Incident Management – OEMS Element 9

Element 9 defines how Beach classifies, investigates, reports and learns from incidents. An incident is any unplanned event or change that results in potential or actual adverse effects or consequences to people, the environment, assets, reputation, or the community.

Standard 9.1 (Incident Management) defines the requirement for incident notification, reporting and subsequent investigation requirements. It ensures that incident classification is applied consistently across the company, and that the appropriate level of investigation and approval authority is implemented. The standard describes the requirement for identifying and assigning remedial actions, and for communicating key learnings throughout the business. As such, the standard also defines the requirement for adequate training for those persons involved in performing investigations.

The incident management standard requires that all HSE incidents, including near misses, are reported, investigated and analysed to ensure that preventive actions are taken, and learnings are shared throughout the organisation.

Incident reports and corrective actions are managed using the Beach Incident Management System.

9.2.9 Environment and Community – OEMS Element 10

Element 10 focuses on the measures the organisation must take to ensure that it upholds its reputation as a responsible and ethical company and continues its open and transparent engagements with its communities and stakeholders. Beach operates in environmentally sensitive areas, in close proximity to communities, with potential impacts on stakeholders. Beach has an obligation to ensure that potential impacts from its future activities are clearly identified, minimised to ALARP and mitigated where there is an economic loss to a stakeholder directly impacted by Beach activities.

9.2.9.1 Standard 10.1 - Environmental Management

The purpose of Standard 10.1 is to ensure that all areas of the Company implement appropriate plans and procedures to conduct environmental management of operations in a responsible and sustainable manner.

An assessment of environmental aspects, effects, risks and impacts must be prepared to identify and assess impacts to the environment as a result of the Company's operations and activities. The impact assessment must cover design, development, operation and decommissioning and meet all statutory regulatory compliance requirements. The Standard covers land disturbance, reinstatement and rehabilitation activities, and defines obligations for management of biodiversity, water, air quality and emissions, noise and vibration, amenity and waste.

9.2.9.2 Standard 10.2 - Community Engagement

Standard 10.2 defines the minimum requirements for the conduct of Beach and its staff within the community, and the commitments to plan and execute effective community engagement in the course of its business. Beach staff will conduct themselves as ambassadors for the company and engage positively and respectfully with the community.

The standard describes the obligation of the company to proactively engage with the community at the outset of any activity that may have an impact on that community, and to develop a stakeholder engagement plan to manage that engagement.

Stakeholder consultation specific to the activity is discussed in Section 10 of this OPP.

9.2.9.3 Assurance and Reporting – OEMS Element 11

Element 11 establishes that the company must apply the requirements of relevant policies, and the commitments detailed in the OEMS standards throughout its activities. An assurance process therefore exists to systematically quantify compliance with those commitments, and with the underlying procedures and systems. This Element also documents Beach's approach to sustainability and reporting company performance using established sustainability performance metrics.

9.2.9.4 Standard 11.1 - Sustainability

The purpose of this standard is to operationalise the requirements established by the Company's Sustainability Policy and other associated Beach policies. The standard details how Beach incorporate environmental, social and government requirements into the Board, sustainability reporting, performance monitoring and evaluation, company and project risk assessments and emissions reduction assessments and activities.

9.2.9.5 Standard 11.2 - Assurance

Standard 11.2 describes the "Three Lines of Defence" assurance model employed by Beach to govern its activities and ensure compliance with its commitments and standards. The standard defines Beach's requirements for the establishment and management of risk-based assurance activities at all levels within the company. The assurance process establishes the adequacy and effectiveness of Beach's risk controls and quantifies the status of compliance against our obligations. It ensures that Beach proactively closes any gaps in performance so it can address those issues before harm is manifested. As such, the assurance programme identifies improvement opportunities in business processes and risk controls.

The Standard describes the need to have assurance plans across the business, and for the assurance activities to take place on multiple levels of the organisation. This approach collectively ensures the operational activities Beach perform are compliant with its procedures, standards and ultimately with governing policies and legislative obligations. The holistic results of the assurance programme are reportable to the Board and Committees.

9.2.9.6 Monitoring, review and reporting of environmental performance

An assurance process is undertaken by Beach to ensure that the EPOs provided in this OPP are demonstrated in future EPs (Table 9-2):

- The environmental impacts and risks of the activity continue to be identified and reduced to a level that is ALARP and acceptable.
- Control measures detailed in future EPs are effective in reducing the environmental impacts and risks of the activity to ALARP and an acceptable levels.
- Environmental performance outcomes and standards set out in the future EP are being met

- Emissions and discharges are monitored.

Non-compliances and opportunities for improvements for activities described in future EPs identified via the assurance processes in the following sections are communicated to the appropriate supervisor and/or manager to report and action in a timely manner. Tracking of non-compliances and actions is undertaken using Beach's incident management system which includes assigning a responsible person for ensuring the action is addressed and closed out. Any additional, or increased, impacts or risks identified are managed as per the Management of Change process.

Where an assurance process identifies a breach of an EPO or EPS in future EPs this will be reported as a recordable incident.

Table 9-2: Assurance Processes

Assurance Process
Future EP Assurance Checks covering: • EPOs, EPS and implementation strategy requirements.
Incident reviews and investigations covering: • Review of all incidents to identify any recordable incidents and reportable incidents and any additional, or increased, environmental impacts or risks. • Reporting and investigation of incidents to identify recordable and reportable incidents and any additional, or increased, environmental impacts or risks.
Environmental Impact and Risk Register to ensure impacts and risks continue to be ALARP and an acceptable level and any additional, or increased, environmental impacts or risks identified.
Activity risk review to ensure impacts and risks can be manage to ALARP and an acceptable level and any additional, or increased, environmental impacts or risks identified.
Performance Reporting for activities described in future EPs covering: • Review of EPOs and EPs.
Emissions and discharge records

9.2.9.7 Audits and Inspections

A future EP assurance checklist details the assurance checks required to ensure that for the duration of the EPs:

- EPOs, EPSs and implementation strategy requirements are met.
- Controls measures are effective in reducing the environmental impacts and risks of the activity to ALARP and acceptable levels
- Any additional, or increased, impacts or risks are identified.
- Assurance Checks define the timing of these checks.

Non-compliances and opportunities for improvements identified via assurance checks or any other means are communicated to the appropriate supervisor and/or manager to report and action in a timely manner. Any additional, or increased, impacts or risks identified are managed as per the Management of Change process. Tracking of non-compliances and actions is undertaken using

Beach's incident management system which includes assigning a responsible person for ensuring the action is addressed and closed out.

9.3 Emergency Preparedness and Response

Beach's Crisis and Emergency Management Standard requires Beach to have plans, procedures and resources are in place to effectively respond to crisis and emergency situations, to protect the workforce, the environment, the public and customers, and to preserve the company's assets and reputation.

For activities described in future EPs, Beach will have in place an Emergency Response Plan which identifies emergency events, including hydrocarbon spills, and details the arrangement in place to control, coordinate and respond to those events. To support the Emergency Response Plan, Beach will have an OPEP and an OSMP covering the oil spill response and monitoring arrangements relevant to the hydrocarbon spill risk associated with activities described in future EPs.

9.4 Decommissioning

Requirements for offshore petroleum property are provided in OPGGS Act and reflected in several government policies and guidelines such as:

- NOPSEMA Policy - Section 572 Maintenance and removal of property (09/12/2022)
- Department of Industry, Science and Resources Guideline: Offshore petroleum decommissioning (2 March 2022)
- NOPSEMA Information Paper – Planning for proactive decommissioning (10/01/2024)
- NOPSEMA Policy - Section 270 Consent to surrender title policy (30/06/2022)

Table 9-3 summarises how the proponent intends to comply with decommissioning requirements under the OPPGS Act and relevant policies and guidelines.

Table 9-3: Decommissioning Requirements under the OPPGS Act and Relevant Polices and Guidelines

Decommissioning requirements

Requirement	**Response**
Section 572(2) A titleholder must maintain in good condition and repair all structures that are, and all equipment and other property that is: (a) in the title area; and (b) used in connection with the operations authorised by the permit, lease, licence or authority.	Compliance with section 572(2) will be achieved by Beach's Inspection, Maintenance & Repair for wells and flowlines **Well Maintenance Management** All well integrity inspections, testing and maintenance activities during the Operate Phase are managed per the Beach Well Integrity Management Framework, comprising of the following: • Well Integrity Management Standard (BSTD 6.3) of Beach's Operating Excellence Management System (OEMS) • Well Integrity Technical Standard (WITS) for the Operate & Maintain Phase (CDN/ID 7726350). • Well Integrity Management Plan - Victoria (CDN/ID 19060027) **Subsea infrastructure Inspections** Regular inspections, maintenance and repair of subsea equipment will be undertaken in line with Beach standards: • Maintenance Management Standard BSTD 6.2) of OEMS – based on time and condition-based criteria to assess the potential impacts of equipment failure on safety, production and the environment All maintenance activities are managed via the Computerised Maintenance Management System (CMMS). Use of the CMMS is central to asset integrity management. It provides traceability for the scheduling and completion of critical maintenance tasks. Upon completion, inspection results, maintenance records and the well's integrity status are captured in the WIMS database.
Section 572(3) A titleholder must remove from the title area all structures that are, and all equipment and other property that is, neither used nor to be used in connection with the operations: (a) in the title area; and (b) used in connection with the	Compliance with section 572(3) will be achieved by removal of all property and infrastructure and the plugging and abandonment of wells as the base case. Decommissioning with comply with relevant laws, guidelines and policy (currently the Australian Government Guideline: Offshore petroleum decommissioning) Beach acknowledges targets set in NOPSEMA's Decommissioning Compliance Strategy 2024-2029 for decommissioning planning.

Decommissioning requirements

operations authorised by the permit, lease, licence or authority	Decommissioning is part of Beach's Asset Management Standard (BSTD 6.1) of OEMS and Beach's Decommissioning Guideline which both acknowledges the requirement to comply with legislative and regulatory frameworks for decommissioning. Beach's decommissioning planning lifecycle recognises planning for decommissioning must commence at a suitable timeframe in advance of cessation of production which is achieved via asset lifecycle management processes, asset decommissioning strategy and plan, and restoration cost estimates and financial provisioning.
Section 270(3) The Joint Authority may consent to the surrender sought by the application only if the registered holder of the permit, lease or licence: c) has, to the satisfaction of NOPSEMA, removed or caused to be removed from the surrender area all property brought into the surrender area by any person engaged or concerned in the operations authorised by the permit, lease or licence; or made arrangements that are satisfactory to NOPSEMA in relation to that property d) has, to the satisfaction of NOPSEMA, plugged or closed off all wells made in the surrender area by any person engaged or concerned in the operations authorised by the permit, lease or licence e) has provided, to the satisfaction of NOPSEMA, for the conservation and protection of the natural resources in the surrender area; and f) has, to the satisfaction of NOPSEMA, made good any damage to the seabed or subsoil in the surrender area caused by any person engaged or concerned in the operations authorised by the permit, lease or licence.	Compliance with section 270(3) may be achieved by: • Demonstrated compliance with relevant EPs and principles of ecologically sustainable development ALARP, and acceptable levels for environmental impacts and risks • Monitoring, surveying and reporting in accordance with accepted EPs • Decommissioning EPs to include visual inspections, surveys and sampling. • Demonstrated compliance with relevant WOMPs for P&A activities in accordance with section 569(1) of OPGGS Act c) Decommissioning of wells and subsea infrastructure will be performed in accordance with accepted decommissioning EPs and may include seabed clearance survey will be conducted following decommissioning to confirm all infrastructure on the seabed has been removed, returning the area to original condition as much as possible and practicable d) Relevant decommissioning EPs will include P&A of wells and compliance with section 270(3)(d). Compliance with relevant WOMPs for P&A activities in accordance with section 569(1) of OPGGS Act e) Relevant decommissioning EPs will address section 270(3)(e) by including an assessment of the natural resources to demonstrate conservation and protection of the natural resources f) Relevant decommissioning EPs will address section 270(3)(f) by committing to make good any damage to the seabed or subsoil in the surrender area •

10 Stakeholder Engagement

Beach is committed to open, on-going and effective engagement with the communities in which it operates and providing information that is clear, relevant and easily understandable. Beach welcomes feedback and is continuously endeavouring to learn from experience in order to manage our impacts and risks.

Stakeholder engagement for the Project is a component of Beach's broader engagement in the Otway region. Stakeholder engagement is an integral component of Beach's environmental risk and impact assessment process and has informed the preparation of the OPP (Phase 1) (refer Section 10.2.3). Further, the opportunity for public comment on the OPP was provided through NOPSEMA's publication of the OPP in accordance with the requirements of Regulation 9 of the OPGGS (Environment) Regulations (Phase2) (refer Section 10.2.4). Phase 1 and Phase 2 engagements have informed this OPP resubmitted to NOPSEMA in accordance with Regulation 11.

10.1 Engagement Background

Activities for the existing Otway Development have run over several phases and many years, beginning with seabed assessments, drilling of exploration wells and production wells in the Geographe and Thylacine gas fields, and installation of seabed infrastructure to support tie-in of the wells to the existing Thylacine A Platform and pipeline and finally the commencement of production in late February 2008. Woodside Energy, the titleholder at the time of the initial development, undertook significant consultation with the community, non-government organisations and Government departments. Consultation has been ongoing through the change of titleholders to Origin and then Lattice. In 2017 Lattice commenced consultation in relation to the broader Otway Development. Following its acquisition of Lattice, Beach commenced consultation with stakeholders in early 2019 in relation to Phase 4 of the Otway Development and has continued to do so for more recent developments as described in the following accepted activity specific Environment Plans (EPs):

- Otway Offshore Operations EP (CDN/ID 17275058)
- Artisan Exploration Drilling EP (CDN/ID S4810AH717904)
- Otway Development Drilling and Well Abandonment EP (CDN/ID S4100AH717905)
- Otway Phase 5 Early Dive Installation Campaign EP (CDN/ID S4130AF725242)
- Thylacine Subsea Installation & Commissioning EP (T/L2 and T/L4) (CDN/ID: S4121AF728393)
- OGV Geophysical and Geotechnical Seabed Survey EP (V-1000-P1-MP-0011)

These EPs, along with all Beach's accepted EPs, can be viewed on the NOPSEMA website.

This ongoing engagement has enabled Beach to establish a database of relevant stakeholders and obtain a good understanding of issues and concerns of stakeholders.

10.2 Stakeholder Engagement Approach and Objectives

- Beach is undertaking a phased program of consultation for the Project, including in the preparation of the OPP: Phase 1: Consultation on the Project during the preparation of the OPP to inform the Project impact and risk assessment process (refer Section 10.2.3). This has included the identification or relevant stakeholders (refer Section 10.2.1) and stakeholder mapping to impacts and risks (refer Section 10.2.2).

- Phase 2: Formal consultation via the OPP public comment period (refer Section 10.2.4)
- Phase 3: Ongoing consultation for Project activities (refer Section 10.2.5), including the development of EPs.

The objectives of Beach's stakeholder engagement in preparation of the OPP are to:

- Identify relevant stakeholders to inform the preparation of the OPP.
- Engage with stakeholders in an open, transparent, timely and responsive manner.
- Provide information to stakeholders about the Project including the physical, ecological, socio-economic and cultural environment that may be affected, the potential impacts and risks that may occur and controls proposed to avoid or minimise those impacts.
- Obtain information from stakeholders in relation to if their functions, interests or activities may be affected by the Project.
- Provide additional information to stakeholders who raise any objections or claims.
- Build and maintain trust with stakeholders.

10.2.1 Stakeholder Identification

Relevant stakeholders have been identified by reviewing:

- Social receptors identified in the existing environment section.
- Existing stakeholders within Beach's stakeholder register.
- Consultation records for previous Otway Basin activities undertaken by Beach and Lattice.
- Commonwealth and State fisheries jurisdictions and fishing effort in the region.
- NOPSEMA Guideline Consultation with Commonwealth Agencies with Responsibilities in the Marine Area.

The identification of stakeholders for the purpose of engagement in the preparation of the OPP has been guided by the categorisation of relevant persons as defined in Regulation 25(1) of the of OPGGS (Environment) Regulations. Table 10-1 provides a summary of relevant persons for the Project arranged by category.

Table 10-1: Relevant Persons for the Project

Categories	**Relevant Persons Examples**
Category A	• Australian Border Force – Maritime Border Command • Australian Fisheries Management Authority (AFMA)

Categories	Relevant Persons Examples
Each Department or agency of the Commonwealth to which the activities to be carried out under the environment plan, or the revision of the environment plan, may be relevant	• Australian Maritime Safety Authority (AMSA) • Department of Agriculture, Water and the Environment (DAWE); Fisheries; Biosecurity Marine Pests • Department of Defence - Australian Hydrographic Office (AHO) • Department of Defence - Infrastructure Division, Defence Support & Reform Group • Department of Industry, Science, Energy and Resources (DISER) • Director of National Parks (DNP) • Department of Climate Change, Energy, the Environment and Water – Oceans • Indigenous Land and Sea Corporation • National Native Title Tribunal
Category B Each Department or agency of a State or the Northern Territory to which the activities to be carried out under the environment plan, or the revision of the environment plan, may be relevant	• Department of Energy, Environment and Climate Action (DEECA) - VIC • Department of Infrastructure and Transport - Marine Safety SA • Department for Environment and Water South Australia - Coast Protection Board • Corangamite Catchment Management Authority • Department of Infrastructure and Transport - Marine Safety SA • Department of Natural Resources and Environment Tasmania - Biosecurity • Department of Natural Resources and Environment Tasmania - Conservation • Department of Natural Resources and Environment Tasmania - Marine/Fisheries(Fishing Tasmania) • Department of Natural Resources and Environment Tasmania - Strategic Projects and Policy • Department of Natural Resources and Environment Tasmania - Tasmania Parks and Wildlife Services • Department of Premier and Cabinet - Office of Aboriginal Affairs - (Tasmania) • Department of Primary Industries and Regions South Australia - Commercial Fishing • Department of State Growth - Mineral Resources Tasmania • Department of Transport and Planning: Marine Pollution • Victorian Fisheries Authority • Parks Victoria • Department of Primary Industries, Parks, Water and Environment (DPIPWE) • EPA Tasmania • EPA South Australia • EPA Victoria • First Peoples – State Relations (Victoria) • Marine and Safety Tasmania • Office of the Minister for Environment • Transport Safety Victoria - Maritime Safety Victoria
Category C The Department of the responsible State Minister, or	• Office of the Minister Energy and Resources

Categories	Relevant Persons Examples
the responsible Northern Territory Minister	
Category D A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the environment plan, or the revision of the environment plan.	• Commercial fishing • Local government authorities • Community • Environmental NGO • Marine based industries • Marine tourism/recreation • Business • Land based tourism • Education & Research organisations • Media • Native Title and Cultural Heritage / Traditional owner groups
Category E Any other person or organisation that the titleholder considers relevant.	• Member of the public or group whose functions, interests or activities are not impacted by Beach Energy activities

10.2.2 Stakeholder Mapping

An initial assessment of stakeholders' functions, interests and activities has been undertaken, based on previous stakeholder consultation and the preliminary impact assessment conducted for the Project. Table 10-2 identifies the receptors and associated potential impacts relevant to each stakeholder group and identifies the planned and unplanned environmental aspects relevant to each stakeholder group. This mapping will be updated as consultation progresses.

Table 10-2: Relevance of Receptor and Environmental Impact to Stakeholder Groups

	Receptor	Potential Impact	Cth Govt	Vic/Tas Govt	Fisheries	Recreation/ Tourism	Industry	Research/ Community Groups
Physical	Ambient light	Change in ambient light	✓	✓		✓		✓
	Ambient noise	Change in ambient noise	✓	✓				
	Water quality	Change in water quality	✓	✓	✓	✓		✓
	Sediment quality	Change in sediment quality	✓	✓	✓			✓
	Air quality	Change in air quality	✓	✓				
	Climate	Change in climate	✓	✓				✓
Ecological	Coastal habitats and communities	Change in habitat	✓	✓				✓
		Change in ecosystem dynamics	✓	✓				✓
	Benthic habitats and communities	Change in habitat	✓	✓				✓
		Change in fauna behaviour	✓	✓	✓			✓
		Injury / mortality to fauna	✓	✓	✓			✓
	Threatened Ecological Communities	Change in habitat	✓	✓				✓
	Plankton	Change in fauna behaviour	✓	✓				✓
		Injury / mortality to fauna	✓	✓		✓		✓
	Seabirds and Shorebirds	Change in fauna behaviour	✓	✓				✓
		Injury / mortality to fauna	✓	✓				✓
	Fish	Change in fauna behaviour	✓	✓		✓		✓
		Injury / mortality to fauna	✓	✓		✓		✓
	Marine mammals	Change in fauna behaviour	✓	✓				✓
		Injury / mortality to fauna	✓	✓				✓

	Receptor	Potential Impact	Cth Govt	Vic/Tas Govt	Fisheries	Recreation/ Tourism	Industry	Research/ Community Groups
	Marine reptiles	Change in fauna behaviour	✓	✓				✓
		Injury / mortality to fauna	✓	✓				✓
Socio-economic	Key Ecological Features	Changes to the functions, interests or activities of other users	✓	✓				✓
		Change in water quality	✓	✓				✓
		Change in habitat	✓	✓				✓
		Injury / mortality to fauna	✓	✓				✓
		Change in fauna behaviour	✓	✓				✓
	Commonwealth Heritage Places	Changes to the functions, interests or activities of other users	✓	✓				✓
	–Australian Marine Parks	Changes to the functions, interests or activities of other users	✓	✓				✓
		Change in water quality	✓	✓				✓
		Change in habitat	✓	✓				✓
		Injury / mortality to fauna	✓	✓				✓
		Change in fauna behaviour						
		Change in aesthetic value						
	State Protected Areas - Marine	Changes to the functions, interests or activities of other users	✓	✓		✓		✓
		Change in water quality	✓	✓				✓
		Change in sediment quality	✓	✓				✓
		Change in habitat	✓	✓				✓
		Injury / mortality to fauna	✓	✓				✓

Receptor	Potential Impact	Cth Govt	Vic/Tas Govt	Fisheries	Recreation/ Tourism	Industry	Research/ Community Groups
	Change in aesthetic value	✓	✓		✓		✓
State Protected Areas - Terrestrial	Changes to the functions, interests or activities of other users	✓	✓		✓		✓
Ramsar Wetlands of International Importance	Change in habitat	✓	✓				✓
Nationally Important Wetlands	Change in habitat	✓	✓				✓
Cth Managed Fisheries	Changes to the functions, interests or activities of other users	✓	✓	✓			✓
State Managed Fisheries	Changes to the functions, interests or activities of other users	✓	✓	✓			✓
Recreation and Tourism	Changes to the functions, interests or activities of other users	✓	✓		✓		✓
	Change in aesthetic value	✓	✓		✓		✓
Industry	Changes to the functions, interests or activities of other users	✓	✓		✓	✓	✓
Heritage and cultural features	Changes to the functions, interests or activities of other users	✓	✓				✓
	Change in water quality	✓	✓		✓		✓
	Change in sediment quality	✓	✓				✓
	Change in habitat	✓	✓				✓
	Injury / mortality to fauna	✓	✓				✓
	Change in fauna behaviour	✓	✓				✓
	Change in aesthetic value	✓	✓		✓		✓

10.2.3 Phase 1: Initial Project Consultation

Whilst consultation requirements for the initial development of the OPP are not prescribed in the OPGGS (Environment) Regulations, Beach has been undertaking consultation for its Offshore Gas Victoria (OGV) Project, including development of EPs, and preliminary advice at the commencement of consultation has included information regarding the development of an OPP. Information provided in relation to the OGV Project and associated activities include:

- Community Information Sessions held in:
    - Port Campbell on 24 July 2023
    - Portland 25 July 2023
    - Warrnambool 26 July 2023
    - Port Fairy 26 July 2023
    - King Island, Burnie, Lakes Entrance and Apollo Bay to follow
- Meetings:
    - Peterborough Residents Association 19 July 2023
    - Corangamite Shire Council 20 July 2023
    - Timboon Action Group 1 August 2023
    - King Island Council 17 August 2023
    - Commercial fishing peak bodies round table 30 August 2023 (Warrnambool)
    - Commercial fishers drop-in 30 August 2023 (Warrnambool)
    - Commercial fishers drop-in scheduled for 12 October 2023 (Lakes Entrance)
    - Moyne Shire Council Meeting scheduled for 17 October 2023
- Provision of information on the Beach website Offshore Gas Victoria | Beach Energy and dedicated online engagement hub, ‘Engage Beach’.
- Provision of the following OGV information sheets (provided in Appendix N) to those stakeholders listed in Table 10-2:
    - Offshore Gas Victoria Project Information sheet
    - OGV Seabed information sheet
    - OGV drilling activities information sheet
    - OGV P&A information sheet

- Ad-hoc requests via phone and email and provision of specific information as requested.
- Public notices published in:
    - Portland Observer
    - Warrnambool Standard
    - Colac Herald
    - Cobden Timboon Coast Times
    - The Advocate (Burnie)
    - South Gippsland Sentinel Times
    - Bairnsdale Advertiser
    - Koori Mail scheduled
    - National Indigenous Times scheduled
- First Nations engagement via a dedicated First Nations Engagement Manager
    - Provision of information sheets
    - Meetings with native title CEOs and board
    - Meetings with key community members
    - Community drop-in sessions to follow
    - Meeting with Heritage Victoria and First Peoples State Relations Victoria

10.2.3.1 Director of National Parks

Beach undertook consultation with the Director of National Parks (DNP) in accordance with the consultation requirements detailed in the NOPSEMA and Parks Australia Petroleum Activities and Australian Marine Parks: A guidance note to support environmental protection and effective consultation (N-04750 -GN1785 A620236 01/06/2023) between September and December 2023.

10.2.4 Phase 2: Project OPP Public Comment Period

On 8 March 2024, NOPSEMA advised that the OPP was suitable for publication for public comment in accordance with Section 9 of the OPGGS (Environment) Regulations 2023. The OPP was published and opened for comment for nine weeks from 18 March 2024 to 20 May 2024.

Beach promoted the public comment process by publishing a public notice in seven different newspapers, emailing the project stakeholder list, and prominently featuring information about the public comment period and links to NOPSEMA's website on Engage Beach, Beach's online consultation hub.

Eleven public submissions were received. Beach acknowledges all those who took time to compile and submit their written comments regarding the OPP. One submission (Submitter 3) provided comments that had no merit and were not relevant to the OPP and was not considered further in the OPP public comment process. One submission (Submitter 4) was made in response to a concurrent public comment process for a separate environmental approval and, by agreement with the submitter, was accepted and managed as part of the public comment process for the environmental approval and excluded from the OPP public comment process.

Beach has prepared a public comment report summarising the comments, an assessment of the merits of each comment, a statement of their response to each comment, and an outline of any changes made to the OPP as a result of the comment. (Appendix P). Where Beach updated the OPP in response to comments, these updates are referenced in the OPP with the corresponding public comment reference number (i.e. [PCXX]).

10.2.5 Phase 3: Ongoing Consultation

Beach will continue to engage with stakeholders on individual activities undertaken for the Project. Consultation will be undertaken as part of developing activity specific EPs as required under the OPGGS (Environment) Regulations. This will be undertaken by:

- Identifying relevant persons that may be potentially affect by the activities.
- Determining the possible consequences of the activities on each stakeholders’ functions, interests or activities from previous knowledge, reviewing any public statements by the stakeholder as to how they want to be engaged by oil and gas companies and/or consulting with stakeholders.
- Providing sufficient information, based on possible consequences and the way they would like to be consulted, for the stakeholder to be able to make an informed assessment of the possible consequences of the activity on their functions, interests or activities.
- Allowing a reasonable period of time for the stakeholder to review and respond to any information provided, typically two to four weeks.
- Providing further information requested by the stakeholder or that becomes available during the consultation period and allowed a reasonable time for the stakeholder to review and respond. Depending on the information provided this was between one to four weeks.
- Ensuring relevant stakeholders are informed about the consultation process and how their feedback, questions and concerns will be considered in the EP.
- Where requested, providing activity notification and specific information such as:
    - type of activity
    - location of activity, coordinates and map
    - timing of activity: expected start and finish date and duration
    - sequencing of locations if applicable

  - vessel/rig details including call sign and contact
  - requested clearance from other vessels
  - Beach contact details

11 References

ABARES (Australian Bureau of Agricultural and Resource Economics and Sciences) (2024) 'Fishery status reports map data', Commonwealth of Australia, ABARES, Canberra, accessed August 2024.

Abrahms, B., E. Hazen, E. Aikens, M.S. Savocae, J.A. Goldbogen, S.J. Bograd, M.G. Jacox, L.M. Irvine, D.M. Palacios and B. Mate. (2019). Memory and resource tracking drive blue whale migrations. Proceedings of the National Academy of Sciences (PNAS) 116(12): 5582–5587. www.pnas.org/cgi/doi/10.1073/pnas.1819031116

ABS. (2021) Australian Bureau of Statistics. https://www.abs.gov.au/

Adam, P. (1990). Saltmarsh Ecology. Cambridge University Press, Cambridge.

Advanced Geomechanics. (2011). Technical Note Origin Doc No. S4200-RU-700699.

AEMO (2024) Australian Energy Market Operator. 2024. Gas Statement of Opportunities. March 2024. For Australia's East Coast Gas Market. https://aemo.com.au/-/media/files/gas/national_planning_and_forecasting/gsoo/2024/aemo-2024-gas-statement-of-opportunities-gsoo-report.pdf?la=en#:~:text=The%202024%20GSOO%20continues%20to,sources%20of%20supply%20from%202028.

AFMA. 2023. Southern and Eastern Scalefish Shark Fishery (SESSF) Species summaries 2023. Australian Fisheries Management Authority, Australian Government. Available from: https://www.afma.gov.au/sites/default/files/2023-02/2023-sessf-species-summaries.pdf

AFMA. (2024a). Australian Fisheries Management Authority Species Profile: Blue Warehou. https://www.afma.gov.au/species/blue-warehou

AFMA. (2024b). Australian Fisheries Management Authority Species Profile: Eastern Gemfish https://www.afma.gov.au/species/gemfish

AFMA. (2024c). Australian Fisheries Management Authority Species Profile: Gummy Shark https://www.afma.gov.au/species/gummy-shark

AFMA. (2024d). Australian Fisheries Management Authority Species Profile: Orange Roughy https://www.afma.gov.au/species/orange-roughy

AFMA. (2024e). Australian Fisheries Management Authority Species Profile: School Shark https://www.afma.gov.au/species/school-shark

AFMA. (2024f). Australian Fisheries Management Authority Species Profile: Southern Bluefin Tuna https://www.afma.gov.au/species/southern-bluefin-tuna

AIATSIS. (2022). Welcome to Country. The Australian Institute of Aboriginal and Torres Strait Islander Studies. https://aiatsis.gov.au/explore/welcome-country

Andrew, N. (1999). Under Southern Seas: the Ecology of Australia's Rocky Reefs: The Ecology of Australia's Rocky Reefs. University of New South Wales Press, Sydney, Australia. (pp. 238).

Andrew, N. L., & O'Neill, A. L. (2000). Large-scale patterns in habitat structure on subtidal rocky reefs in New South Wales. Marine and Freshwater Research, 51, 255-263.

Andrews-Goff, V., Bestley, S., Gales, N. J., Laverick, S. M., Paton, D., Polanowski, A. M., Double, M. C. (2018). Humpback whale migrations to Antarctic summer foraging grounds through the southwest Pacific Ocean. Scientific Reports, 8. doi: 10.1038/s41598-018-30748-4.

Ansell, R., Gibson, R. N., & Barnes, M. (1999). Oceanography and Marine Biology: An Annual Review. Volume 37. The Dunstaffnage Marine Laboratory, Scotland.

ANZECC & ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

ANZG (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Retrieved from: www.waterquality.gov.au/anzguidelines.

APPEA (2008). Code of Environmental Practice. Code_of_Environmental_Practice.pdf (appea.com.au)

API - American Petroleum Institute (2009). Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry. American Petroleum Institute, Washington DC, United States of America.

APPEA. (2021). Key Statistics 2021. Australian Petroleum Products and Exploration Association.

Arnould J.P.Y. & Kirkwood R. (2007). Habitat selection by female Australian fur seals (Arctocephalus pusillus doriferus). Aquatic Conservation: Marine and Freshwater Ecosystems. Vol. 17, suppl. 1, pp. S53.

Atchoi, E., Mitkus., M., Merdeiros, V., Machado, B., Garcia, S., Juliano, M., Bried, J., Rodriguez, A (2024). Do seabirds dream of artificial lights? Understanding light preferences of Procellariforms. DOI:10.1101/2024.03.01.582998.

Atlas of Living Australia (2022) 'Pale Octopus', National Collaborative Research Infrastructure Strategy, CSIRO, Atlas of Living Australia, accessed November 2022.

Atlas of Living Australia (2022) 'Gould's Squid', National Collaborative Research Infrastructure Strategy, CSIRO, Atlas of Living Australia, accessed November 2022.

Attard, C. R. M., Beheregaray, L. B., Sandoval-Castillo, J., Jenner, C. S., Gill, P. C., Jenner, M. N. M., Moller, L. M. (2018). From conservation genetics to conservation genomics: a genome- wide assessment of blue whales (Balaenoptera musculus) in Australian feeding aggregations. Royal Society Open Science, 5(1): doi: 170925.

Aulich, M. G., McCauley, R. D., Saunders, B. J., & Parsons, M. J. G. (2019) Fin whale (Balaenoptera physalus) migration in Australian waters using passive acoustic monitoring. Scientific Reports, 9:8840. doi: 10.1038/s41598-019-45321-w

Austin, M.E., A. McCrodan, C. O'Neill, Z. Li, and A.O. MacGillivray. (2013). Marine mammal monitoring and mitigation during exploratory drilling by Shell in the Alaskan Chukchi and Beaufort Seas, July–November 2012: 90-Day Report. In: Funk, D.W., C.M. Reiser, and W.R. Koski (eds.). Underwater Sound

Measurements. LGL Rep. P1272D–1. Report from LGL Alaska Research Associates Inc. and JASCO Applied Sciences, for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 266 pp plus appendices.

Australian and New Zealand Environment and Conservation Council (ANZECC). (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. National Water Quality Management Strategy, 1: 1-7.

Australian Maritime Safety Authority (AMSA) (2015a). Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities. Australian Government.

Australian Museum. (2020). Orange-bellied Parrot(Neophema chrysogaster). https://australianmuseum.net.au/learn/animals/birds/orange-bellied-parrot-neophema-chrysogaster/

Australian Seaweed Institute (2023). https://www.australianseaweedinstitute.com.au/current-state-of-the-australian-seaweed-industry

Australian Transport Safety Bureau [ATSB] (2024). Marine investigations database. https://www.atsb.gov.au/marine-investigation-reports

Backhouse, G., O'Connor, J., & Jackson, J. (2008). National Recovery Plan for the Australian Grayling (Prototroctes maraena). Department of Sustainability and Environment, Melbourne.

Baker, A. N. (1985). Pygmy right whale (Caperea marginate) (Gray, 1846). In: Ridgway, S H and R. Harrison, eds. Handbook of Marine Mammals Vol. 3: The Sirenians and Baleen Whales (pp. 345-354). Academic Press, London.

Baker, C. S., Patenaude, N. J., Bannister, J. L., Robins, J., & Kato, H. (1999). Distribution and diversity of mtDNA lineages among southern right whales (Eubalaena australis) from Australia and New Zealand. Marine Biology, 134, 1–7.

Baker, G. B., Gales, R., Hamilton, S., & Wilkinson, V. (2002). Albatrosses and petrels in Australia: a review of their conservation and management. Emu, 102, 71-97.

Baker, B and Hamilton, S (2013). South-east Marine Region — Review of Biologically Important Areas [for EPBC-listed seabirds], Reports I and II. Unpublished reports to the Department of Sustainability, Environment, Water, Population and Communities, Latitude 42 Environmental Consultants Pty Ltd, Hobart.

Balcom, B. J., Graham, B. D., Hart, A. D., & Bestall, G. P. (2012). Benthic impacts resulting from the discharge of drill cuttings and adhering synthetic based drilling fluid in deep water, in: International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production. Presented at the International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Society of Petroleum Engineers, Perth, p. SPE-157325-MS.

Ball, D., & Blake, S. (2007). Shallow water habitat mapping at Victorian Marine National Parks and Marine Sanctuaries, Volume 1: Western Victoria. Parks Victoria Technical Series No.36. Parks Victoria, Melbourne.

Bannister, J. L., Kemper, C. M., & Warneke, R. M. (1996). The Action Plan for Australian Cetaceans. Canberra: Australian Nature Conservation Agency. Retrieved from http://www.environment.gov.au/coasts/publications/cetaceans-action-plan/pubs/whaleplan.pdf.

Bannister JL. (2008). 'Great Whales' CSIRO Publishing: Collingwood.

Bannister, J. L. (2017). Project A7- Monitoring Population Dynamics of 'Western' Right Whales off Southern Australia 2015-2018. Final report to National Environment Science Program, Australian Commonwealth Government.

Barrett N, Monk J and Bastiaansen A (2023) 'Frankling and Zeehan Marine Park Multibeam mapping and drop-camera validation for Parks Australia', University of Tasmania, Report. https://doi.org/10.25959/24719955.v1

Barton, J., Pope, A., & Howe, S. (2012). Marine Natural Values Study Vol 2: Marine Protected Areas of the Central Victoria Bioregion. Parks Victoria Technical Series No. 76. Parks Victoria, Melbourne.

BBG (2003). Gas Project. Pipeline routes video survey report. Report by Bowman Bishaw Gorham Pty Ltd for Woodside Australia Pty Ltd.

Beaver, PE (2022). Year-round diet, niche breadth, distribution and habitat use of a small procellariiform, the wedgetailed shearwater Ardenna pacifica breeding in south-eastern Australia. University of Tasmania. Thesis. https://doi.org/10.25959/23246975.v3

Berlincourt, M. and Arnould, J.P (2015). Breeding short-tailed shearwaters buffer local environmental variability in south-eastern Australia by foraging in Antarctic waters. Movement ecology, 3:1-11.

Bessell-Browne P, Day J, Sporcic M and Appleyard S (2021). SESSF species stock structure review: Jackass Morwong, Pink Ling and Blue Warehou. Technical report for AFMA, April 2021. 80p

Bilney, R. J., & Emison, W. B. (1983). Breeding of the White-bellied Sea-eagle in the Gippsland Lakes Region of Victoria, Australia. Australian Bird Watcher, 10, 61-68.

BirdLife Australia. (2025). Little Penguin. Bird Profile. Little Penguin - BirdLife Australia.

BirdLife International (2023) Important Bird Area factsheet: King Island. Downloaded from http://datazone.birdlife.org/site/factsheet/king-island-iba-australia on 15/08/2023.

Blower, D. C, Pandolfi, J. M., Bruce, B. D., Gomez-Cabrera, M., & Ovenden, J. R. (2012). Population genetics of Australian white sharks reveals fine-scale spatial structure, trans - oceanic dispersal events and low effective population sizes. Marine Ecology Progress Series, 455, 229−244.

BoM and CSIRO. (2024). State of the Climate 2024. Retrieved from http://www.bom.gov.au/state-of-the-climate/2024/documents/2024-state-of-the-climate.pdf

Bone, C. (1998). Preliminary investigation into leatherback turtle, Dermochelys coriacea (L.) distribution, abundance and interactions with fisheries in Tasmanian waters. Unpublished Report. Tasmanian Parks and Wildlife Service.

Bonwick J. 1858. Western Victoria, Its Geography, geology and Social condition: The narrative of an educational tour in 1857, Melbourne, Heinemann 1970.

Boon, P., Allen, T., Brook, J., Carr, G., Frood, D., Harty, C., Yugovic, J. (2011). Mangroves and Coastal Saltmarsh of Victoria, Distribution, Condition, Threats and Management. Institute for Sustainability and Innovation, Victoria University.

Booth JD and Stewart RA (1991) 'Distribution of phyllosoma larvae of the red rock lobster Jasus edwardsii off the east coast of New Zealand in relation to the oceanography: In 'Proceedings of the Australian Society for Fish Biology workshop on larval biology', Hobart, 138-148.

Boreen, T., James, N., Silson, C., & Heggi, D. (1993). Surfical cool-water carbonate sediments on the Otway continental margin, Southeastern Australia. Elsevier Science Publishers BV, Marine geology, 112, 35-56.

BP (2013). Shah Deniz Stage 2 (SD2) Project, Environmental and Social Impact Assessment. Retrieved from https://www.bp.com/en_az/caspian/sustainability/environment/env-and-social-documentation/ShahdenizESIAs/ESIA.html.

Branch, T. A., Matsuoka, K., & Miyashita, T. (2004). Evidence for increases in Antarctic blue whales based on Bayesian modelling. Marine Mammal Science, 20(4), 726-754.

Bransbury, J. (1985). Waders of littoral habitats in south-eastern South Australia. South Australian Ornithologist, 29, 180-187.

Brothers, N., Pemberton, D., Pryor, H; & Halley, V. (2001). Tasmania's Offshore Islands: seabirds and other natural features. Tasmanian Museum and Art Gallery: Hobart. ISBN 0-7246-4816-X

Brooke, M., DE, L. (2004). Albatrosses and Petrels Across the World. Marine Ornithology, 33: 73-73.

Bruce B, Griffin D and Bradford R (2007) 'Laval Transport and Recruitment Processes of Southern Rock Lobster', Fisheries Research and Development Corporation, CSIRO Marine and Atmospheric Research.

Bruce, B. D., Harasti, D., Lee, K., Gallen, C., & Bradford, R. (2019). Broad-scale movements of juvenile white sharks Carcharodon carcharias in eastern Australia from acoustic and satellite telemetry. Marine Ecology Progress Series, 619, 1-15. doi: 10.3354/meps12969.

Buckley, R. W. (1993). Sites of Geological and Geomorphological Significance along the Victorian Coast, Geological Survey of Victoria.

Burgoyne I. (2000). The Mirning: We are the Whales. Magabala Books Aboriginal Corporation. Broome, Western Australia.

Burnell, S. R. (2001). Aspects of the reproductive biology, movements and site fidelity of right whales off Australia. Journal of Cetacean Research and Management (Special Issue 2), 89-102.

Butler I, Patterson H, Bromhead D, Galeano D, Timmiss T, Woodhams J and Curtotti R. (2024). 'Fishery status reports 2024', Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

Butler I, Patterson H, Bromhead D, Galeano D, Timmiss T, Woodhams J and Curtotti R. (2023). 'Fishery status reports 2023', Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

Cai, W., Cowan, T. (2006). SAM and regional rainfall in IPCC AR4 models: Can anthropogenic forcing account for southwest Western Australian winter rainfall reduction? Geophysical Research Letters 33.

Carr, G. (2003). Harmers Haven Flora and Fauna Reserve, South Gippsland – An assessment of vegetation and management issues, Ecology Australia Pty Ltd, Fairfield, Victoria.

Carroll EL, Patenaude N, Alexander A, Steel D and others. 2011. Population structure and individual movement of southern right whales around New Zealand and Australia. Mar Ecol Prog Ser 432: 257−268.

Carnes, M.R. 2009. Description and Evaluation of GDEM-V 3.0. US Naval Research Laboratory, Stennis Space Center, MS. NRL Memorandum Report 7330-09-9165. 21 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/a494306.pdf

Casper, B.M., A.N. Popper, F. Matthews, T.J. Carlson, and M.B. Halvorsen. (2012). Recovery of barotrauma injuries in Chinook salmon, Oncorhynchus tshawytscha from exposure to pile driving sound. PLOS ONE 7(6): e39593. https://doi.org/10.1371/journal.pone.0039593.

CEE Consultants Pty Ltd (2003). Otway Gas project Gas field and Subsea Pipeline Marine Biological Conditions. Existing Conditions and Impact Assessment.

Charlton, C. M. (2017) Population demographics of southern right whales (Eubalaena australis) in Southern Australia. (pp. 171) (PhD Thesis). Curtin University, Western Australia.

Charlton C, Ward R, McCaukey RD, Brownwell Jr. RL, Guggenheimer S, Salago Kent CP and Bannister JL. (2019). Southern right whales (Eubalaena australis) return to a former wintering calving ground: Fowlers Bay, South Australia. Marine Mammal Science. Vol 35, Issue 4. October 2019. https://doi.org/10.1111/mms.12611

Chatto, R., & Warneke, R. (2000). Records of Cetacean stranding's in the Northern Territory of Australia. Beagle: Records of the Museums and Art Galleries of the Northern Territory, 16, 163-175.

Chevillon, L., Tourmetz, J., Dubos, J., Soulaimana-Mattoir, Y., Hollinger, C., Pinet, P., Couzi, F., Riethmuller, M. and Le Corre, M (2022). 25 years of light-induced petrel groundings in Reunion Island: Retrospective analysis and predicted trends. Global Ecolgoy and Conservation, 38 (e02232).

Chevron (2015). Gorgon Gas Development and Jansz Feed Gas Pipeline: Reverse Osmosis Brine Disposal via Ocean Outfall Environmental Management and Monitoring Plan. Retrieved from https://australia.chevron.com/-/media/australia/our-businesses/documents/gorgon-emp-reverse-osmosis-brine-disposal-via-ocean-outfall-environmental-plan.pdf.

Chevron (2018). Wheatstone Project. Wheatstone Well Intervention and Infill Drilling Environment Plan Summary. Document ID: ABU180200939. Chevron, Perth, Western Australia.

Church, J.A., Hunter, J.R., McInnes, K.L., White, N.J. (2006). Sea-level rise around the Australian coastline and the changing frequency of extreme sea-level events. Australian Meteorological Magazine 55: 253–260.

CIN (2005). Chemical Hazard Assessment and Risk Management, for the use and discharge of chemicals used offshore. User Guide version 1.4. CHARM Implementation Network (CIN).

Clancy, G.P. (2005). The diet of the Osprey (Pandion haliaetus) on the north coast of New South Wales. Emu 105:87-91.

Clark I. (1990). Aboriginal Languages and Clans. An Historical Atlas of Western and Central Victoria, Monash University, Melbourne, VIC.

Clarke, P.A. (2001). The significance of whales to the Aboriginal people of southern South Australia. Records of the South Australian Museum. Vol. 34, no. 1, pp. 19-35.

Clarke, R.H. (2010). The Status of Seabirds and Shorebirds at Ashmore Reef and Cartier and Browse Islands: Monitoring program for the Montara Well release - Pre-impact Assessment and First Post-impact Field Survey. Prepared on behalf of PTTEP Australasia and the Department of the Environment, Water, Heritage and the Arts, Australia.

CoA (2005). A Guide to the Integrated Marine and Coastal Regionalisation of Australia Version 4.0. Department of the Environment and Heritage, Canberra.

CoA. (2013). Matters of National Environmental Significant. Significant Impact Guidelines 1.1. Environmental Protection and Biodiversity Conservation Act 1999. Commonwealth of Australia.

CoA (2015). South-east Marine Region Profile: A description of the ecosystems, conservation values and uses of the South-east Marine Region. Commonwealth of Australia.

CoA (2015b). Conservation Management Plan for the Blue Whale (Balaenoptera musculus)- A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999.

CoA (2017). Recovery for Marine Turtles in Australia. Commonwealth of Australia.

CoA. (2017b) Budj Bim Cultural Landscape: World Heritage Nomination. Australian Department of the Environment and Energy. https://www.environment.gov.au/system/files/pages/b42e9c8e-370d-4094-8cef-37ce503e81a3/files/budj-bim-nomination-dossier.pdf

CoA (2017c). National Strategy for Reducing Vessel Strikes on Cetaceans and other Marine Megafauna. Department of the Environment and Energy, Canberra.

CoA (2020). National Recovery Plan for the Australian Fairy Tern (Sternula nereis nereis). Commonwealth of Australia 2020.

CoA. 2020a. Wildlife Conservation Plan for Seabirds. Commonwealth of Australia.

CoA. (2022). National Recovery Plan for Albatrosses and Petrels. Commonwealth of Australia. Commonwealth of Australia 2022.

CoA. (2022a). National Recovery Plan for the Australian Painted Snipe (Rostratula australis). Commonwealth of Australia 2022.

Cogger, H. G., Cameron, E. E., Sadlier, R. A. & Eggler, P. (1993). The Action Plan for Australian Reptiles. Canberra, ACT: Australian Nature Conservation Agency. Retrieved from http://www.environment.gov.au/biodiversity/threatened/action/reptiles/index.html.

Compagno, L.J.V. (1984). Part 1 - Hexanchiformes to Lamniformes. FAO Species Catalogue, Vol. 4., Sharks of the World. An Annotated and Illustrated Catalogue of Sharks Known to Date. FAO Fisheries Synopsis. 4(1):1-249.

Cooper (2024) Otway Offshore Operations Environment Plan. Doc No: CHN-EN-EMP-0001. Cooper Energy Limited. Adelaide.

Correa, I. C. S., Tolodo, E. E. Jr., & Teledo, F. A. L. (2010). Impacts on seafloor geology of drilling disturbance in shallow waters. Environmental Monitoring Assessment, 167. 79-16. Cited in: IAOPG, 2016. Environmental fates and Effects of Ocean Discharge of Drilling Cuttings and Associated Drilling Fluids from Offshore Oil and Gas Operations. Prepared by Sanzone, D.M., Neff, J.M., Lewis, D., Vinhateriom, N., Blake, J. for International Association of Oil Gas Producers.

Cranford, T. W., & Krysl, P. (2015). Fin whale sound reception mechanisms: Skull vibration enables low-frequency hearing. PLoS ONE, 10(1), Article e0116222. https://doi.org/10.1371/journal.pone.0116222

Cranmer, G. (1988) Environmental survey of the benthic sediments around three exploration well sites. Report No 88/02. Report to the United Kingdom Offshore Operators Association. Aberdeen University Marine Studies Ltd, Aberdeen, UK, 33pp.

CSIRO (2020). State of the Climate 2020. Australian Government Bureau of Meteorology. https://www.csiro.au/en/research/environmental-impacts/climate-change/state-of-the-climate

Currie, D. R., & Isaacs, L. R. (2005) Impact of exploratory offshore drilling on benthic communities in the Minerva gas field, Port Campbell, Australia. Marine Environmental Research, 59. 217– 233.

Currie DR and Ward TM (2009) 'South Australia Giant Crab (Pseudocarcinus gigas) Fishery', Fisheries Assessment Report for PIRSA, South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

Daan, R., & Mulder, M. (1996) On the short-term and long-term impact of drilling activities in the Dutch sector of the North Sea. ICES Journal of Marine Science, 53. 1036-1044.

Daase M and Soreide JE. (2021). Seasonal variability in non-consumptive mortality of Arctic zooplankton. Journal of Plankton Research 43:4, 565-585.

Dabuleviciene, T., Kozlov, I., Vaiciute, D., Dailidiene, I. (2018). Remote sensing of coastal upwelling in the south-eastern Baltic Sea: statistical properties and implications for the coastal environment. Remote Sens. 10, 1752.

DAFF. (2024). Map of marine pests in Australia. Department of Agriculture, Forestry and Fisheries, Commonwealth of Australia, Canberra. https://www.marinepests.gov.au/pests/map.

Dai, A. (2013). Increasing drought under global warming in observations and models. Nature climate change 3: 52–58.

Dawson J. (1881). Australian Aborigines: The Languages and Customs of Several Tribes of Aborigines in the Western District of Victoria, Australia. George Robertson, Melbourne.

de Campos, L. F., Paiva, P. M., Rodrigues, P. P. G. W., Ferreira, M. I. P., & Lugon, J. Jnr. (2017). Disposal of waste from cementing operation from offshore oil and gas wells building. Ciência e Natura, 39(2). 413 – 422. Retrieved from https://pdfs.semanticscholar.org/15f8/5dd7aab34c3700f8580345ed9d9eb41e18bd.pdf.

DAWE (2021). Guidance on key terms within the Blue Whale Conservation Management Plan. September 2021. https://www.awe.gov.au/sites/default/files/documents/guidance-key-terms-blue-whale-conservation-management-plan-2021.pdf. Accessed on 20 March 2022.

DCCEEW (2023). Draft Guidelines for Working in the Near and Offshore Environment to Protect Underwater Cultural Heritage. Department of Climate Change, Energy, the Environment and Water, Canberra.

DCCEEW (2023a). National Light Pollution Guidelines for Wildlife, Department of Climate Change, Energy, the Environment and Water, Canberra, May. CC BY 4.0

DCCEEW. (2023b) Species Profile and Threats Database: Bonney coast upwelling. Department of Climate Change, Energy, the Environment and Water. Accessed August 2023 at: https://www.environment.gov.au/sprat-public/action/kef/view/89;jsessionid=01AD87551D0DE1B0248C8722BE137004

DCCEEW (2023c) The National Electric Vehicle Strategy, Department of Climate Change, Energy, the Environment and Water, Canberra,. CC BY 4.0.

DCCEEW (2023d). Conservation Advice for Ardenna grisea (sooty shearwater). Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/biodiversity/threatened/species/pubs/82651-conservation-advice-21122023.pdf

DCCEEW (2023e). Conservation Advice for Stagonopleura guttata (diamond firetail). Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/59398-conservation-advice-31032023.pdf

DCCEEW (2023f). Conservation Advice for *Numenius madagascariensis* (Far Eastern Curlew). Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice-18122023.pdf

DCCEEW. (2023g). Conservation Advice for Aphelocephala leucopsis (southern whiteface). Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/529-conservation-advice-31032023.pdf.

DCCEEW. (2023h). National Recovery Plan for the Australasian Bittern (Botaurus poiciloptilus). Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: https://www.dcceew.gov.au/sites/default/files/documents/national-recovery-plan-australasian-bittern.pdf

DCCEEW. (2023i). Safeguard Mechanism Reforms Position Paper January 2023. Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: https://storage.googleapis.com/files-au-climate/climate-au/p/prj23cd662ff4387d8c254ae/public_assets/Safeguard%20Mechanism%20Reforms%20Position%20Paper.pdf

DCCEEW (2023j) The Protocol for Designation of Biologically Important Areas for Protected Marine Species (The BIA Protocol), Department of Climate Change, Energy, the Environment and Water, Canberra, August. CC BY 4.0.

DCCEEW (2024). Biologically important areas of regionally significant marine species. Department of Climate Change, Energy, the Environment and Water. https://www.dcceew.gov.au/environment/marine/marine-species/bias

DCCEEW (2024a). Australian Marine Spatial Information System (AMSIS). Commonwealth of Australia, Canberra. Retrieved from https://geoscience-au.maps.arcgis.com/apps/webappviewer/index.html?id=eee105ff33d2435a819bcff994eb1b9a.

DCCEEW. (2024b). Australian Wetland Database. Department of Climate Change, Energy, the Environment and Water.

DCCEEW. (2024c). Sea Country Indigenous Protected Areas Program - Grant Opportunity. Department of Climate Change, Energy, the Environment and Water. https://www.dcceew.gov.au/environment/land/indigenous-protected-areas/sea-country-grant-opportunity

DCCEEW. (2024d). Conservation Advice for Arenaria interpres (ruddy turnstone). Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/872-conservation-advice-05012024.pdf

DCCEEW. (2024e). Conservation advice for Limosa lapponica baueri (Bar-tailed Godwit) Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://environment.gov.au/biodiversity/threatened/species/pubs/86380-conservation-advice-05012024.pdf

DCCEEW. (2024f). Conservation advice for Limosa limosa (Black-tailed Godwit) Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/845-conservation-advice-05012024.pdf

DCCEEW. (2024g). Conservation Advice for Calidris acuminata (sharp-tailed sandpiper) Department of Climate Change, Energy, the Environment and Water, Canberra. Available from:

http://www.environment.gov.au/biodiversity/threatened/species/pubs/874-conservation-advice-05012024.pdf

DCCEEW. (2024h). Conservation advice for Neophema chrysostoma (Blue-winged Parrot) Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/726-conservation-advice-31032023.pdf

DCCEEW. (2024i). Conservation Advice for Xenus cinereus (terek sandpiper). Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/59300-conservation-advice-05012024.pdf.

DCCEEW (2024j). Conservation Advice for Gallinago hardwickii (Latham's snipe). Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/863-conservation-advice-05012024.pdf

DCCEEW (2024k). Conservation Advice for Pluvialis squatarola (grey plover). Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/865-conservation-advice-05012024.pdf

DCCEEW (2024l). Conservation Advice for Calidris tenuirostris (great knot). Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/862-conservation-advice-05012024.pdf

DCCEEW. (2024m). Conservation Advice for Calidris canutus (red knot). Canberra: Department of Climate Change, Energy, the Environment and Water.

DCCEEW (2024n). National Recovery Plan for the Swift Parrot (Lathamus discolor). Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.dcceew.gov.au/environment/biodiversity/threatened/recovery-plans/swift-parrot-2024. In effect under the EPBC Act from 30-Apr-2024.

DCCEEW. (2024o). National Recovery Plan for the Southern Right Whale. Department of Climate Change, Energy, the Environment and Water.

DCCEEW. (2024p). Species Profile and Threats Database: Southern Giant-petrel. Department of Climate Change, Energy, the Environment and Water. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1060

DCCEEW. (2024q). Nominating a species, ecological community or key threatening process under the EPBC Act Any person may nominate a native species, ecological community or threatening process for listing under any of the categories specified in the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

DCCEEW. (2024r). Australia Emissions Projections. Department of Climate Change, Energy, the Environment and Water. Available from: https://www.dcceew.gov.au/climate-change/publications/australias-emissions-projections-2024

DCCEEW (2025a). Offshore wind facts. Department of Climate Change, Energy, the Environment and Water. Available from: https://www.dcceew.gov.au/energy/renewable/offshore-wind/offshore-wind-facts

DCCEEW (2025b) Conservation Advice for Eubalaena australis — Southern Right Whale. Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=40

DEC NSW (2006). Approved Recovery Plan for Gould's Petrel (Pterodroma leucoptera leucopters). Available from: http://www.environment.gov.au/system/files/resources/ba3f6508-b2d7-4d20-9424-75b36b016c37/files/p-leucoptera.pdf

Debus, S. J. S., Baker, G., Owner, D., & Nottidge, B. (2014). Response of White-bellied Sea-Eagles Haliaeetus leucogaster to encroaching human activities at nest sites. Corella, 38(3), 53-62.

DELWP (2015) Ngootyoong Gunditj Ngootyoong Mara South West Management Plan. Department of Environment, Land, Water and Planning.

DELWP (2016). National Recovery Plan for the Orange-bellied Parrot (Neophema chrysogaster). Australian Government, Canberra.

Dernie KM KM, Kaiser, MJ, Richardson EA, Warwick RM. 2003. 'Recovery of soft sediment communities and habitats following physical disturbance', Journal of Animal Ecology 72 (6) 1043-1056 (2003). Accessed December 2022.

DEWHA. 2008. Approved Conservation Advice for Dermochelys coriacea (Leatherback Turtle). Canberra: Department of the Environment, Water, Heritage and the Arts.

DISR (2024). Department of Industry, Science and Resources. Future Gas Strategy Analytical Report May 2024. https://www.industry.gov.au/sites/default/files/2024-05/future-gas-strategy-analytical-report.pdf

DNP (2013). South-East Commonwealth Marine Reserves Network Management Plan 2013–23. Department of Environment Canberra, Available at: http://www.environment.gov.au/system/files/pages/de2de49a-7eed-4a70-bfbb-463f8d00f2ca/files/se-networkm kmanagement-plan2013-23.pdf

DNP (2025) South-east Marine Parks Network Management Plan. Director of National Parks. Available from: https://australianmarineparks.gov.au/static/0a1fca1937a3392d1eecf0be90531239/south-east-network-management-plan-2025.pdf

DNRET. (2022). Department of Natural Resources and Environment Tasmania. 'Wildlife Management', Tasmanian Government, DNRET, Fishing Tasmania, accessed June 2023.

DNRET (Department of Natural Resources and Environment Tasmania) (2022a) 'Tasmanian Abalone Fishery: Proposed Amendments to the Fisheries (General and Fees) Regulations 2016 - Commercial Blacklip Abalone Size Limits', Tasmanian Government, DNRET, Wild Fisheries Management Branch.

DoD. (2022). Categories for Unexploded (UXO) Ordnance Potential – Categorisation Criteria, Warnings and Advice – webpage. A WWW webpage accessed in December 2022 at Categories for UXO Potential https://www.whereisuxo.org.au. Department of Defence. Canberra.

DoD. (2023). Where is Unexploded Ordnance – Interactive Map. A WWW database accessed in March 2023 at https://www.whereisuxo.org.au. Department of Defence. Canberra.

DoE (2014a). Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*). Department of the Environment, Canberra. Retrieved from: http://www.environment.gov.au/resource/recovery-plan-grey-nurse-shark-carcharias-taurus

DoE (2014b) 'Assessment of the Tasmanian Giant Crab Fishery', Commonwealth of Australia, DoE, Canberra, accessed May 2021.

DoE. (2015f). Conservation Advice for Calidris ferruginea (Curlew Sandpiper). Department of the Environment, Canberra.

DoE. (2023a). Balaenoptera musculus in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

DoE (2023b). Ardenna carneipes Flesh-footed Shearwater in Species Profile and Threats Database. Department of the Environment, Canberra. Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82404.

DoE (2023d) Species Profile and Threats Database: Carcharodon carcharias – White Shark. Department of Climate Change, Energy, the Environment and Water. Accessed August 2023 at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64470

DoE (2023f). Balaenoptera bonaerensis-Antarctic Minke Whale in Species Profile and Threats Database. Department of the Environment, Canberra. Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=67812.

DoE (2023i). Megaptera novaeangliae-Humpback Whale in Species Profile and Threats Database. Department of the Environment, Canberra. Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=38.

DoE (2023j). Physeter macrocephalus-Sperm Whale in Species Profile and Threats Database. Department of the Environment, Canberra. Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59.

DoE (2023k). Dusky Dolphin (Lagenorhynchus obscurus) in Species Profile and Threats Database. Department of the Environment, Canberra. Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=43.

DoE (2023l). Orcinus orca-Killer Whale in Species Profile and Threats Database. Department of the Environment, Canberra. Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=46.

DoE (2023m). Chelonia mydas-Green Turtles in Species Profile and Threats Database. Department of the Environment, Canberra. Retrieved from http://www. Dermochelys coriacea environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1765.

DoE (2023n). Dermochelys coriacea-Leatherback in Species Profile and Threats Database. Department of the Environment, Canberra. Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1768.

DoE (2025). Ardenna pacifica — Wedge-tailed Shearwater in Species Profile and Threats Database. Department of the Environment, Canberra. Retrieved from https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=84292

Donaldson S. 2012. Exploring Ways of Knowing Protecting and Acknowledging First Nations Totems across the Eurobodalla Shire Far South Coast NSW. Report for the Eurobodalla Shire Council First Nations Advisory Committee. Eurobodalla.

DPI (Department of Primary Industries) (2009) 'Victorian Rock Lobster Fishery Management Plan: Fisheries Victoria Management Report Series No. 70', Government of Victoria, DPI, Victoria.

DPI (Department of Primary Industries) (2024) 'Blacklip Abalone', New South Wales Government, DPI, Sydney, accessed January 2024.

DPIPWE. 2016. Marine Life and Their Habitats. Department of Primary Industries, Water and Environment. Available from: http://dpipwe.tas.gov.au/conservation/the-marine-environment/fisheries-habitats

DPIRD (Department of Primary Industries and Regional Development) (2016) 'Fisheries: Abalone', Government of Western Australia, DPIRD, Perth, accessed October 2024.

Draper N. 2015. Islands of the dead? Prehistoric occupation of Kangaroo Island and other southern offshore islands and watercraft use by First Nations Australians. Quaternary international, 385, 229-242.

DSE (2004). Controlling the Northern Pacific Seastar (Asterias amurensis) in Australia. Final Report for the Australian Government Department of the Environment and Heritage. Department of Sustainability and Environment Victoria.

DSE (2008). National Recovery Plan for the Australian Grayling Prototroctes maraena. State of Victoria Department of Sustainability and Environment. East Melbourne.

DSE (2012) Marine National Parks. DSE, Melbourne.

DSEWPaC. (2011). Approved Conservation Advice for Sternula nereis nereis (Fairy Tern). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/82950-conservation-advice.pdf.

DSEWPaC. (2012a). Conservation Management Plan for the Southern Right Whale .2011 – 2021. Department of Sustainability, Environment, Water, Population and Communities. Australian Antarctic Division. Canberra.

DSEWPaC. (2012b). Approved Conservation Advice for Giant Kelp Marine Forests of South East Australia. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities.

DSEWPaC (2012c). Species group report card – seabirds; Supporting the marine bioregional plan for the South-west Marine Region. Australian Government. Retrieved from https://www.environment.gov.au/system/files/pages/a73fb726-8572-4d64-9e33-1d320dd6109c/files/south-west-report-card-seabirds.pdf [10 October 2019].

DSEWPaC (2013a). Approved Conservation Advice for Rostratula australis (Australian Painted Snipe). Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/77037-conservation-advice.pdf

DSEWPaC (2013b). Conservation Advice for Subtropical and Temperate Coastal Saltmarsh. Canberra: Department of Sustainability, Environment, Water, Population and Communities.

DSEWPaC. (2013c). Recovery Plan for the White Shark (Carcharodon carcharias). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities.

DSEWPaC (2013d). Recovery Plan for the Australian Sea Lion (Neophoca cinerea). Department of Sustainability, Environment, Water, Population and Communities. Commonwealth of Australia.

Duncan, A. J., Gavrilov, A. N., McCauley, R. D., Parnum, I. M., & Collis, J. M. (2013). Characteristics of sound propagation in shallow water over an elastic seabed with a thin cap-rock layer. Journal of the Acoustical Society of America, 34, 207-215.

Dunlop, R.A., M.J. Noad, R.D. McCauley, L. Scott-Hayward, E. Kniest, R. Slade, D. Paton, and D.H. Cato. (2017). Determining the behavioural dose–response relationship of marine mammals to air gun noise and source proximity. Journal of Experimental Biology 220(16): 2878-2886.

Dunlop J.N. and Rippey E. (2001). Unpublished submission to the: Turquoise Coast island Nature Reserves – draft management plan. Department of Conservation and land management, Conservation Committee of Australia in Barter M. (2004) Human Disturbance to Colonially Breeding Seabirds and Guidelines for Visitor management on Islands off the Coast of Western Australia. Murdoch University, Perth.

Durante LM, Smart JJ and Tsolos A. (2022). South Australian Charter Boat Fishery 2020/21. Final Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences, Adelaide. SARDI Publication No. F2007/000847-6. ARDI Research Series No.1139. 47pp.

ECC. 2000. Marine, Coastal and Estuarine Investigation Final Report, Environment Conservation Council, East Melbourne.

Edmunds, M. J., Judd, A., Pickett, P. & Parks Victoria. (2010). Reef surveys at Twelve Apostles Marine National Park and the Arches Marine Sanctuary. Melbourne: Parks Victoria

Edyvane, K. (2003). Conservation, Monitoring and Recovery of Threatened Giant Kelp (Macrocystis pyrifera) Beds in Tasmania – Final Report (to Environment Australia). Department of Primary Industries, Water and Environment, Tasmania.

Eldridge R. 2015. The cultural Interactions of Aborigines with Whales, Whalers and Whaling in southwest Victoria 1828-1850. Unpublished Thesis https://researchonline.federation.edu.au/vital/access/manager/Repository/vital:10437

EMAC. 2015. Meerreengeeye Ngakeepoorryeeyt (Our Country) Plan. Eastern Maar Aboriginal Corporation.

EMAC. (2024) About - Eastern Maar Aboriginal Corporation. https://easternmaar.com.au/about/

Erbe, C., Ainslie, M. A., de Jong, C. A. F., Racca, R., & Stocker, M. (2016). The need for protocols and standards in research on underwater noise impacts on marine life. In: Popper, A.N., Hawkins, A. (eds.) The Effects of Noise on Aquatic Life II. Advances in Experimental Medicine and Biology, 875. 1265–1271.

Fandry, C. B (1983). Model for the three-dimensional structure of wind driven and tidal circulation in Bass Strait, Australian Journal of Marine Freshwater Research, 34, 121 –141.

Faulkner, R., Farcas, A. and Merchant, N. (2018). Guiding principles for assessing the impact of underwater noise. Journal of Applied Ecology. Available online at: https://doi.org/10.1111/1365-2664.13161

Ferguson G and Johnson D (2021) 'Pipi (2020)', Victorian Fisheries Authority, Fisheries Research and Development Corporation, accessed November 2022.

Finneran, J.J. (2016). Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise. Technical Report.

Finneran, J.J., E.E. Henderson, D.S. Houser, K. Jenkins, S. Kotecki, and J. Mulsow. (2017). Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III). Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). 183 p.

Fishes of Australia (2015). Family Syngnathidae. A WWW database. Available from: http://www.fishesofaustralia.net.au/home/family/34#moreinfo.

Flagstaff Hill (2015). Guide to the Historic Shipwreck Trail on Victoria's West Coast. Retrieved from www.flagstaffhill.com/media/uploads/ShipwreckTrail.pdf.

Forteath, G., Picken, B., Ralph, R. and Williams, J. (1982). Marine Growth Studies on the North Sea oil platform Montrose Alpha. Marine Ecology Progress Series 8: 61-68.

FRDC (Fisheries Research and Development Corporation) (2017) 'Giant Crab', FRDC, accessed May 2021.

FRDC (Fisheries Research and Development Corporation) (2018) 'Giant Crab' FRDC, accessed May 2021.

FRDC (Fisheries Research & Development Corporation) (2020), Report: Southern Rock Lobster Jasus edwardsii, Fisheries Research & Development Corporation. Accessed December 2022.

FRDC (Fisheries Research & Development Corporation) (2020a), Report: Giant Crab Pseudocarcinus gigas, Fisheries Research & Development Corporation. Accessed December 2022.

FRDC (Fisheries Research & Development Corporation) (2023) ‘A Report Card for Australia’s sharks, rays and chimaeras 30 October 2023’, Fisheries Research & Development Corporation. Accessed January 2024.

French-McCay, D. (2004). Oil spill impact modelling: Development and validation. Environmental toxicology and chemistry / SETAC. 23. 2441-56. 10.1897/03-382.

French-McCay, D. (2009). ‘State-of-the-art and research needs for oil spill impact assessment modelling’. Proceedings of the 32nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa, 601–653.

Fraser MW, Short J, Kendrick G, McLean D, Keesing J, Byrne M, Caley JM, Clarke D, Davis AR, Erftemeijer PLA, Field S, Gustin-Craig S, Huisman J, Keough M, Lavery P, Masini R, McMahon K, Mengersen K, Rasheed M, Statton J, Stoddart J, Wu P. 2017. Effects of dredging on critical ecological processes for marine invertebrates, seagrasses and macroalgae, and the potential for management with environmental windows using Western Australia as a case study, Ecological Indicators, Volume 78, 2017, Pages 229–242

Fromant, Aymeric., Delore, Karine., Bost, Charles-Andre., Eizenberg, Yonina H., Botha, Jonathan A., Cherel, Yves., Bustamante, Paco., Gardner, Brett R., Brault-Favrou, Maud., Lec’hvien, Arnaud., Arnould, John P.Y. (2021). Impact of Extreme Environmental Conditions: Foraging Behaviour and Trophic Ecology Responses of a Diving Seabird, The Common Diving Petrel. Progress in Oceanography. 198(7). https://doi.org/10.1016/j.pocean.2021.102676

Fugro (2019) Artisan Site Survey Geophysical/Geotechnical Factual Report. 21 November 2019. Provided to Beach Energy Limited.

Fugro (2020a). Geophysical/Geotechnical Factual Report - Thylacine Site. Otway Offshore Well Site Survey. Victoria, Australia. 135846-52-REP-002. 27 February 2020. Provided to Beach Energy Limited.

Fugro (2020b). Geophysical/Geotechnical Factual Report - Geographe Site. Otway Offshore Well Site Survey. Victoria, Australia. 135846-52-REP-003. 19 February 2020. Provided to Beach Energy Limited.

Fuller RS and Bursill LW. 2021. Linking the Pleiades to a reawakened Black Duck Songline in Southeastern Australia. Australian Journal Of Anthropology, 32(2), 116-134

Gallaway, B.J., Martin, L.R., Howard, R.L., Boland, G.S. and Dennis, G.D. (1981). Effects on artificial reef and demersal fish and microcrustacean communities. In: Environmental Effects of Offshore Oil Production. Middleditch, B.S. (ed). Springer, New York.

Gannier, A., Drouot, V., & Gould, J. C. (2002). Distribution and the relative abundance of Sperm Whales in the Mediterranean Sea. Marine Ecology Progress Series, 243. 281 -293.

Gardner C (1998) 'The larval and reproductive biology of the Giant Crab Pseudocarcinus gigas (PhD Thesis)', University of Tasmania, Hobart.

Gardner C and Mills DJ (2013) 'Determination of moulting events in rock lobsters from pleopod clipping', PLoS One, 8(8): e74146.

Gardner C and Welsford D (2003) 'Development of juvenile Australian giant crabs, (Pseudocarcinus gigas Lamarck, 1818) (Decapoda: Oziidae), reared in the laboratory', Australian Journal of Zoology, 51: 285-295.Garnett S, Szabo J and Dutson G (2011) 'The Action Plan for Australian Birds 2010', CSIRO Publishing, Melbourne.

Gavrilov, A. (2012). Sesimic signal transmission, pygmy blue whale abundance and passage and ambient noise measurements during and after the Bellerive seismic survey in Bass Strait, 2011. Curtin University centre for Marine Science.

Geiling, N. (2014). Arctic Shipping: Good for Invasive Species, Bad for the Rest of Nature. Smithsonian. Available at: https://www.smithsonianmag.com/science-nature/global-warmings-unexpected-consequence-invasive-species-180951573/

Geraci, J. R. (1990). Physiologic and Toxic Effects on Cetaceans. In: Sea Mammals and Oil: Confronting the Risks. Geraci, J. R. and St. Aubin, D. J. (eds). Academic Press Inc., San Diego, California.

Geraci, J. R., & St. Aubin, D. J. (1988). Synthesis of Effects of Oil on Marine Mammals. Report to U.S. Department of the Interior, Minerals Management Service, Atlantic OCS Region, OCS Study. Ventura, California.

Gill, P. C. (2002). A blue whale (Balaenoptera musculus) feeding ground in a southern Australian coastal upwelling zone. Journal of Cetacean Research and Management, 4. 179-184.

Gill, P. C. (2020). Blue Whale Literature Review - Offshore Victoria (Otway basin/Bass Strait). Report to Beach Energy Limited. Blue Whale Study Inc.

Gill, P. C., & Morrice, M. (2003). Cetacean Observations. Blue Whale Compliance Aerial Surveys. Santos Ltd Seismic Survey Program Vic/P51 and P52. November – December 2002. Report to Santos Ltd.

Gill P. C., Kemper C.M., Talbot M. & Lyons S.A. (2008). Large group of pygmy right whales seen in a shelf upwelling region off Victoria, Australia. Marine Mammal Science, 24(4): 962-968.

Gill, P. C., Morrice, M. G., Page, B., Pirzl, R., Levings, A. H., & Coyne, M. (2011). Blue whale habitat selection and within-season distribution in a regional upwelling system off southern Australia. Marine Ecology Progress Series, 421. 243–263. Retrieved from http://www.intres.com/articles/meps_oa/m421p243.pdf.

Gill, P.C., Pirzl, R., Morrice, M. G., & Lawton, K. (2015). Cetacean diversity of the continental shelf and slope off southern Australia. The Journal of Wildlife Management, 79.

Gillanders BM, Doubleday Z, Cassey P, Clarke S, Connell SD, Deveney M, Dittmann S, Divecha S, Doubell M, Goldsworthy S, Hayden B, Huveneers C, James C, Leterme S, Li X, Loo M, Luick J, Meyer W, Middleton J, Miller D, Moller L, Prowse T, Rogers P, Russell BD, van Ruth P, Tanner JE, Ward T, Woodcock SH and Young M. 2013. Spencer Gulf Ecosystem & Development Initiative. Report on

Scenario development, Stakeholder workshops, Existing knowledge & Information gaps. Report for Spencer Gulf Ecosystem and Development Initiative. The University of Adelaide, Adelaide.

GLAWAC. 2015. Gunaikurnai Whole-of-Country Plan. Gunaikurnai Land and Waters Aboriginal Corporation. Bairnsdale, Victoria.

GMTOAC. 2023. Gunditjmara Nyamat Mirring Plan 2023-2033. Gunditj Mirring Traditional Owners Aboriginal Corporation RNTBC. Breakaway Creek, Victoria.

Goldsworthy, S. D. (2008). The Mammals of Australia. Third Edition. New Holland. Sydney.

Gomez, C., Lawson, J.W., Wright, A.J., Buren, A.D., Tollit, D. and Lesage, V. (2016). A systematic review on the behavioural responses of wild marine mammals to noise: the disparity between science and policy. Canadian Journal of Zoology 94(12): 801–819.

Government of South Australia. 2023 Bull Kelp - *Durvillaea potatorum* Bio-region Fact Sheet. https://cdn.environment.sa.gov.au/landscape/docs/hf/bull-kelp-bio-region-fact.pdf

Green, R. H. (1969). The birds of Flinders Island. Records of the Queen Victoria Museum, 34 (pp. 1-32).

Griffin, Thompson, Bax, Hallegraeff (1997). The 1995 mass mortality of pilchards: No role found for physical or biological oceanographic factors in Australia. Australian Journal Marine Freshwater Research, 48. 27-58.

Gubili, C., Clinton, Geremy, C., Wintner, S., Mahmood, S., Demian, C., Noble, L. (2012). Application of molecular genetics for conservation of the white shark, Carcharodon carcharias, L. 1758. In: Domeier ML (ed) Global perspectives on the biology and life history of the white shark. CRC Press, Boca Raton, FLO, p 357−380.

Hannay, D., MacGillivray, A., Laurinolli, M., & Racca, R. (2004). Source Level Measurements from 2004 Acoustics Programme. Sakhalin Energy (pp. 66).

Harding, S. B., Wilson, J. R., & Geering, D. W. (2007). Threats to shorebirds and conservation actions. In: Geering, A., L. Agnew and S. Harding, eds. Shorebirds of Australia. (pp. 197-213). Melbourne, Victoria: CSIRO Publishing.

Harrison, P. L. (1999). Oil pollutants inhibit fertilization and larval settlement in the scleractinian reef coral Acropora tenuis from the Great Barrier Reef, Australia. Sources, Fates and Consequences of Pollutants in the Great Barrier Reef and Torres Strait, GBRMPA: 11-12.

Hartmann K, Gardner C and Hobday D (2013) ‘Fishery Assessment Report: Tasmanian Rock Lobster Fishery 2011/12’, Institute for Marine and Antarctic Studies, University of Tasmania.

Hartmann K, Reilly D, How J and McLeay L (2021) ‘Giant Crab (2020)’, Victorian Fisheries authority, Fisheries Research and Development Corporation, accessed November 2022.

Hartmann K (2022) ‘Rebuilding Southern Rock Lobster populations on the Tasmanian East Coast’, Accompaniment to NRE Tasmania’s “Proposed Rules and Policy Changes”.

Hastie, G. D., Swift, R. J., Gordon, J. C. D., Slesser, G., & Turrell, W.R. (2003). Sperm Whale Distribution and Seasonal Density in the Faroe Shetland Channel. Journal of Cetacean Research and Management, 5(3). 247-252.

Hawkins, A.D. and Popper, A.N. (2017) A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates, ICES Journal of Marine Science, Volume 74, Issue 3, March-April 2017, Pages 635–651, https://doi.org/10.1093/icesjms/fsw205

Hayes KR, Dunstan P, Woolley S, Barrett N, Howe SA, Samson CR, Bowling R, Ryan MP, Foster S, Monk J, Peel D, Hosack GR and Francis SO (2021) ‘Designing a Targeted Monitoring Program to Support Evidence Based Management of Australian Marine Parks: A Pilot on the South-East Marine Parks Network’, Report to Parks Australia and the National Environmental Science Program, Marine Biodiversity Hub, Parks Australia, University of Tasmanian and CSIRO, Hobart, Australia.

Heap, A. D., & Harris, P. T. (2008). Geomorphology of the Australian margin and adjacent seafloor, Australian Journal of Earth Sciences, 55(4). 555-585.

Heeren T and Mitchell BD (1997) ‘Morphology of the mouthparts, gastric mill and digestive tract of the giant crab, Pseudocarcinus gigas (Milne Edwards) (Decapoda:Oziidae)’, Marine and Freshwater Research, 48: 7-18.Hernandez-Urcera J, Murillo FJ, Regueira M, Cabanellas-Reboredo M and Planas M (2021) ‘Preferential habitats prediction in syngnathids using species distribution models’, Marine Environmental Research, 172, 105488.

Heisler, S., & Parry, G. D. (2007). Parks Victoria Technical Series – Number 53. Species diversity and composition of benthic infaunal communities found in Marine National Parks along the outer Victorian coast. Parks Victoria, Melbourne. Retrieved from http://parkweb.vic.gov.au/__data/assets/pdf_file/0015/314520/19_2096.pdf.

Heritage Victoria (2004). Victorian Heritage Register. Department of Infrastructure, Melbourne.

Hiddink JG, Jennings S, Sciberra M, Szostek CL, Hughes, KM KM, Ellis, N, Rijnsdorp AD, McConnaughey RA, Mazor T, Hilborn R, Collie JS, Pitcher CR, Amoroso RO, Parma AM, Suuronen P, Kaier MJ. 2017. ‘Global analysis of depletion and recovery of seabed biota after bottom trawling disturbance’. Proc. Natl. Acad. Sci. U.S.A. 114, 8301–8306 (2017).Higgins, P. J., & Davies, S. J. J. F. (1996). Handbook of Australian, New Zealand and Antarctic Birds. Volume Three - Snipe to Pigeons. Melbourne, Victoria: Oxford University Press.

Higgins PJ and Davies SJJF. Eds. 1996. Handbook of Australian, New Zealand and Antarctic Birds. Volume Three - Snipe to Pigeons. Melbourne, Victoria: Oxford University Press.

Hinwood, J. B., Poots, A. E., Dennis, L. R., Carey, J. M., Houridis, H., Bell, R. J., Ayling, A. M. (1994). Drilling activities. In: Swan JM, Neff JM, Young PC (eds) Environmental Implications of offshore oil and gas development in Australia: findings of an independent scientific review. Australian Petroleum Production and Exploration Association, Canberra, (pp. 123–207).

Hoegh-Guldberg, O., Jacob, D., Taylor, M., Bindi, M., Brown, S., Camilloni, I., Diedhiou, A., Djalante, R., Ebi, K.L., Engelbrecht, F., Guiot, J., Hijioka, Y., Mehrotra, S., Payne, A., Seneviratne, S., Thomas, A., Warren, R., Guangsheng, Z., (2018). Impacts of 1.5 C global warming on natural and human systems, in:

Global Warming of 1.5° C. An IPCC Special Report. Intergovernmental Panel on Climate Change, Geneva.

Hofmeyr, G. & Gales, N. (2008). Arctocephalus pusillus. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2.

Holmes, K. W., Radford, B., Van Niel, K. P., Kendrick, G. A., & Grove, S. L. (2007). Mapping the Benthos in Victoria's Marine National Parks, Volume 4: Twelve Apostles Marine National Park. Parks Victoria Technical Series No. 43. Parks Victoria, Melbourne.

Hook S, Batley G, Holloway M, Irving P and Ross A. (eds) (2016). Oil Spill Monitoring Handbook. CSIRO Publishing, Australia.

Horwood, J. (1987). The sei whale: Population biology, ecology, and management. Croom Helm, Sydney.

Hotchkin, C. and S. Parks. (2013). The Lombard effect and other noise-induced vocal modifications: Insight from mammalian communication systems. Biological Reviews 88(4): 809-824. https://doi.org/10.1111/brv.12026

Houser, D.S., W. Yost, R. Burkard, J.J. Finneran, C. Reichmuth, and J. Mulsow. (2017). A review of the history, development and application of auditory weighting functions in humans and marine mammals. Journal of the Acoustical Society of America 141(3): 1371-1413. https://doi.org/10.1121/1.4976086.

Huang Z. and Wang X.H. (2019). Mapping the spatial and temporal variability of the upwelling systems of the Australian south-eastern coast using 14-year of MODIS data, Remote Sensing of Environment. Volume 227, 2019, Pages 90-109, ISSN 0034-4257.

Hughes, L. (2003). Climate change and Australia: trends, projections and impacts. Austral Ecology28: 423- 443.

Hughes, L., (2011). Climate change and Australia: key vulnerable regions. Regional Environmental Change 11: 189–195.

Huisman, J. M. (2000). Marine Plants of Australia. University of Western Australia Press.

Hume, F., Hindell, M. A., Pemberton, D., & Gales, R. (2004). Spatial and temporal variation in the diet of a high trophic level predator, the Australian fur seal (Arctocephalus pusillus doriferus). Marine biology, 144(3). 407-415.

Hyland, J., Hardin, D., Steinhauer, M., Coats, D., Green, R., & Neff, J. (1994). Environmental impact of offshore oil development on the outer continental shelf and slope off Point Arguello, California. Marine Environmental Research, 37(2). 195-229.

IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities) (2021) IALA Recommendation (Normative) R0139 (O-139) The Marking of Man-Made Structures, Edition 3.0, IALA, accessed October 2022.

IOGP (2016). Environmental fate and effects of ocean discharge of drill cuttings and associated drilling fluids from offshore oil and gas operations. Report No. 543. March 2016. International Association of Oil & Gas Producers and IPIECA. London.

IOGP (2019). Risk Assessment Data Directory of Blowout Frequencies. Available online https://www.iogp.org/bookstore/product/risk-assessment-data-directory-blowout-frequencies/

IOGP-IPIECA, (2020). Environmental management in the upstream oil and gas industry. Report No. 254. August 2020. International Association of Oil & Gas Producers and IPIECA. London.

IPCC (2018). Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp. Global Warming of 1.5 ºC — (ipcc.ch)

IPCC, (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change[Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, In press, doi:10.1017/9781009157896.

IPCC, (2022a). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844.

IPCC, (2022b). Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926

IPCC, (2023). Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 184 pp., doi: 10.59327/IPCC/AR6-9789291691647

IPIECA (1995). Biological Impacts of Oil Pollution: Rocky Shores. IPIECA. London.

IWC. (2013). Report of the International Whaling Commission workshop on the assessment of southern right whales. J. Cetacean Res. Manage.14 (Suppl.): 439-462.

Jackson GD and McGrath-Steer BL (2003) 'Arrow squid in southern Australian waters—supplying management needs through biological investigations', Final report to the FRDC, Institute of Antarctic and Southern Ocean Studies, University of Tasmania, Hobart.

James, N. P., Reid, C. M., Bone. Y., Levings, A., & Malcolm, I. (2013). The macroalgal carbonate factory at a cool-to-warm temperate transition, Southern Australia, Sedimentary Geology, 291. 1-26.

Jenkins, G., & McKinnon, L. (2006). Port Phillip Bay Channel Deepening Project: supplemental environmental effects statement – aquaculture and fisheries.

Johnson, A. (2018). The Effects of Turbidity and Suspended Sediments on ESA-Listed Species from Projects Occurring in the Greater Atlantic Region. Greater Atlantic Region Policy Series 18-02. NOAA Fisheries Greater Atlantic Regional Fisheries Office - www.greateratlantic.fisheries.noaa.gov/policyseries/

Jones, ISF., Padman, L. (1983). Semidiurnal Internal Tides in Eastern Bass Strait. Australian Journal of Marine and Freshwater Research 34(1): 159-171. https://doi.org/10.1071/MF9830159

Jones DOB, Hudson IR and Bett BJ. 2006. Effects of physical disturbance on the cold-water megafaunal communities of the Faroe−Shetland Channel. Mar Ecol Prog Ser 319: 43−54

JP Kenny. (2012). Otway Phase 3 Rock Bolting Installation Procedure. Sapura Clough Doc no. 12300-50-G-0001.

Kampf J, Doubell M, Griffin D, Matthews RL and Ward TM. 2004. Evidence of a large seasonal coastal upwelling system along the southern shelf of Australia. Geophys. Res. Lett. 31, L09310.

Kemper, C.A. 2002a. Distribution of the pygmy right whale, Caperea marginata, in the Australasian region. Marine Mammal Science. 18(1):99-111.

Ketten, D.R. (1992). The cetacean ear: form, frequency, and evolution. In Thomas, J.A., R.A. Kastelein, and A.Y. Supin (eds.). Marine Mammal Sensory Systems. Plenum Press, New York. 53-75.

Ketten, D.R. and Bartol, S.M. (2005). Functional measures of sea turtle hearing. ONR project final report. Document Number ONR Award Number N00014-02-1-0510. Office of Naval Research (US).

Kirkham, H. (1997). Seagrasses of Australia, Australia: State of the Environment, Technical Paper Series (Estuaries and the Sea). Environment Australia, Commonwealth of Australia.

Kirkwood, R., Warneke, R.M., Arnould. J.P. (2009). Recolonization of Bass Strait, Australia, by the New Zealand fur seal, Arctocephalus forsteri. Mar. Mam. Sci. 25(2): 441–449.

Koessler, M and C. McPherson (2021). Technical Addendum – Beach Otway Project: Additional and revised modelling study. 27 August 2021.

Koessler, M, Matthews M-N R, and C. McPherson. (2020). Otway Offshore Project – Drilling Program: Assessing Marine Fauna Sound Exposures. Document 02033, Version 1.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

Koster, W.M., Aarestrup, K., Birnie-Gauvin, K., Church, B., Dawson, D., Lyon, J., O'Connor, J., Righton, D., Rose, D., Westerberg, H. and Stuart, I. (2021). First tracking of the oceanic spawning migrations of Australasian shortfinned eels (Anguilla australis). Scientific reports, 11(1), pp.1-13.

Krueck N, Hartmann K and Lyle J (2020) 'Tasmanian Scalefish Fishery Assessment 2018/19', Tasmanian Government, IMAS, University of Tasmania, Hobart.

Krueck N, Rodgers P, Hill N and Hall K (2021) 'Pale Octopus (2020)', Victorian Fisheries Authority, Fisheries Research and Development Corporation, accessed November 2022.

Krueck N, Fowler A and Hughes J (2021b) 'Bluethroat Wrasse (2020)', , Victorian Fisheries Authority, Fisheries Research and Development Corporation, accessed December 2022.

Laist, D. W., Knowlton, A. R., Mead, J. G., Collet, A. S., Podesta, M. (2001). Collisions between ships and whales. Marine Mammal Science, 17. 35-75.

Lane L. 1980. Records of the Victorian Archaeological Survey Number 10 June 1980, Ministry for Conservation Publication.

Last, P. R., & Stevens, J. D. (2009). Sharks and Rays of Australia. Second edition. CSIRO Publishing, Australia.

Lattice Energy. 2017. Offshore Environment Plan Summary: Otway. VIC 9000 ENV PLN CDN/ID 17275058.

Leon R, Gardner C and Hartmann K (2017) 'Assessment of interaction between giant crab trap and benthic trawl fisheries'.

Levings, A. H., Mitchell B.D., McGarvey, R., Mathews, J., Laurenson, L., Austin, C., Heeron, T., Murphy, N., Miller, A., Rowsell, M. and Joneset, P. (2001). Fisheries Biology of the Giant Crab, Pseudocarcinus gigas. Final report to the Fisheries Research and Development Corporation, Australia, for projects 93/220 & 97/132. Deakin University.

Levings, A., & Gill, P. (2011). Seasonal Winds Drive Water Temperature Cycle and Migration Patterns of Southern Australian Giant Crab Pseudocarcinus gigas. (pp. 461-478).

Lewis, R.K. (1981). Seasonal upwelling along the south-eastern coastline of South Australia. Mar. Freshw. Res. 32, 843–854.

Lewis, M., & Pryor, R. (2013). Toxicities of oils, dispersants and dispersed oils to algae and aquatic plants: Review and database value to resource sustainability. Environmental Pollution, 180. 345–367.

Limpus, C. J. (2008). A biological review of Australian Marine Turtles. 1. Loggerhead Turtle Caretta (Linneaus). Queensland Environment Protection Agency. Retrieved from http://www.epa.qld.gov.au/publications/p02785aa.pdf/A_Biological_Review_Of_Australian_Marine_Turtles_1_Loggerhead_Turtle_emCaretta_Caretta/em_Linnaeus.pdf.

Linnane A, Gardener C, Reilly D and How J (2021) 'Southern Rock Lobster 2020', Fisheries Research and Development Corporation, accessed November 2022.

Linnane A, McGarvey R, Feenstra J and Hawthorne P (2022) 'Southern Zone Rock Lobster (Jasus edwardsii) Fishery Stock Assessment 2020/21', Government of South Australia, PIRSA, SARDI, Adelaide.

Loehr, L. C., Beegle-Krause, C. J., George, K., McGee, C. D., Mearns, A. J., & Atkinson, M. J. (2006). The significance of dilution in evaluating possible impacts of wastewater discharges from large cruise ships. Marine Pollution Bulletin, 52. 681–688.

Loyn, R.H., Lane, B.A., Chandler, C and Carr, G.W. (1986). Ecology of Orange-bellied Parrots Neophema chrysogaster at their main remnant wintering site. Emu. 86:195-206.

Lutcavage, M. E., Lutz, P. L., Bossart, G. D., & Hudson, D. M. (1995). Physiologic and clinicopathologic effects of NERAcrude oil on loggerhead sea turtles. Archives of Environmental Contamination and Toxicology, 28. 417-422.

MacGillivray, A. O., Racca, R., & Li, Z. (2013). Marine Mammal Audibility of Selected Shallow-water Survey Sources. Journal of Acoustical Society of America, 135(1).

Mackay AI, Bailleul F, Childerhouse S and Harcourt R. (2015). Offshore migratory movement of southern right whales: informing critical conservation and management needs. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2015/000526-1. SARDI Research Report Series No. 859. 40pp.

Marchant, S. & Higgins, P. J. (1993). Handbook of Australian, New Zealand and Antarctic Birds. Vol. 2. Raptors to Lapwings. Melbourne, Victoria: Oxford University Press.

Marchant, S., & Higgins, P. J. (1990). Handbook of Australian, New Zealand and Antarctic Birds. Vol. 1. Oxford University Press, Australia.

Martin, B., J. MacDonnell, N.E. Chorney, and D. Zeddies. 2012. Appendix A: Sound Source Verification of Fugro Geotechnical Sources. In ESS Group, Inc. Renewal Application for Incidental Harassment Authorization for the Non-Lethal Taking of Marine Mammals Resulting from Pre-Construction High Resolution Geophysical Survey. For Cape Wind Associates, LLC. http://www.nmfs.noaa.gov/pr/pdfs/permits/capewind_iha_application_renewal.pdf .

Massola A. 1968. Bunjil's Cave: Myths, Legends and Superstitions of the Aborigines of South-East Australia. Lansdown Press, Melbourne.

Mathews RH. 1904, Ethnological notes on the Aboriginal tribes of New South Wales and Victoria, Journal and Proceedings of the Royal Society of New South Wales, vol 38, p. 203-381

Matthews, M. N. R. (2012). Underwater Sound Propagation from an Airgun Array in Baffin Bay: Shell 2012 Seismic Surveys in Baffin Bay Blocks 5 and *. Version 3.0. Jasco Applied Sciences.

Matthews, M.-N. R., M.W. Koessler, and C.R. McPherson. (2020). Otway Offshore Project – Construction Program: Assessing Marine Fauna Sound Exposures. Document 02112, Version 1.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

Mayfield S, Stobart B, Burnell O, Strain L and Mundy C (2021) 'Greenlip Abalone (2020)', Victorian Fisheries Authority, Fisheries Research and Development Corporation, accessed November 2022.

McCauley, R. D. (2004). Underwater sea noise in the Otway Basin – drilling, seismic and blue whales. Report prepared by Centre for Marine Science and Technology, Curtin University, for Santos Ltd

McCauley, R.D., M.-N. Jenner, C. Jenner, and D.H. Cato. (1998a). Observations of the movements of humpback whales about an operating seismic survey vessel near Exmouth, Western Australia. Journal of the Acoustical Society of America 103: 2909-2909. https://doi.org/10.1121/1.422068.

McCauley, R.D., M.-N. Jenner, C. Jenner, K.A. McCabe, and J. Murdoch. (1998b). The response of humpback whales (Megaptera novaeangliae) to offshore seismic survey noise: Preliminary results of observations about a working seismic vessel and experimental exposures. Australian Petroleum Production Exploration Association (APPEA) Journal 38(1): 692-707. https://doi.org/10.1071/AJ97045.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, et al. (2000a). Marine seismic surveys: Analysis and propagation of air- gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. Report Number R99-15. Prepared for Australian Petroleum Production Exploration Association by Centre for Maine Science and Technology, Western Australia. 198 p. https://cmst.curtin.edu.au/wp-content/uploads/sites/4/2016/05/McCauley-et-al-Seismic- effects-2000.pdf.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, et al. (2000b). Marine seismic surveys: A study of environmental implications. Australian Petroleum Production Exploration Association (APPEA) Journal 40(1): 692-708. https://doi.org/10.1071/AJ99048.

McCauley, R. D., & Duncan, A. J. (2001). Marine Acoustic Effects Study, Blue Whale Feeding Aggregations, Otway Basin, Bass Strait Victoria. Centre for Marine Science and Technology, Curtin University March 2001 For Ecos Consulting.

McCauley, R.D. and D.H. Cato. (2016). Evening choruses in the Perth Canyon and their potential link with Myctophidae fishes. Journal of the Acoustical Society of America 140(4): 2384-2398.

McCauley, R.D., R.D. Day, K.M. Swadling, Q.P. Fitzgibbon, R.A. Watson, and J.M. Semmens. (2017). Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecology & Evolution 1(7): 1-8. https://doi.org/10.1038/s41559-017-0195.McCauley, R.D., A.N. Gavrilov, C.D. Jolliffe, R. Ward, and P.C. Gill. 2018. Pygmy blue and Antarctic blue whale presence, distribution and population parameters in southern Australia based on passive acoustics. Deep Sea Research Part II 157–158: 154-168. https://doi.org/10.1016/j.dsr2.2018.09.006.

McCauley R.D., Gavrilov A.N., Jolliffe C.D., Ward R. & Gill P.C. (2018). Pygmy blue and Antarctic blue whale presence, distribution and population parameters in southern Australia based on passive acoustics. Deep-Sea Research Part II: Topical Studies in Oceanography 157-158: 154-168.

McClatchie, S., Middleton, J., Pattiaratchi, C., Currie, D., & Kendrick, G. (2006). The South-west Marine Region: Ecosystems and Key Species Groups. Department of the Environment and Water Resources. Australian Government.

McCutcheon C, Dann P, Salton M, Renwick L, Hoskins A, Gormley A, Arnould J. (2011). The Foraging Range of Little Penguins (Eudyptula minor) During Winter. Emu. 111(4): 321-329, doi: 10.1071/Mu10078.

McDonald, M.A., J.A. Hildebrand, and S.C. Webb. (1995). Blue and fin whales observed on a seafloor array in the Northeast Pacific. Journal of the Acoustical Society of America 98(2): 712-721. https://doi.org/10.1121/1.413565.

McInnes, K. L., & Hubbert, G. D. (2003). A numerical modelling study of storm surges in Bass Strait. Australian Meteorological Magazine 52(3).

McKinley, A., Johnston, E.L., (2010). Impacts of contaminant sources on marine fish abundance and species richness: a review and meta-analysis of evidence from the field. Evolution & Ecology Research Centre, School of Biological, Earth and Environmental Sciences, University of New South Wales, Sydney. Marine Ecological Progress Series 420: pp175–191.doi: 10.3354/meps08856

McLeay, L. J., Sorokin, S. J., Rogers, P. J., & Ward, T. M. (2003). Benthic Protection Zone of the Great Australian Bight Marine Park: Literature Review. South Australia Marine Research and Development Institute (Aquatic Sciences), Commonwealth Department of Environment and Heritage.

McLeay. L. (2022) Stock Status Report for the South Australian Giant Crab (Pseudocarcinus gigas) Fishery in 2020/21. Fishery Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000332-11. SARDI Research Report Series No. 1123. 20pp.

McPherson, C. and Wood, M. (2017). Otway Basin Geophysical Operations Acoustic Modelling - Acoustic Modelling for Assessing Marine Fauna Sound Exposures. Prepared for Lattice Energy on 2 November 2017. Document 01473.

McPherson, C, M. Weirathmueller, S. Denes, D. Cusano, and M. Koessler. (2020). Otway Offshore Project – Drilling Program: Pygmy Blue Whale Exposure Modelling. Document 02169, Version 1.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

McPherson, C.R., Z. Li, C.C. Wilson, K.A. Kowarski, and M. Koessler (2021). Beach Otway Development Acoustic Monitoring: Characterisation, Validation, and Marine Mammals. Document Number 02424, Version 2.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

Melton, H. R., Smith, J. P., Martin, C. R., Nedwed, T. J., Mairs, H. L., & Raught D.L. (2000). Offshore Discharge of Drilling Fluids and Cuttings – A Scientific Perspective on Public Policy. International Oil and Gas Conference, Rio, Brazil; 13-19 October 2000.

Menkhorst, P (2010). A Survey of Colonially-breeding Birds on Mud Islands, Port Phillip, Victoria, with an annotated list of all terrestrial vertebrates. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment.

MESA. (2015). Mangroves of Australia – Distribution and Diversity. Marine Education Society of Australasia. Available from: http://www.mesa.edu.au/mangroves/mangroves01.asp.

Middleton, J.F., Bye, J.A.T. (2007). A review of the shelf-slope circulation along Australia's southern shelves: Cape Leeuwin to Portland. Prog. Oceanogr. 75, 1–41.

Möller LM, Double MC, Paton D, Attard CRM and Bilgmann K. (2015). Satellite tagging of blue whales in southern Australian waters: examining movements and occupancy patterns to inform management decision-making. Final Report to Australian Marine Mammal Centre.

Möller LM, Attard CRM, Bilgmann K, Andrews-Goff V, Jonsen I, Paton D and Double MC. (2020). Movements and behaviour of blue whales satellite tagged in an Australian upwelling system. Scientific Reports 10:21165.

Möller LM, Allen SJ and Harcourt RG. (2002). Group characteristics, site fidelity and abundance of bottlenose dolphins (Tursiops aduncus) in Jervis Bay and Port Stephens, southeastern Australia. Australian Mammalogy. 24:11 -21.

Myrberg, J. F., Arthur, C., Van Ruth, P., Ward, T. M., McClean, J. L, Maltrud, M. E., Middleton, S. (2007). El Nino Effects and Upwelling off South Australia. Journal of Physical Oceanography, 37(2). 458–2,477.

Miller, B. S., Kelly, N., Double, M. C., Childerhouse, S. J., Laverick, S. & Gales, N. (2012). Cruise report on SORP 2012 blue whale voyages: development of acoustic methods. Paper SC/64/SH1 1 presented to the IWC Scientific Committee.

Milton, S. L., & Lutz, P. (2003). Physiological and Genetic response to Environmental Stress. The Biology of Sea Turtles 2. CRC Press, Boca Raton (pp. 163).

Minton, C., & Deleyev, J. (2001). Analysis of recoveries of VWSG banded Caspian Terns. Victorian Wader Study Group Bulletin 2. (pp.71-75).

Mollet, H. F., Cliff, G., Pratt Jr, H. L., & Stevens, J. D. (2000). Reproductive Biology of the female shortfin mako, Isurus oxyrinchus Rafinesque, 1820, with comments on the embryonic development of lamnoids. Fishery Bulletin, 98. 299-318.

Mooney, A. T., Yamato, M., Branstetter, B. K. (2012). Hearing in Cetaceans: From Natural History to Experimental Biology. Biology Department, Woods Hole Oceanographic Institution, CA.

Morrice, M. G., Gill, P. C., Hughes, J., & Levings, A. H. (2004). Summary of aerial surveys conducted for the Santos Ltd EPP32 seismic survey, 2-13 December 2003. Report # WEG-SP 02/2004, Whale Ecology Group-Southern Ocean, Deakin University. unpublished.

Mundy C, Chick R, Stobart B and Strain L (2021) ‘Blacklip Abalone (2020)’, Victorian Fisheries Authority, Fisheries Research and Development Corporation, accessed November 2022.

Mundy C and McAllister J (2022) ‘Tasmanian Abalone Fishery Assessment 2021’, Tasmanian Government, IMAS, University of Tasmania, Hobart.

Mustoe, S. H. (2008). Killer Whale (Orchinus orca) sightings in Victoria. Victorian Naturalist, 125(3). 76-81.

Newcastle University. 2024. Colonial Frontier Massacres, Australia, 1788 to 1930. https://c21ch.newcastle.edu.au/colonialmassacres/map.php

NOAA 2019. ESA Section 7 Consultation Tools for Marine Mammals on the West Coast (webpage), 27 Sep 2019. https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west . (Accessed 10 Mar 2022).

Nedwed, T., Smith, J. P., & Melton, R. (2006). Fate of Nonaqueous Drilling Fluid Cuttings Discharged from a Deepwater Exploration Well. Presented at the SPE International Health Safety and Environment Conference. Abu Dhabi, UAE, 2-4 April 2006. SPE98612.

Neff, J. M. (2005). Composition, environmental fates, and biological effects of water based drilling muds and cuttings discharged to the marine environment: a synthesis and annotated bibliography. Report prepared for the Petroleum Environmental Research Forum (PERF). Washington DC: American Petroleum Institute.

Neff, J. M. (2010). Fate and Effects of Water Based Drilling Muds and cuttings in Cold Water Environments. Neff & Associates LLC. Shell Exploration and Production Company.

Neff, J. M., Hillman, R. E., & Waugh, J. J. (1989) Bioaccumulation of trace metals from drilling mud barite by benthic marine animals. (pp. 461-479).

Neff, J. M., Mckelvie, S., Jr, R.C. (2000). Environmental impacts of synthetic based drilling fluids. Report prepared for Minerals Management Service (MMS) by Robert Ayers & Associates.

NERA (2017). Environment Plan Reference Case, Planned discharge of sewage, putrescible waste and grey water. National Energy Resources Australia (NERA), Kensington, WA. Accessed August 2023.

Nicholls (2022). Australian Museum – Animal factsheets: Orange-bellied Parrot. Available from: https://australian.museum/learn/animals/birds/orange-bellied-parrot-neophema-chrysogaster/#:~:text=Seasonality,they%20mostly%20travel%20at%20night

Nieblas, A.E., Sloyan, B.M., Hobday, A.J., Coleman, R., Richardson, A.J. (2009). Variability of biological production in low wind-forced regional upwelling systems: a case study off southeastern Australia. Limnol. Oceanogr. 54, 1548–1558.

NMFS (2018). Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. National Marine Fisheries Service. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. (pp. 167).

NNTT. 2010. Native title: an overview. National Native Title Tribunal. http://www.nntt.gov.au/Information%20Publications/Native%20Title%20an%20overview.pdf

Noad, M. J., Dunlop, R. A., Paton, D., & Cato, D. H. (2011). Absolute and relative abundance estimates of Australian east coast humpback whales. Journal of Cetacean Research and Management, Special issue 3. 243-252.

NOO (2002). Sea Country – an Indigenous perspective. The South-east Regional Marine Plan. National Oceans Office. Hobart.

NOPSEMA (2019). Environmental Bulletin: Oil Spill Modelling. Document number: A652993. April 2019. National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/sites/default/files/documents/2021-04/A652993.pdf

NOPSEMA (2024). Offshore project proposal decision making guideline. Document Number: A630598. January 2024. National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/sites/default/files/documents/OPP%20-%20Decision%20making%20guideline%20Jan2024.pdf.

NOPSEMA (2024a). Offshore project proposal content requirements Guidance Note. Document Number: A473026. January 2024. National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/sites/default/files/documents/Offshore%20project%20proposal%20content%20requirements%20guidance%20note.pdf.

Noriega R, Lyle J, Hall K, Moore B (2021) 'Gould's Squid 2020', FRDC, accessed November 2022.

Norman, Frederick & Dann, Peter & Guesclin, P & Drynan, D & Sutherland, Duncan. (2017). Recoveries of Little Penguins Eudyptula minor flipper-banded at colonies in western Victoria. Corella. 41. 20-26.

Norro A.M.J., Rumes B., Degraer S.J. (2013). Differentiating between Underwater Construction Noise of Monopile and Jacket Foundations for Offshore Windmills: A Case Study from the Belgian Part of the North Sea. The Scientific World Journal. Volume 2013, Article ID 897624, 7 pages Accessed at <http://dx.doi.org/10.1155/2013/897624>

Nowacek, D., Johnson, M. and Tyack, P.L. (2004). North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alarm stimuli. Proceedings of the Royal Society of London B 271: 227–231.

NRE Tasmania (2024). Orange-bellied Parrots: Latest Updates. Tasmanian Government, Department of Natural Resources and Environment Tasmania, Hobart. Accessed January 2025. Accessed from: https://nre.tas.gov.au/conservation/threatened-species-and-communities/lists-of-threatened-species/threatened-species-vertebrates/orange-bellied-parrot/latest-updates

NSF (2011). National Science Foundation (U.S.), U.S. Geological Survey, and [NOAA] National Oceanic and Atmospheric Administration (U.S.). 2011 Final Programmatic Environmental Impact Statement/Overseas. environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey. National Science Foundation, Arlington, VA.

O'Hara, T., McShane, P. E., & Norman, M. (1999). Victoria. In N. L. Andrew (ed.). Under Southern Seas: the ecology of Australia's rocky reefs. (pp. 72−78). UNSW Press, Sydney (pp. 20−30).

Oil and Gas UK (2014). The UK offshore oil and gas industry guidance on risk-related decision making (Oil & Gas UK, formerly UKOOA, 2014)

Oke, P.R., Griffin, D. (2011). The cold-core eddy and strong upwelling off the coast of New South Wales in early 2007. Deep-Sea Res. II 58, 574–591.

Oke, P.R., Middleton, J.H. (2001). Nutrient enrichment off Port Stephens: the role of the East Australian Current. Cont. Shelf Res. 21, 587–606.

OSPAR. Overview of Impact of anthropogenic underwater sound in the marine environment. Biodiversity Series, OSPAR Commission, 2009.

O'Sullivan D and Cullen J (1983) 'Food of the squid Nototodarus gouldi in Bass Strait', Australian Journal of Marine and Freshwater Research, 34(2): 261 – 285.

Ovenden JR, Brasher DJ and White R (1992) 'Mitochondrial DNA analyses of the Red Rock Lobster Jasus edwardsii supports an apparent absence of population subdivision throughout Australasia', Marine Biology, 112: 319-326.

Owen, K., Jenner, C. S., Jenner, M. N. M., & Andrews, D. R. (2016). A week in the life of a pygmy blue whale: migratory dive depth overlaps with large vessel drafts. Animal Biotelemetry 4. 17. doi:10.1186/s40317-016-0109-4.

Pade, N. G., Queiroza, N., Humphries, N. E., Witt, M. J., Jones, C. S. Noble, L. R., & Sims D. W. (2009). First results from satellite-linked archival tagging of porbeagle shark, Lamnanasus: Area fidelity, wider-scale movements and plasticity in diel depth changes. Journal of Experimental Marine Biology and Ecology, 370(1-2). 64–74.

Pardini, A. T., Jones, C. S., Scholl, M. C., & Noble, L. R. (2000). Isolation and characterization of dinucleotide microsatellite loci in the great white shark, Carcharodon carcharias. Molecular Ecology 9. 1176–1178.

Parliament of South Australia. 2011. Little Penguins Report "Away with the fairies". 59th Report for the Natural Resources Committee.

Pangerc T, Robinson S, Theobald P and Galley L. 2016. Underwater sound measurement data during diamond wire cutting: First description of radiated noise. Proc. Mtgs. Acoust. 27, 040012 (2016); https://doi.org/10.1121/2.0000322.

Parker, D. (1978). Observations of Whales on ANARE Voyages between Australia and Antarctica. Australian Wildlife Research, 5(1), 25-39.

Parks, S.E., C.W. Clark, and P.L. Tyack. (2007). Short-and long-term changes in right whale calling behavior: The potential effects of noise on acoustic communication. Journal of the Acoustical Society of America 122(6): 3725-3731. https://doi.org/10.1121/1.2799904.Version 1.1 92

Parks Victoria (1998). The Port Campbell National Park and Bay of Islands Coastal Park Management Plan. Parks Victoria, Melbourne. Retrieved from http://parkweb.vic.gov.au/explore/parks/port-campbell-national-park.

Parks Victoria (1998a) Mornington Peninsula National Park and Arthurs Seat State Park Management Plan.

Parks Victoria (2003). Cape Liptrap Coastal Park Management Plan. Parks Victoria, Melbourne.

Parks Victoria (2005a). Corner Inlet Marine National Park Management Plan. Parks Victoria, Melbourne.

Parks Victoria (2005b). Management Plan for Point Addis Marine National Park, Point Danger Marine Sanctuary and Eagle Rock Marine Sanctuary. Parks Victoria, Melbourne.

Parks Victoria (2006a). Wilsons Promontory Marine National Park and Wilsons Promontory Marine Park Management Plan May 2006. Parks Victoria, Melbourne.

Parks Victoria (2006b). Bunurong Marine National Park Management Plan. Parks Victoria, Melbourne.

Parks Victoria (2006c). Port Phillip Heads Marine National Park Management Plan. Parks Victoria, Melbourne.

Parks Victoria (2006d). Management Plan for Twelve Apostles Marine National Park and The Arches Marine Sanctuary. Parks Victoria, Melbourne.

Parks Victoria (2007a). Marengo Reefs Marine Sanctuary Management Plan. Parks Victoria, Melbourne. Retrieved from http://parkweb.vic.gov.au/__data/assets/pdf_file/0003/313347/Marengo-Reef-Marine-Sanctuary-Management-Plan.pdf.

Parks Victoria (2007b). Barwon Bluff Marine Sanctuary Management Plan. Parks Victoria, Melbourne. Retrieved from http://parkweb.vic.gov.au/__data/assets/word_doc/0005/637601/Barwon-Bluff-Marine-Sanctuary-Management-Plan-accessible-version.docx.

Parks Victoria (2007c). Merri Marine Sanctuary Management Plan. Parks Victoria, Melbourne. Retrieved from http://parkweb.vic.gov.au/explore/parks/merri-marine-sanctuary.

Parks Victoria (2007d). Mushroom Reef Marine Sanctuary Management Plan. Parks Victoria, Melbourne.

Parks Victoria (2012). Parks Victoria Marine Protected Areas Program Plan 2012-2014. Parks Victoria, Melbourne.

Parks Victoria (2012a). Cape Howe Marine National Park Visitor Guide. Parks Victoria, Melbourne.

Parks Victoria (2012b). Parks Victoria Technical Paper Series No. 79. Marine Natural Values Study (Vol 2). Marine Protected Areas of the Flinders and Twofold Shelf Bioregions.

Parks Victoria (2013). Mornington Peninsula National Park and Arthurs Seat State Park Management Plan. Parks Victoria, Melbourne. Retrieved from http://parkweb.vic.gov.au/explore/parks/mornington-peninsula-national-park.

Parks Victoria (2015). NgootyoongGunditj Ngootyoong Mara South West Management Plan. Parks Victoria, Melbourne. Retrieved from http://parkweb.vic.gov.au/explore/parks/discoverybay-coastal-park.

Parks Victoria (2016). Enviroactive. Retrieved from http://www.enviroactive.com.au/wetlands/shorebirds.

Parks Victoria. (2017). Point Nepean National Park. Parks Australia, Melbourne. Available From: https://www.parks.vic.gov.au/-/media/project/pv/main/parks/documents/plans-and-projects/point-nepean-master-plan/point-nepean-np-master-plan-2017.pdf

Parks Victoria (2017a). Lake Connewarre Wildlife Reserve. Parks Victoria, Melbourne. Retrieved from http://parkweb.vic.gov.au/explore/parks/lake-connewarre-w.r.

Parks Victoria. 2019. Port Campbell National Park. Available from: https://www.parks.vic.gov.au/places-to-see/parks/port-campbell-national-park

Parks Victoria and DSE. (2009), Caring for Country — The Otways and You. Great Otway National Park and Otway Forest Park Management Plan, Parks Victoria and DSE, Melbourne.

Parnell, P.E. (2003). The effects of sewage discharge on water quality and phytoplankton of Hawai'ian Coastal Waters. Marine Environmental Research, 44, 293–311.

Parry GD and Gason A. (2006). The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia. Fisheries Research, 79: 272–284.

Parry, G. D., Campbell, S. J., & Hobday, D. K. (1990). Marine Resources off East Gippsland, Southeastern Australia. Technical Report No. 72. Marine Science Laboratories. Department of Conservation and Natural Resources.

Paterson A. and Wilson C. (2019). "Ngarrindjeri Whaling Narratives and Reconciliation at Encounter Bay, South Australia." In: "New Histories of Pacific Whaling," edited by Ryan Tucker Jones and Angela Wanhalla, RCC Perspectives: Transformations in Environment and Society 2019, no. 5, 91–97. doi.org/10.5282/rcc/8967.

Patterson, H, Bromhead, D, Galeano, D, Larcombe, J, Timmiss, T, Woodhams, J and Curtotti, R. (2022). Fishery status reports 2022, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0. https://doi.org/10.25814/gx9r-3n90.

Paulay, G., Kirkendale, L., Lambert, G., & Meyer, C. (2002). Anthropogenic Biotic Interchange in a Coral Reef Ecosystem: A Case Study from Guam. Pacific Science, 56(4).

Payne, J., Andrews, C., Fancey, L., Cook, A., Christian, J. (2007). Pilot study on the effects of seismic air gun noise on lobster (Homarus americanus). Fisheries and Oceans Canada.

Payne, J., Andrews, C., Fancey, L., White, D. and Christian, J. (2008). Potential Effects of Seismic Energy on Fish and Shellfish: An Update since 2003. Report Number 2008/060. Canadian Science Advisory Secretariat.

Peel, D., Smith, J. N., & Childerhouse, S. (2016). Historical data on Australian Whale Vessel Strikes. International Whaling Commission. SC/66b/HIM/05 Rev 1).

Pegler, J. M. (1983). A brief survey of the water birds in the Shoalhaven-Crookhaven estuary. Australian Birds, 17. 38-42.

Pendoley (2022). Barossa Pipelay Light Modelling 2022 (Report number J06009). Prepared by Pendoley Environmental Pty Ltd for Santos Pty Ltd.

Phalan, Ben & Phillips, Richard & Silk, J. & Afanasyev, Vsevolod & Fukuda, A. & Fox, J. & Catry, Paulo & Higuchi, Hiroyoshi & Croxall, John. (2007). Foraging Behavior of Four Albatross Species by Night and Day. Marine Ecology-Progress Series, 340. 271-286. 10.3354/meps340271.

PIRSA (Department of Primary Industries and Regions South Australia) (2002) ‘A Report Prepared for Environment Australia on the Management of the South Australian Giant Crab (Pseudocarcinus gigas) Fishery for the purposes of Section 303FN (Approved Wildlife Trade Operation) of the Environment Protection and Biodiversity Conservation Act 1999’, PIRSA, accessed April 2021

PIRSA (Department of Primary Industries and Regions South Australia) (2021a) ‘Management Plan for the South Australian Commercial Abalone Fisheries (2021)’, Government of South Australia, PIRSA, Adelaide.

PIRSA (Department of Primary Industries and Regions South Australia) (2021b) ‘Sardine Fishery Operator User Guide’, Government of South Australia, PIRSA, Adelaide.

PIRSA (Department of Primary Industries and Regions South Australia) (2021c) ‘Marine Scalefish Fishery Operator User Guide’, Government of South Australia, PIRSA, Adelaide.

PIRSA (Department of Primary Industries and Regions South Australia) (2022) ‘South Australian fisheries catch and effort data’, Email from PIRSA, South Australia.

PIRSA (Department of Primary Industries and Regions South Australia) (2022b) ‘Miscellaneous fishery’, Government of South Australia, PIRSA, Adelaide.

Pirzl, R., Patenaude, N. J., Burnell, S., & Bannister, J. (2009). Movements of southern right whales (Eubalaena australis) between Australian and subantarctic New Zealand populations. Marine Mammal Science, 25. 455-461.

Pizzey, G., & Knight, F. (1999). The Graham Pizzey and Frank Knight Field Guide to the Birds of Australia. Pymble, Sydney: Angus and Robertson.

Plotkin, P.T., Wicksten, M.K., & Amos, A. F. (1993). Feeding ecology of the loggerhead sea turtle Caretta in the northwestern Gulf of Mexico. Marine Biology, 115(1).

Plummer, A., Morris, L., Blake, S., & Ball, D. (2003). Marine Natural Values Study, Victorian Marine National Parks and Sanctuaries. Parks Victoria Technical Series No. 1, Parks Victoria, Melbourne.

Poore (2004) ‘Marine decapod crustacea of Southern Australia: a guide to identification’, CSIRO Publishing, Collingwood, VIC Australia.

Popper, A. (2018). Potential for Impact of Cumulative Sound Exposure on Fishes During a Seismic Survey. Produced for Santos Ltd. Bethany 3D Seismic Survey Environment Plan Summary.

Popper, A. N., M. E. Smith, P. A. Cott, B. W. Hanna, A. O. MacGillivray, M. E. Austin, and D. A. Mann. (2005). Effects of exposure to seismic airgun use on hearing of three fish species. J. Acoust. Soc. Am. 117:3958-3971.

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D. A., Bartol, S., Carlson, T. J., Løkkeborg, S. (2014). Sound exposure guidelines for fishes and sea turtles. Springer Briefs in Oceanography, 10(1007). 978-3.

Ports Australia. (2022). Trade Statistics Financial Year 2018 – 2019. https://www.portsaustralia.com.au/resources/trade-statistics

Price, C. A (2022). Short-tailed shearwater, *Ardenna tenuirostris*, trophic levels, lag, longitudinal study, seabird harvest. University Of Tasmania. Thesis. Accessed from: https://doi.org/10.25959/23250506.v1

Prideaux, G. (2017). Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities. Convention on Migratory Species of Wild Animals, Bonn.

Przeslawski, R., Bruce, B., Carroll, A., Anderson, J., Bradford, R., Durrant, A., Williams, S. (2016). Marine Seismic Survey Impacts on Fish and Invertebrates: Final Report for the Gippsland Marine Environmental Monitoring Project. Record 2016/35. Geoscience Australia, Canberra.

PWS. (2000). Lavinia Nature Reserve (Ramsar Site) Management Plan 2000 (Draft). Parks and Wildlife Service Department of Primary Industries, Water and Environment, Hobart, Tasmania, 2000. Retrieved from https://www.parks.tas.gov.au/file.aspx?id=6601 [11 October 2019].

Quinn, D. J. (1969). The White-breasted Sea-Eagle in Western Port, Victoria. Australian Bird Watcher, 3. 162-165.

Ramboll. (2020). Environmental Survey: Otway Basin. Ramboll New Zealand Limited.

Reid TA, Hindell MA, Eades DW, and Newman N. 2002. Atlas of the Seabirds of Southeast Australia, Monograph 4, Birds Australia, Melbourne.

Reilly, S. B., Bannister, J. L., Best, P. B., Brown, M., Brownell Jr., R. L., Butterworth, D. S., Zerbini, A. N. (2018). Balaenoptera acutorostrata. In: IUCN 2008. 2008 IUCN Red List of Threatened Species.

Research Data Australia. (2013). Marine Key Ecological Features. Department of Sustainability, Environment, Water, Population and Communities, Australian Government Database. Accessed from: https://catalogue.aodn.org.au/geonetwork/srv/eng/catalog.search#/metadata/baabcdcf-e620-4d9e-b273-91d1de3ec107

Richardson, W. J., Greene, C. R., Maime, C. I., & Thomson, D. H. (1995). Marine Mammals and Noise. Academic Press, San Diego, California. Cited in Wyatt. R. 2008. Joint Industry Programme on Sound and Marine Life. Review of Existing Data on Underwater Sounds Produced by the Oil and Gas Industry, Issue 1. Seiche Measurements Ltd., Great Torrington. Retrieved from https://gisserver.intertek.com/JIP/DMS/ProjectReports/Cat1/JIP-Proj1.4_Soundsinventory_Seiche_2008.pdf.

Richardson, W.J. (ed,). (1997). Northstar marine mammal monitoring program, 1996: Marine mammal and acoustical monitoring of a seismic program in the Alaskan Beaufort Sea. Rep. frOID LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Explor. (Alaska) Inc., Anchorage, AK, and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD

Richardson A.J., Matear RJ and Lenton A. (2017). Potential impacts on zooplankton of seismic surveys. CSIRO, Australia. 34 pp.

Robinson, S., Gales, R., Terauds, A., & Greenwood, M. (2008). Movements of fur seals following relocation from fish farms. Aquatic Conservation: Marine and Freshwater Ecosystems, 18(7). 1189-1199.

Rodriguez, A., Burgan, G., Dann, P., Jessop, R., Negro, JJ., Chiaradia, A (2014). Fatal attraction of short-tailed shearwaters to artificial lights. PloS One, 9, 10, e110114.

Rogers P. (2011). Habitat use, movement and dietary dynamics of pelagic sharks in coastal and shelf ecosystems

Ross, P., Minchinton, T., & Ponder, W. (2009). The ecology of molluscs in Australian saltmarshes. In: Australian Saltmarsh Ecology. (ed.. N Saintilan). CSIRO Publishing, Victoria.

Roughan, M., Middleton, J.H. (2004). On the East Australian Current: variability, encroachment, and upwelling. J. Geophys. Res. 109, C07003.

RPS (2014). Marine Fauna Observer’s Report during Enterprise 3D Marine Seismic Survey 30 October 2014 to 9 November 2014. Report prepared by RPS for Origin Energy Resources Ltd. Perth.

RPS (2023). Offshore Gas Victoria Oil Spill Modelling (MAQ1296J). August 2023. Report for Beach Energy.

RPS (2024). Offshore Gas Victoria Oil Spill Modelling (GOC365512). August 2024. Report for Beach Energy.

Runcie, J., Macinnis-Ng, C., & Ralph, P. (2019). The toxic effects of petrochemicals on seagrasses. Literature review. Retrieved from https://www.researchgate.net/publication/252133825_The_toxic_effects_of_petrochemicals_on_seagrasses_Literature_review.

Sanderson, J. C. (1997). Subtidal Macroalgal Assemblages in Temperate Australian Coastal Waters. Australia: State of the Environment, Technical Paper Series (Estuaries and the Sea). Environment Australia, Commonwealth of Australia.

Schahinger, R.B. (1987). Structure of coastal upwelling events observed off the south-east coast of South Australia during February 1983-April 1984. Mar. Freshw. Res. 38, 439–459.

Seiche Ltd. 2020. Review on existing data on underwater sounds produced by the oil and gas industry. Submitted to: E & P Sound & Marine Life, Joint Industry Programme.

Semmens J, Ewing G and Keane J (2020) ‘Tasmanian Scallop Fishery Assessment 2019’, Tasmanian Government, IMAS, University of Tasmania, Hobart.

Semmens J and Woodhams J (2021) ‘Commercial Scallop 2020’, Victorian Fisheries Authority, Fisheries Research and Development Corporation, accessed November 2022.

Shaughnessy, P. D. (1999). The Action Plan for Australian Seals. CSIRO Wildlife and Ecology, Natural Heritage Trust, Environment Australia.

Shell (2020). Crux Project - Offshore Project Proposal.

Shepherd, S. A., & Edgar, G. J. (2012). Living Reefs: the Ecology of southern Australian Reefs. CSIRO Publishing.

Skira, I (1991). The Short-tailed Shearwater: A review of its biology. Australian Bird Reviews – Number 3, Department of Parks, Wildlife and Heritage, Hobart. 15(2): 45-52.

Skira, I. J., Brothers, N. P., & Pemberton, D. (1996). Distribution, abundance and conservation status of Short-tailed Shearwaters Puffinus tenuirostris in Tasmania, Australia. Marine Ornithology, 24. 1–14.

Smart J, Steer M, Bailleul F, Hall D, Knuckey I, Magnusson A, Morison J, Presser J and Schirmer J. 2022. Informing the structural reform of South Australia's Marine Scalefish Fishery. Adelaide. Fisheries Research Development Corporation and South Australian Research and Development Institute (Aquatic Sciences), Adelaide. FRDC Project No. 2017-014. 319 pp.

Smith, J., Jones, D., Travouillon, K., Kelly, N., Double, M., & Bannister, J. L. (2019) Monitoring Population Dynamics of 'Western' Right Whales off Southern Australia 2018-2021 - Final Report on activities for 2018. Report to the National Environmental Science Program, Marine Biodiversity Hub. Western Australian Museum (lead organisation).

Smith, T. G., Geraci, J. R. and St. Aubin, D. J. (1983). Reaction of bottlenosed dolphins, Tursiops truncates, to a controlled oil spill. Canadian Journal of Fisheries and Aquatic Science 40(9): 1522-1525.

Smyth, D. and Isherwood, M. (2016). Protecting sea country: Indigenous people and marine protected areas in Australia. Big, Bold and Blue: Lessons from Australia's marine protected areas, pp.307-325.

Solomon, S., Manning, M., Marquis, M., Qin, D., (2007). Climate change 2007-the physical science basis: Working group I contribution to the fourth assessment report of the IPCC. Cambridge University Press

South East Trawl Fishing Industry Association (SETFIA) (2019). Report to Beach Energy on trawl and gillnet fishing activity around Beach Energy's proposed Otway offshore project. Report to Beach Energy. (pp. 7).

Southall, B. L., Bowles, A. E., Ellison, W.T., Finneran, J. J., Gentry, R. L., Greene, C. R., Miller, J. H. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, 33(4). 411-521.

Southall, B.L., T. Rowles, F. Gulland, R.W. Baird, and P.D. Jepson. 2013. Final report of the Independent Scientific Review Panel investigating potential contributing factors to a 2008 mass stranding of melon-headed whales (Peponocephala electra) in Antsohihy, Madagascar.

Southall, B.L., D.P. Nowaceck, P.J.O. Miller, and P.L. Tyack. (2016). Experimental field studies to measure behavioral responses of cetaceans to sonar. Endangered Species Research 31: 293-315. https://doi.org/10.3354/esr00764.

Southall, B.L., J.J. Finneran, C.J. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 45(2): 125-232. https://doi.org/10.1578/AM.45.2.2019.125.

Southall, B.L., D.P. Nowacek, A.E. Bowles, V. Senigaglia, L. Bejder, and P.L. Tyack. (2021). Marine Mammal Noise Exposure Criteria: Assessing the Severity of Marine Mammal Behavioral Responses to Human Noise. Aquatic Mammals 47(5): 421-464.

SRL (Southern Rock Lobster Ltd) (2021) 'The life of a Southern Rock Lobster', Fisheries Research and Development Corporation, SRL, accessed May 2021.

Stamation K, Watson M, Moloney P, Charlton C and Bannister J. (2020). Population estimate and rate of increase of southern right whales Eubalaena australis in southeastern Australia. Endangered species research, 41, 373-383.Steffen, W., A Burbridge, L. Hughes, R. Kitching, D. Lindenmayer, W. Musgrave, S.I. Staford, P. Werner. (2009). Australia's Biodiversity and Climate Change: A strategic assessment of the vulnerability of Australia's Biodiversity to climate change. CSIRO Publishing.

Stephenson L.H. (1991). Orange-bellied Parrot Recovery Plan: Management Phase. Tas. Dept Parks, Wildlife & Heritage.

Stevens R. (2021). On the Tail of the Eel. ABC News Story Lab. https://www.abc.net.au/news/2021-05-29/eel-migration-from-victoria-to-tropical-spawning-grounds/100142688

Stroot, D.H., M.W. Koessler, and C.R. McPherson. 2022a. Beach Energy Yolla Drilling Campaign: Acoustic Modelling for Assessing Marine Fauna Sound Exposures. Document 02741, Version 3.0 DRAFT. Technical report by JASCO Applied Sciences for Beach Energy.

Stroot, D.H., M.W. Koessler, and C.R. McPherson. 2022b. Bass Strait Mobile Offshore Drill Unit Modelling Study. Document 02751, Version 3.0 DRAFT. Technical Memo by JASCO Applied Sciences for Beach Energy.

Suchanek, T. H. (1993). Oil Impacts on Marine Invertebrate Populations and Communities. Amer. Zool. 33: 510-523.

Taylor, I. R., & Roe, E. L. (2004). Feeding ecology of little terns Sterna albifrons sinensis in south-eastern Australia and the effects of pilchard mass mortality on breeding success and population size. Marine and Freshwater Research, 55. 799-808.

Teague, W.J., M.J. Carron, and P.J. Hogan. 1990. A comparison between the Generalized Digital Environmental Model and Levitus climatologies. Journal of Geophysical Research 95(C5): 7167-7183. https://doi.org/10.1029/JC095iC05p07167

Terrens, G. W., Gwyther, D., & Keogh, M. J. (1998). Environmental Assessment of Synthetic-based Drilling Mud Discharges to Bass Strait, Australia. APPEA Journal. V38: Part 1. Proceedings of the APPEA Conference, Canberra, 8-11 March 1998.

Thiele, K. (1977). Sightings from land of the sooty albatross. South Australian Ornithologist, 27(7). 259.

Thomsen, M. S., Wernberg, T., Engelen, A. H., Tuya, F., Vanderklift, M.A., & Holmer, M. (2012). A Meta-Analysis of Seaweed Impacts on Seagrasses: Generalities and Knowledge Gaps. PLoS ONE 7(1). Retrieved from https://doi.org/10.1371/journal.pone.0028595.

Thursby, G. B., & Steele, R. L. (2003). Toxicity of arsenite and arsenate to the marine macroalga Champia parvula (rhodophyta). Environmental Toxicology and Chemistry, 3(3). 391-397.

Thurstan, RH, Brittain, Z, Jones, DS, Cameron, E, Dearnaley J and Bellgrove A. (2017). Aboriginal uses of seaweeds in temperate Australia: an archival assessment. Journal of Applied Phycology (2018) 30:1821–1832 https://doi.org/10.1007/s10811-017-1384-z

Todd, V.L.G., Warley, J.C., and Todd, I.B. (2016). Meals on Wheels? A decade of megafaunal visual and acoustic observations from offshore oil & gas rigs and platforms in the North and Irish seas. PloS one 11.

Tonkinson R. 1972. Da:Wajil: a western desert aboriginal rainmaking ritual (T). Retrospective Theses and Dissertations, 1919-2007. University of British Columbia.

Tormosov, D. D., Mikhalev, Y. A., Best, P. B., Zemsky, V. A., Sekiguchi, K., & Brownell, Jr, R. L. (1998). Soviet catches of southern right whales, Eubalaena australis, 1951-1971; biological data and conservation implications. Biology Conservation. 86(2). 185-97.

Torres, L.G., D.R. Barlow, T.E. Chandler and J.D. Burnett. (2020). Insight into the kinematics of blue whale surface foraging through drone observations and prey data. PeerJ 8:e8906. http://doi.org/10.7717/peerj.8906.

Threatened Species Section (2023). Listing Statement for Haliaetus leucogaster (Whitebellied sea-eagle). Department of Natural Resources and Environment, Tasmania.

TSSC. (2011). Approved Conservation Advice for Sternula nereis nereis (Australian Fairy Tern) Department of the Environment. Retrieved from https://environment.gov.au/biodiversity/threatened/species/pubs/82950-conservation-advice.pdf

TSSC. (2012). Commonwealth Listing Advice on Giant Kelp Marine Forests of South East Australia. Department of Sustainability, Environment, Water, Population and Communities. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities

TSSC. (2014). Conservation Advice for Ardenna carneipes (flesh-footed shearwater). Canberra: Department of the Environment. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82404

TSSC (2015a). Approved Conservation Advice for Pterodroma mollis (soft-plumaged petrel). Department of the Environment. Retrieved from http://www.environment.gov.au/biodiversity/threatened/species/pubs/1036-conservation-advice-01102015.pdf.

TSSC (2015b). Approved Conservation Advice for Pachyptila subantarctica (Fairy prion (Southern)). Department of the Environment. Retrieved from http://www.environment.gov.au/biodiversity/threatened/species/pubs/64445-conservation-advice-01102015.pdf.

TSSC. (2015c). Approved Conservation Advice for the Blue Petrel (Halobaena caerulea). Threatened Species Scientific Committee. Department of the Environment.

TSSC. (2015d). Approved Conservation Advice for Balaenoptera physalus (Fin Whale). Threatened Species Scientific Committee. Department of the Environment.

TSSC. (2015e). Approved Conservation Advice for Balaenoptera borealis (Sei Whale). Threatened Species Scientific Committee. Department of the Environment.

TSSC. (2015f). Conservation Advice Lathamus discolor swift parrot. Canberra: Department of the Environment.

TSSC (2016a). Approved Conservation Advice Limosa lapponica menzbieri Bar-tailed godwit (northern Siberian). Threatened Species Scientific Committee. Canberra: Department of the Environment. Retrieved from http://www.environment.gov.au/biodiversity/threatened/species/pubs/86432-conservation-advice-05052016.pdf.

TSSC (2016b). Conservation Advice for Charadrius leschenaultia (Greater Sand Plover). Retrieved from http://www.environment.gov.au/biodiversity/threatened/species/pubs/877-conservation-advice-05052016.pdf.

TSSC (2018). Approved Conservation Advice (including Listing Advice) for the Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community. Retrieved from www.environment.gov.au/biodiversity/threatened/communities/pubs/132-conservation-advice.pdf.

TSSC (2019). Approved Conservation Advice for Botaurus poiciloptilus (Australasian Bittern). Retrieved from http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1001

TSSC (2020). Conservation Advice Neophoca cinerea (Australian Sea Lion). Canberra: Department of Agriculture, Water and the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/22-conservation-advice-23122020.pdf

TSSC (2021). Conservation Advice Prototroctes mareana (Australian Grayling). Canberra: Department of Agriculture, Water and the Environment. Available from: https://environment.gov.au/biodiversity/threatened/species/pubs/26179-conservation-advice-19102021.pdf

TSSC. (2022). Approved Listing Advice for Megaptera novaeangliae (Humpback Whale). . Threatened Species Scientific Committee. Department of the Environment.

UTAS (2023) 'Review of Southern Rock Lobster (*Jasus edwardsii*) population characteristics within the Zeehan Marine Park region, Draft report', IMAS, UTAS, Hobart.

Van de Kam, J., Ens, B., Piersma T., & Zwarts, L. (2004). Shorebirds: An illustrated behavioural ecology. Utrecht, Holland: KNNV Publishers.

VACL. 2014. Nyernila: Listen Continuously. Victorian Aboriginal Corporation for Languages. Creative Victoria, Melbourne.

VFA. (2017) Victorian Eel Fishery Management Plan 2017. Victorian Fisheries Authority.

VFA (2021) 'Fisheries Overview', Victoria State Government, VFA, Melbourne, accessed October 2024.

VFA (2022a) Eel Fishery. Victorian Fisheries Authority. https://vfa.vic.gov.au/commercial-fishing/commercial-fisheries/eels

VFA (2022b) Short-finned eel. Victorian Fisheries Authority. https://vfa.vic.gov.au/education/fishspecies/short-finned-eel

VFA (2022c) Long-finned eel. Victorian Fisheries Authority. https://vfa.vic.gov.au/education/fish-species/long-finned-eel

VFA (2023) Kelp Forests Poster website. Accessed 15.3.2023 https://vfa.vic.gov.au/education/featured/teachers-resource/kelp-forests-poster

VFA (2023a). Seaweed Aquaculture. https://vfa.vic.gov.au/aquaculture/seaweed-aquaculture

VFA (2024) 'Commercial fisheries', State Government of Victoria, VFA, Melbourne, accessed October 2024.

Volkman, J.K., Miller, G.J., Revill, A.T. and Connell, D.W. (1994). Oil Spills. In: Environmental implications of offshore oil and gas development in Australia: The finidings of an independent scientific review. Swam, J.M., Neff, J.M. and Young, P.C. (eds) Australian Petroleum Exploration Association, Sydney, New South Wales.

Warham J. (1996). 'The Behaviour, Population Biology and Physiology of the Petrels', Elsevier Science, United Kingdom.

Wartzok, D. and D.R. Ketten. (1999). Marine Mammal Sensory Systems. (Chapter 4) In Reynolds, J. and S. Rommel (eds.). Biology of Marine Mammals. Smithsonian Institution Press, Washington, DC. pp. 117-175.

Watson, M., Westhorpe, I., Bannister, J., Hedley, S., & Harcourt, R. (2015). Final report on the assessment of numbers and distribution of southern right whales in Southeast Australia. Report to the Australian Marine Mammal Centre.

Watson, M., Stamation, K., Charlton, C., & Bannister, J. (2021). Calving rates, long-range movements and site fidelity of southern right whales (Eubalaena australis) in south-eastern Australia. Journal of Cetacean Research and Management. 22-2021 pp. 17-28.

Weilgart, L.S. (2007). The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology 85: 1091–1116.

Weimerskirch, H., and Cherel, Y (1998). Feeding ecology of short-tailed shearwaters: breeding in Tasmania and foraging in Antarctica? Marine Ecology Progress Series 167: 261–234.

Wesson S, 2001. First Nations Whalers of Twofold Bay. NSW National Parks and Wildlife Service and Bega, Eden and Merrimans Aboriginal Forests Management Committee. NSW.

WGCMA (2003). West Gippsland Native Vegetation Plan. West Gippsland Catchment Management Authority.

White, WT & Last, PR 2008, 'Description of two new species of gummy sharks, genus Mustelus (Carcharhiniformes: Triakidae), from Australian waters', in PR Last, WT White & JJ Pogonoski (eds), Descriptions of new Australian chondricthyans, CSIRO Marine and Atmospheric Research paper 22, CSIRO Marine and Atmospheric Research, Canberra.

Williams, A., Bax, N. J., Kloser, R. J., Althaus, F., Barker, B., & Keith, G. (2009). Australia's deep-water reserve network: implications of false homogeneity for classifying abiotic surrogates of biodiversity. ICES Journal of Marine Science, 66. 214–224.

Williams A, Gardner C, Althaus F and Barker B (2009) 'Understanding shelf-break habitat for sustainable management of fisheries with spatial overlap', Final Report to the Fisheries Research and Development Corporation, Project No. 2004/066, June 2009.

Williams S.H, Gende S.M, Lukacs P.M, Webb K. (2016). Factors affecting whale detection from large ships in Alaska with implications for whale avoidance. ENDANGERED SPECIES RESEARCH. Vol. 30: 209–223, 2016.

Willis, J., Hobday, A.J. (2007). Influence of upwelling on movement of southern bluefin tuna (Thunnus maccoyii) in the Great Australian Bight. Mar. Freshw. Res. 58, 699–708.

Wilson RS and Poore GCB. 1987. The Bass Strait Survey: Biological Sampling Stations, 1979- 1984.

Woodside. (2003). Environmental Impact Statement/Environmental Effects Statement: Otway Gas Project. Woodside Backhouse, G., O'Connor, J., & Jackson, J. (2008). National Recovery Plan for the Australian Grayling (Prototroctes maraena). Department of Sustainability and Environment, Melbourne. Energy Ltd., Perth, Australia.

Woodside (2014) Browse FLNG Development, Draft EIS, EPBC 2013/7079, November 2014, Woodside Energy, Perth WA.

Woodside (2024) Goodwyn Area Infill Development Offshore Project Proposal. Revision 2, July 2024. Woodside Energy, Perth WA.

Woodside (2025) Minerva Decommissioning and Field Management Environment Plan Minerva Decommissioning. Document No: 1401801084. Woodside Energy Limited, Perth.

Woodward, B.L., J.P. Winn and F.E. Fish. (2006). Morphological specialisations of baleen whales associated with hydrodynamic performance and ecological niche. Journal of Morphology 267:1284–1294.

WTOAC. 2020. Paleert Tjaara Dja. Let's make Country good together 2020-2030. Wadawurrung Country Plan. Wadawurrung Traditional Owners Aboriginal Corporation. Geelong, Victoria

Xodus (2024). T/49P Otway Drilling EP - Light Emissions and Line of Sight Modelling (Ref: P-100273-S00-A-REPT-003)

Xodus (2025). Otway Development GHG Emissions Report (Ref: 100383-S01-A-REPT-001)

Zieman, J. C., Orth, R., Phillips, R. C., Thayer, G. W., & Thorhaug, A. (1984). The effects of oil on seagrass ecosystems. In: Cairns J, Buikema AL (eds) Restoration of habitats impacted by oil spills. Butterworth-Heinemann, Boston, MA. (pp. 37−64).

Appendix A EPBC Protected Matters Search Tool Report - Project Area

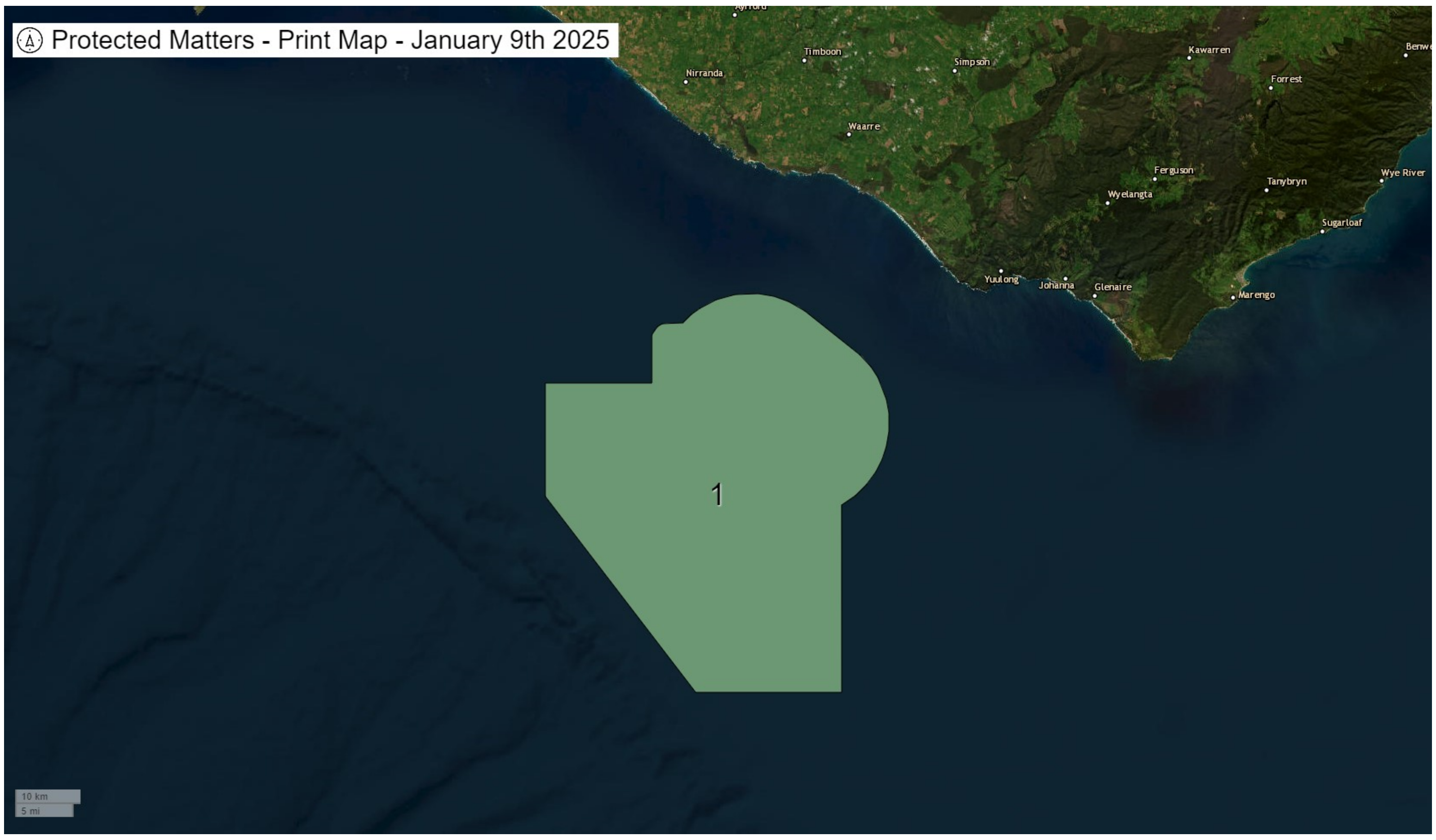
Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 09-Jan-2025



Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	40
Listed Migratory Species:	40

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	61
Whales and Other Cetaceans:	27
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	27
Key Ecological Features (Marine):	1
Biologically Important Areas:	12
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
FISH		
Hoplostethus atlanticus Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area
Seriolella brama Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
MAMMAL		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
SHARK		
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Migration route known to occur within area
Centrophorus uyato		
Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area
Galeorhinus galeus		
School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea		
Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Diomedea antipodensis		
Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharias taurus Grey Nurse Shark [64469]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Migration route known to occur within area

Scientific Name	Threatened Category	Presence Text
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Stercorarius antarcticus as Catharacta skua Brown Skua [85039]		Species or species habitat may occur within area
Sterna striata White-fronted Tern [799]		Migration route may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei as Thalassarche sp. nov. Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and Other Cetaceans

[Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia East	2024/09795		Completed
Otway Astrolabe 3D Marine Seismic Survey, Otway Basin	2012/6421		Completed
Controlled action			
Casino Gas Field Development	2003/1295	Controlled Action	Post-Approval
Otway Development	2002/621	Controlled Action	Post-Approval
Schomberg 3D Marine Seismic Survey	2007/3754	Controlled Action	Completed
VICP61 2D Marine Seismic Survey	2008/4075	Controlled Action	Completed
Not controlled action			
Exploration drilling for liquid/gaseous hydrocarbons	2004/1681	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Moonlight Head' 3D seismic survey, VIC/P38(V), VIC/P43 and VIC/RL8	2005/2236	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey near King Island	2004/1461	Not Controlled Action (Particular Manner)	Post-Approval
Astrolabe 3D Marine Seismic Survey	2011/6048	Not Controlled Action (Particular Manner)	Post-Approval
BHPBilliton Otway 3D Seismic Survey	2007/3443	Not Controlled Action (Particular Manner)	Post-Approval
Deepwater Sorell Basin 2001 Non-Exclusive 2D Seismic Survey	2001/156	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Drill and Profile Exploration Well Somerset 1, License Area T34P	2009/5037	Not Controlled Action (Particular Manner)	Post-Approval
Geographe-A gas exploration well	2000/82	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
La Bella 3D Marine Seismic Survey, Otway Basin, VIC	2012/6683	Not Controlled Action (Particular Manner)	Post-Approval
Otway Basin Exploration Drilling Campaign, Vic	2011/6125	Not Controlled Action (Particular Manner)	Post-Approval
Santos Otway 3d Seismic VIC/P44	2007/3367	Not Controlled Action (Particular Manner)	Post-Approval
Schomberg 3D Marine Seismic survey	2007/3868	Not Controlled Action (Particular Manner)	Post-Approval
Strike Oil NL Seismic Surveys	2000/107	Not Controlled Action (Particular Manner)	Post-Approval
Thylacine-A Exploration Well	2000/81	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5700	Not Controlled Action (Particular Manner)	Post-Approval
Vic/P37(v) and Vic/P44 3D marine seismic survey	2003/1102	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
VIC P44 Gas Exploration Wells	2002/662	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 2D seismic survey	2002/811	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
VICP61 2D Marine Seismic Survey	2008/3975	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
West Tasmania Canyons	South-east

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Likely to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur

Scientific Name	Behaviour	Presence
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

Appendix B EPBC Protected Matters Search Tool Report – Planning Area

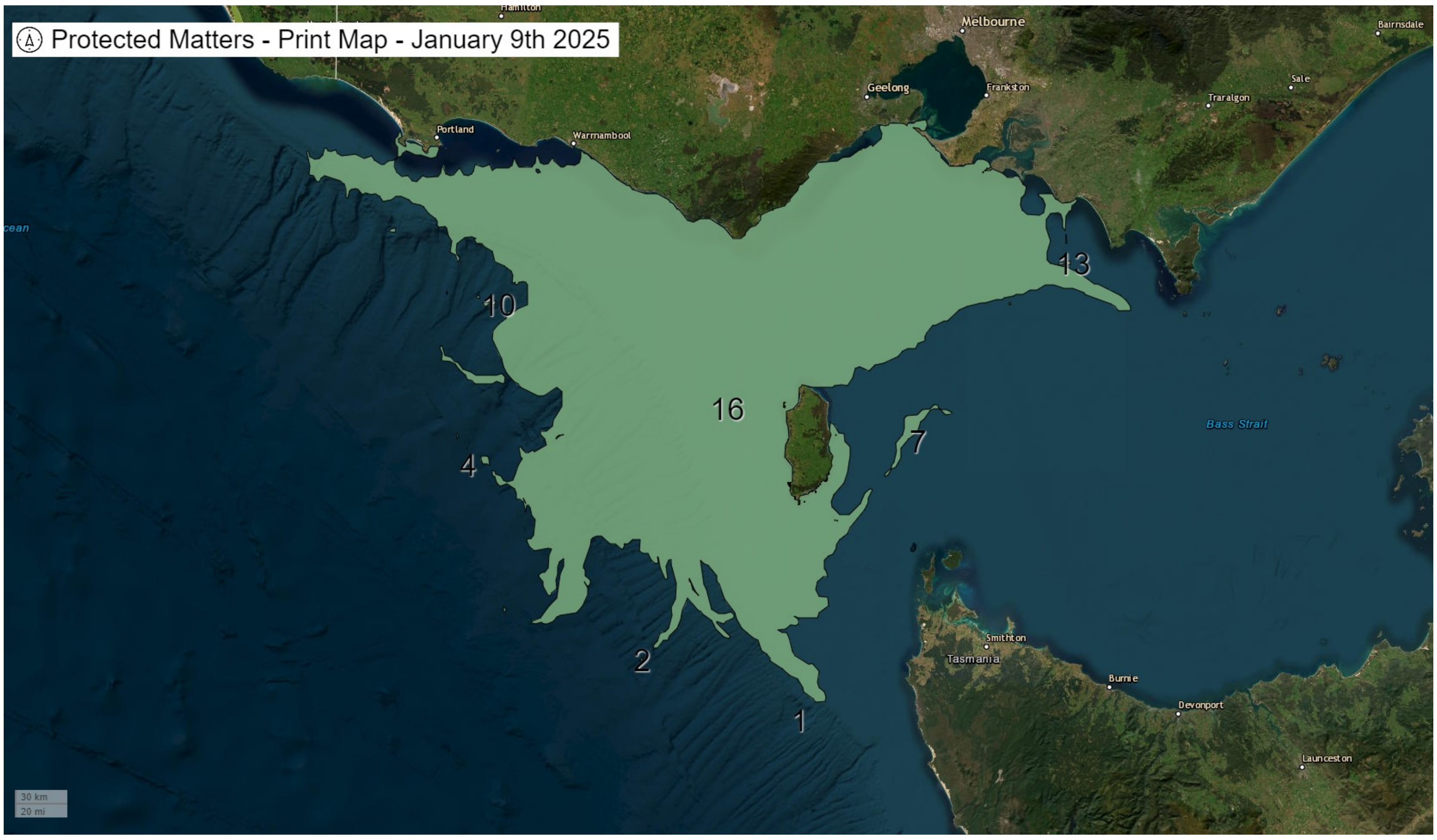
Australian Government

Department of Climate Change, Energy,
the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 09-Jan-2025



Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	3
Wetlands of International Importance (Ramsar	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	12
Listed Threatened Species:	130
Listed Migratory Species:	71

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	24
Commonwealth Heritage Places:	5
Listed Marine Species:	123
Whales and Other Cetaceans:	31
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	4
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	66
Regional Forest Agreements:	2
Nationally Important Wetlands:	14
EPBC Act Referrals:	143
Key Ecological Features (Marine):	2
Biologically Important Areas:	25
Bioregional Assessments:	1
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places [Resource Information]

Name	State	Legal Status
Historic		
Great Ocean Road and Scenic Environs	VIC	Listed place
Point Nepean Defence Sites and Quarantine Station Area	VIC	Listed place
Quarantine Station and Surrounds	VIC	Within listed place

Wetlands of International Importance (Ramsar Wetlands) [Resource Information]

Ramsar Site Name	Proximity
Glenelg estuary and discovery bay wetlands	Within Ramsar site
Lavinia	Within Ramsar site
Port phillip bay (western shoreline) and bellarine peninsula	Within Ramsar site
Western port	Within 10km of Ramsar site

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	Endangered	Community likely to occur within area
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area

Community Name	Threatened Category	Presence Text
Grassy Eucalypt Woodland of the Victorian Volcanic Plain	Critically Endangered	Community likely to occur within area
Karst springs and associated alkaline fens of the Naracoorte Coastal Plain Bioregion	Endangered	Community may occur within area
King Island scrub complex	Endangered	Community may occur within area
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	Community likely to occur within area
Natural Temperate Grassland of the Victorian Volcanic Plain	Critically Endangered	Community likely to occur within area
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	Critically Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Tasmanian Forests and Woodlands dominated by black gum or Brookers gum (Eucalyptus ovata / E. brookeriana)	Critically Endangered	Community likely to occur within area
Tasmanian white gum (Eucalyptus viminalis) wet forest	Critically Endangered	Community may occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Acanthiza pusilla magnirostris King Island Brown Thornbill, Brown Thornbill (King Island) [91709]	Endangered	Species or species habitat known to occur within area
Acanthornis magna greeniana King Island Scrubtit, Scrubtit (King Island) [82329]	Critically Endangered	Species or species habitat known to occur within area
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Aphelocephala leucopsis Southern Whiteface [529]	Vulnerable	Species or species habitat may occur within area
Aquila audax fleayi Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian) [64435]	Endangered	Species or species habitat may occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat known to occur within area
Calyptorhynchus banksii graptogyne South-eastern Red-tailed Black-Cockatoo [25982]	Endangered	Species or species habitat likely to occur within area
Ceyx azureus diemenensis Tasmanian Azure Kingfisher [25977]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Climacteris picumnus victoriae Brown Treecreeper (south-eastern) [67062]	Vulnerable	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Melanodryas cucullata cucullata South-eastern Hooded Robin, Hooded Robin (south-eastern) [67093]	Endangered	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route known to occur within area

Scientific Name	Threatened Category	Presence Text
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Pedionomus torquatus Plains-wanderer [906]	Critically Endangered	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Platycercus caledonicus brownii Green Rosella (King Island) [67041]	Vulnerable	Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting known to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Pycnoptilus floccosus Pilotbird [525]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Strepera fuliginosa colei Black Currawong (King Island) [67113]	Vulnerable	Breeding likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area
CRUSTACEAN		
Euastacus bispinosus Glenelg Spiny Freshwater Crayfish, Pricklyback [81552]	Endangered	Species or species habitat may occur within area
FISH		
Galaxiella pusilla Eastern Dwarf Galaxias, Dwarf Galaxias [56790]	Endangered	Species or species habitat may occur within area
Hoplostethus atlanticus Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area
Nannoperca obscura Yarra Pygmy Perch [26177]	Endangered	Species or species habitat known to occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Rexea solandri (eastern Australian population) Eastern Gemfish [76339]	Conservation Dependent	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Seriolella brama Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
FROG		
Litoria raniformis Southern Bell Frog,, Growling Grass Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat known to occur within area
INSECT		
Synemon plana Golden Sun Moth [25234]	Vulnerable	Species or species habitat may occur within area
MAMMAL		
Antechinus minimus maritimus Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Endangered	Species or species habitat known to occur within area
Miniopterus orianae bassanii Southern Bent-wing Bat [87645]	Critically Endangered	Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Perameles gunnii Victorian subspecies Eastern Barred Bandicoot (Mainland) [88020]	Endangered	Translocated population known to occur within area
Petauroides volans Greater Glider (southern and central) [254]	Endangered	Species or species habitat may occur within area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus trisulcatus Long-nosed Potoroo (southern mainland) [86367]	Vulnerable	Species or species habitat known to occur within area
Pseudomys fumeus Smoky Mouse, Konoom [88]	Endangered	Species or species habitat may occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys shortridgei Heath Mouse, Dayang, Heath Rat [77]	Endangered	Species or species habitat known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
PLANT		

Scientific Name	Threatened Category	Presence Text
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat likely to occur within area
Caladenia calcicola Limestone Spider-orchid [10065]	Vulnerable	Species or species habitat likely to occur within area
Caladenia colorata Coloured Spider-orchid, Small Western Spider-orchid, Painted Spider-orchid [54999]	Endangered	Species or species habitat likely to occur within area
Caladenia concolor Crimson Spider-orchid, Maroon Spider-orchid [5505]	Vulnerable	Species or species habitat may occur within area
Caladenia hastata Melblom's Spider-orchid [16118]	Endangered	Species or species habitat likely to occur within area
Caladenia orientalis Eastern Spider Orchid [83410]	Endangered	Species or species habitat known to occur within area
Caladenia ornata Ornate Pink Fingers [76213]	Vulnerable	Species or species habitat may occur within area
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat known to occur within area
Dodonaea procumbens Trailing Hop-bush [12149]	Vulnerable	Species or species habitat may occur within area
Eucalyptus strzeleckii Strzelecki Gum [55400]	Vulnerable	Species or species habitat known to occur within area
Euphrasia collina subsp. muelleri Purple Eyebright, Mueller's Eyebright [16151]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat known to occur within area
Grevillea infecunda Anglesea Grevillea [22026]	Vulnerable	Species or species habitat known to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat known to occur within area
Hiya distans listed as Hypolepis distans Scrambling Ground-fern [92548]	Endangered	Species or species habitat known to occur within area
Ixodia achillaeoides subsp. arenicola Sand Ixodia, Ixodia [21474]	Vulnerable	Species or species habitat known to occur within area
Lachnagrostis adamsonii Adamson's Blown-grass, Adamson's Blowngrass [76211]	Endangered	Species or species habitat may occur within area
Leiocarpa gatesii Wrinkled Buttons [76212]	Vulnerable	Species or species habitat known to occur within area
Lepidium aschersonii Spiny Peppercress [10976]	Vulnerable	Species or species habitat known to occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat likely to occur within area
Pimelea spinescens subsp. spinescens Plains Rice-flower, Spiny Rice-flower, Prickly Pimelea [21980]	Critically Endangered	Species or species habitat likely to occur within area
Prasophyllum litorale listed as Prasophyllum littorale Coastal Leek Orchid [55234]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat known to occur within area
Prasophyllum suaveolens Fragrant Leek-orchid [64956]	Endangered	Species or species habitat may occur within area
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat known to occur within area
Pterostylis cucullata Leafy Greenhood [15459]	Vulnerable	Species or species habitat known to occur within area
Pterostylis tenuissima Swamp Greenhood, Dainty Swamp Orchid [13139]	Vulnerable	Species or species habitat known to occur within area
Senecio macrocarpus Large-fruit Fireweed, Large-fruit Groundsel [16333]	Vulnerable	Species or species habitat likely to occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat known to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area
Thelymitra matthewsii Spiral Sun-orchid [4168]	Endangered	Species or species habitat known to occur within area
Thelymitra orientalis Hoary Sun-orchid [88011]	Critically Endangered	Species or species habitat may occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		

Scientific Name	Threatened Category	Presence Text
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Delma impar Striped Legless Lizard, Striped Snake-lizard [1649]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Lissolepis coventryi Swamp Skink, Eastern Mourning Skink [84053]	Endangered	Species or species habitat known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Centrophorus uyato Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Migratory Marine Species

Scientific Name	Threatened Category	Presence Text
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharias taurus Grey Nurse Shark [64469]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Eubalaena australis as Balaena glacialis australis		
Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isurus oxyrinchus		
Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus		
Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus		
Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus		
Sperm Whale [59]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus		
White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres		
Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area

Scientific Name	Threatened Category	Presence Text
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Defence	
Defence - CROWS NEST CAMP - QUEENSCLIFF [21029]	VIC
Defence - CROWS NEST CAMP - QUEENSCLIFF [21027]	VIC
Defence - CROWS NEST CAMP - QUEENSCLIFF [21028]	VIC
Defence - CROWS NEST CAMP - QUEENSCLIFF [21026]	VIC
Defence - STAFF COLLEGE-FORT QUEENSCLIFF [21031]	VIC
Defence - STAFF COLLEGE-FORT QUEENSCLIFF [21030]	VIC
Defence - STAFF COLLEGE-FORT QUEENSCLIFF [21034]	VIC
Defence - STAFF COLLEGE-FORT QUEENSCLIFF [21032]	VIC
Defence - STAFF COLLEGE-FORT QUEENSCLIFF [21033]	VIC
Defence - SWAN ISLAND TRAINING AREA [21446]	VIC
Defence - SWAN ISLAND TRAINING AREA [21448]	VIC
Defence - SWAN ISLAND TRAINING AREA [21447]	VIC
Defence - TRAINING CENTRE (Norris Barracks) - Portsea [21025]	VIC
Defence - WEST HEAD GUNNERY RANGE [21112]	VIC
Unknown	
Commonwealth Land - [21583]	VIC
Commonwealth Land - [21582]	VIC

Commonwealth Land Name	State
Commonwealth Land - [21509]	VIC
Commonwealth Land - [60115]	TAS
Commonwealth Land - [21492]	VIC
Commonwealth Land - [60113]	TAS
Commonwealth Land - [21570]	VIC
Commonwealth Land - [22391]	VIC
Commonwealth Land - [60111]	TAS
Commonwealth Land - [60114]	TAS

Commonwealth Heritage Places

[Resource Information]

Name	State	Status
Historic		
Cape Wickham Lighthouse	TAS	Listed place
Fort Queenscliff	VIC	Listed place
Sorrento Post Office	VIC	Listed place
Swan Island Defence Precinct	VIC	Listed place
Natural		
Swan Island and Naval Waters	VIC	Listed place

Listed Marine Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris as Puffinus tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni as Diomedea gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Larus dominicanus Kelp Gull [809]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area overfly marine area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area overfly marine area
Morus capensis Cape Gannet [59569]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Morus serrator Australasian Gannet [1020]		Breeding known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area overfly marine area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route known to occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Onychoprion fuscatus as Sterna fuscata Sooty Tern [90682]		Breeding known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting known to occur within area overfly marine area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area overfly marine area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area overfly marine area
Stercorarius antarcticus as Catharacta skua Brown Skua [85039]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Sterna striata White-fronted Tern [799]		Foraging, feeding or related behaviour likely to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]		Breeding known to occur within area
Sternula nereis as Sterna nereis Fairy Tern [82949]		Breeding known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei as Thalassarche sp. nov. Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thalasseus bergii as Sterna bergii Greater Crested Tern [83000]		Breeding known to occur within area
Thinornis cucullatus as Thinornis rubricollis Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area
Thinornis cucullatus cucullatus as Thinornis rubricollis rubricollis Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area overfly marine area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area overfly marine area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys mollisoni Mollison's Pipefish [66260]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area

Current Scientific Name	Status	Type of Presence
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Hyperoodon planifrons Southern Bottlenose Whale [71]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tasmacetus shepherdi Shepherd's Beaked Whale, Tasman Beaked Whale [55]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Park Name	Zone & IUCN Categories
Apollo	Multiple Use Zone (IUCN VI)
Franklin	Multiple Use Zone (IUCN VI)
Zeehan	Multiple Use Zone (IUCN VI)
Zeehan	Special Purpose Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Aire River	Heritage River	VIC
Aire River W.R.	Natural Features Reserve	VIC
Aireys Inlet B.R.	Natural Features Reserve	VIC
Badger Box Creek	Nature Reserve	TAS
Barham Paradise S.R.	Natural Features Reserve	VIC
Barwon Bluff	Marine Sanctuary	VIC
Bay of Islands Coastal Park	Conservation Park	VIC
Breamlea F.F.R.	Nature Conservation Reserve	VIC
Bunurong	Marine National Park	VIC
Bunurong Marine Park	National Parks Act Schedule 4 park or reserve	VIC
Cape Nelson	State Park	VIC
Cape Patterson N.C.R	Natural Features Reserve	VIC
Cape Wickham	State Reserve	TAS
Cape Wickham	Conservation Area	TAS
Cataraqui Point	Conservation Area	TAS
Christmas Island	Nature Reserve	TAS

Protected Area Name	Reserve Type	State
City of Melbourne Bay	Conservation Area	TAS
Colliers Forest Reserve	Conservation Covenant	TAS
Colliers Swamp	Conservation Area	TAS
Councillor Island	Nature Reserve	TAS
Counsel Hill	Conservation Area	TAS
Currie Lightkeepers Residence	Historic Site	TAS
Disappointment Bay	State Reserve	TAS
Discovery Bay	Marine National Park	VIC
Discovery Bay Coastal Park	Conservation Park	VIC
Eagle Rock	Marine Sanctuary	VIC
Eldorado	Conservation Area	TAS
Great Otway	National Park	VIC
Lake Connewarre W.R	Natural Features Reserve	VIC
Lake Gillear W.R	Natural Features Reserve	VIC
Latrobe B.R.	Natural Features Reserve	VIC
Lavinia	State Reserve	TAS
Lily Pond B.R.	Natural Features Reserve	VIC
Marengo N.C.R.	Nature Conservation Reserve	VIC
Marengo Reefs	Marine Sanctuary	VIC
Mornington Peninsula	National Park	VIC
Muddy Lagoon	Nature Reserve	TAS
Mushroom Reef	Marine Sanctuary	VIC
New Year Island	Game Reserve	TAS
Painkalac Creek	Reference Area	VIC
Phillip Island Nature Park	Other	VIC

Protected Area Name	Reserve Type	State
Point Addis	Marine National Park	VIC
Point Nepean	National Park	VIC
Porky Beach	Conservation Area	TAS
Port Campbell	National Park	VIC
Portland H46 B.R.	Natural Features Reserve	VIC
Portland H47 B.R.	Natural Features Reserve	VIC
Port Phillip Heads	Marine National Park	VIC
Princetown W.R	Natural Features Reserve	VIC
Red Hut Point	Conservation Area	TAS
Red Hut Road #1	Conservation Covenant	TAS
Red Hut Road #2	Conservation Covenant	TAS
Reid Rocks	Nature Reserve	TAS
Sea Elephant	Conservation Area	TAS
Sea Elephant River	Conservation Covenant	TAS
Seal Rocks	State Reserve	TAS
Seal Rocks	Conservation Area	TAS
South Rd Nugara	Conservation Covenant	TAS
Stokes Point	Conservation Area	TAS
Stony Creek (Otways)	Reference Area	VIC
The Arches	Marine Sanctuary	VIC
Twelve Apostles	Marine National Park	VIC
Unnamed P0176	Private Nature Reserve	VIC
Wild Dog B.R.	Natural Features Reserve	VIC
Wild Dog Creek SS.R.	Natural Features Reserve	VIC
Wonthaggi Heathlands N.C.R	Natural Features Reserve	VIC

Protected Area Name	Reserve Type	State

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included. Please see the associated resource information for specific caveats and use limitations associated with RFA boundary information.

RFA Name	State
Tasmania RFA	Tasmania
West Victoria RFA	Victoria

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Aire River	VIC
Bungaree Lagoon	TAS
Lake Connewarre State Wildlife Reserve	VIC
Lake Flannigan	TAS
Lavinia Nature Reserve	TAS
Lower Aire River Wetlands	VIC
Mud Islands	VIC
Pearshape Lagoon 1	TAS
Pearshape Lagoon 2	TAS
Pearshape Lagoon 3	TAS
Pearshape Lagoon 4	TAS
Princetown Wetlands	VIC
Swan Bay & Swan Island	VIC
Western Port	VIC

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Apollo Bay to Skenes Creek Coastal Trail	2022/09274		Assessment
Cape Winds Offshore Windfarm Geophysical, Geotechnical and Marine Studies	2023/09629		Completed
City Of Greater Geelong Mosquito Control Program 2021-2030, Vic	2020/8782		Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Decommissioning of the Minerva Pipeline in Victorian state waters	2024/09879		Completed
Dolphin Tungsten Mine Grassy King Island	2023/09653		Referral Decision
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia East	2024/09795		Completed
Offshore Tidal Energy Facility and Submarine Cable	2008/4480		Completed
Otway Astrolabe 3D Marine Seismic Survey, Otway Basin	2012/6421		Completed
Point Nepean Research & Education Field Station	2024/09963		Completed
Portland Energy Park	2024/09947		Assessment
Southern Winds Offshore Wind Project	2022/09435		Completed
Southern Winds Offshore Wind Project Initial Marine Field Investigations	2022/09436		Completed
Spinifex Offshore Surveys	2022/09359		Completed
Spinifex Offshore Wind Farm - Offshore Investigations	2024/09918		Referral Decision
Controlled action			
Alston-1 petroleum exploration well, permit VIC/P44	2003/1315	Controlled Action	Post-Approval
Casino Gas Field Development	2003/1295	Controlled Action	Post-Approval
Establishment of plantation for use of effluent water	2003/1063	Controlled Action	Completed
Lonsdale Golf Club Redevelopment	2003/969	Controlled Action	Post-Approval
Lorne Golf Course redevelopment	2004/1513	Controlled Action	Post-Approval
Mosquito Control	2005/2132	Controlled Action	Post-Approval
Otway Development	2002/621	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Pacific Hydro (Portland) Wind Farm SW Victoria	2000/18	Controlled Action	Post-Approval
Port Phillip Bay Channel Deepening	2002/576	Controlled Action	Post-Approval
Redevelopment of post office and construction of dwellings	2007/3639	Controlled Action	Completed
Residential Subdivision & Infrastructure Parish of Belfast	2005/1954	Controlled Action	Completed
Schomberg 3D Marine Seismic Survey	2007/3754	Controlled Action	Completed
Strike Oil Gas Exploration Well, Otway Basin (VIC/P44)	2000/97	Controlled Action	Completed
Twelve Apostles Saddle Lookout	2019/8571	Controlled Action	Post-Approval
VIC Offshore Windfarm	2021/8966	Controlled Action	Assessment Approach
VICP61 2D Marine Seismic Survey	2008/4075	Controlled Action	Completed
Victorian Desalination Project, Bass Coast	2008/3948	Controlled Action	Post-Approval
Not controlled action			
accomodation units and associatedadministration and recreational facilities	2001/430	Not Controlled Action	Completed
Airey Inlet water reclamation plant to Anglesea sewerage system	2006/2539	Not Controlled Action	Completed
Amrit-1 exploration well	2004/1572	Not Controlled Action	Completed
Apollo Bay Water Storage Basin, VIC	2012/6484	Not Controlled Action	Completed
Bluff Heights Estate Stages 2 to 4	2003/1047	Not Controlled Action	Completed
CO2 geosequestration - Otway Basin Pilot Project	2006/2699	Not Controlled Action	Completed
Construct a Recycled Water Pipeline from Somers Treatment Plant to Blue Scope S	2009/4982	Not Controlled Action	Completed
Construction and operation of Barwon Water biosolids treatment facility	2008/4345	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Construction of Barwon Heads Bridge	2005/2375	Not Controlled Action	Completed
construction of pump station for pump diversion from the Barham River	2003/1242	Not Controlled Action	Completed
Construction of the Edgars Road Extension, from Childs Road, Lalor to Cooper Street, Epping	2003/1135	Not Controlled Action	Completed
Development of Pt Nepean Quarantine Station (former) National Centre for Coasts and Climate	2008/4653	Not Controlled Action	Completed
Divestment of Norris Barracks	2003/963	Not Controlled Action	Completed
Drilling of Callister-1 exploration well in VIC/P51	2004/1633	Not Controlled Action	Completed
Enterprise 1 Exploration Drilling Program, near Port Campbell, Vic	2019/8438	Not Controlled Action	Completed
Establishment of a 6 turbine windfarm near Wonthaggi	2002/820	Not Controlled Action	Completed
Exploration drilling for liquid/gaseous hydrocarbons	2004/1681	Not Controlled Action	Completed
Ferry Service Infrastructure Development	2001/269	Not Controlled Action	Completed
Gas Field Development	2006/2635	Not Controlled Action	Completed
Gas Fields Development	2011/5879	Not Controlled Action	Completed
Golflinks Road Residential Development & Water Storage Facility at Barwon Heads	2004/1793	Not Controlled Action	Completed
Grevillea infecunda tip cuttings and soil samples	2005/1979	Not Controlled Action	Completed
Halladale and Speculant Gas Pipeline Project, North of Port Campbell, Vic	2015/7551	Not Controlled Action	Completed
Henry-1 Exploration Well, Petroleum Permit Area VIC/P44	2005/2147	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Installation of a 35 metre telecommunicaitons facility at Jirrahlinga Animal San	2003/1151	Not Controlled Action	Completed
Installation of optic fibre cable from Inverloch, Victoria to Stanley, Tasmania	2002/906	Not Controlled Action	Completed
Maintenance and priority works to heritage buildings at Point Nepean Quarantine	2006/3151	Not Controlled Action	Completed
Maintenance Dredging South Channel 2012	2011/6198	Not Controlled Action	Completed
Maintenance works at Barwon Heads Bridge	2003/1199	Not Controlled Action	Completed
Minerva Cut Back Project, Vic	2017/8036	Not Controlled Action	Completed
Newhaven Yacht Squadron marina extension	2004/1450	Not Controlled Action	Completed
New Water Infrastructure Upgrade, Grassy Dam, King Island	2013/6882	Not Controlled Action	Completed
Nirranda South Wind Farm Pty Ltd	2002/763	Not Controlled Action	Completed
Offshore exploration drilling within permit area VIC/P 37(v)	2004/1466	Not Controlled Action	Completed
Optic fibre cable installation - San Remo to Cowes	2005/2386	Not Controlled Action	Completed
Point Nepean Quarantine Station (former)/Restoration of Medical Superintendent's	2006/3149	Not Controlled Action	Completed
Port Campbell Headland Walking Trail Realignment	2012/6676	Not Controlled Action	Completed
Portland Landfill Borehole Installation, Vic	2017/7886	Not Controlled Action	Completed
Port Phillip Channel Deepening Project - Trial Dredge Program	2005/2164	Not Controlled Action	Completed
Proposed replacement of existing road culvert	2013/7077	Not Controlled Action	Completed
Queenscliff Harbour Redevelopment	2004/1352	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Remedial Works to the Swan Island Bridge	2003/1129	Not Controlled Action	Completed
Residential/Resort/Golf Course development	2002/907	Not Controlled Action	Completed
Stage 1 residential subdivision, Anna Catherine Drive	2005/1992	Not Controlled Action	Completed
Telstra optic fibre cable across Bass Strait - Sub bottom profiler Surve	2002/779	Not Controlled Action	Completed
To construct a shared trail within the Arthurs Seat Road, road reserve south side from Mornington Fl	2004/1565	Not Controlled Action	Completed
Torquay Sewerage Strategy - pipe replacement between Torquay and the Black Rock	2004/1704	Not Controlled Action	Completed
Track construction - Great Ocean Walk	2002/793	Not Controlled Action	Completed
Transfer of 90ha Point Nepean Quarantine Station from Commonwealth to Victorian	2008/4521	Not Controlled Action	Completed
VIC-P44 Stage 2 Gas Field Development	2007/3767	Not Controlled Action	Completed
Victorian Generator Project	2005/1984	Not Controlled Action	Completed
Wind Farm Construction and Operation	2001/471	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Moonlight Head' 3D seismic survey, VIC/P38(V), VIC/P43 and VIC/RL8	2005/2236	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2005/2295	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey in Permit Areas T/32P and T/33P	2002/845	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2003/1214	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
2D Seismic Survey	2008/3962	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey, Petroleum Exploration Permit Area EPP27	2006/2776	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey in VIC/P50 and VIC/P46	2004/1810	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey VIC/P50	2005/2313	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey near King Island	2004/1461	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey within Torquay Sub-basin off sthn Victoria	2012/6256	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic program VIC/P38(v), VIC/P43 and VIC/RL8	2003/1137	Not Controlled Action (Particular Manner)	Post-Approval
Astrolabe 3D Marine Seismic Survey	2011/6048	Not Controlled Action (Particular Manner)	Post-Approval
Benbows Paddock residential development, Cape Bridgewater	2007/3247	Not Controlled Action (Particular Manner)	Post-Approval
Bernoulli 3D Seismic Survey	2006/3053	Not Controlled Action (Particular Manner)	Post-Approval
BHPBilliton Otway 3D Seismic Survey	2007/3443	Not Controlled Action (Particular Manner)	Post-Approval
Construct private dwelling	2008/4234	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Controlled Burn, Understorey Clearance and Removal of UXO	2003/1030	Not Controlled Action (Particular Manner)	Post-Approval
Deepwater Sorell Basin 2001 Non-Exclusive 2D Seismic Survey	2001/156	Not Controlled Action (Particular Manner)	Post-Approval
Drill and Profile Exploration Well Somerset 1, License Area T34P	2009/5037	Not Controlled Action (Particular Manner)	Post-Approval
Enterprise Three-dimensional Transition Zone Seismic Survey, Victoria	2016/7800	Not Controlled Action (Particular Manner)	Post-Approval
Fuelbreak construction	2009/4915	Not Controlled Action (Particular Manner)	Post-Approval
Geelong Bypass Section 3	2005/2099	Not Controlled Action (Particular Manner)	Post-Approval
Geographe-A gas exploration well	2000/82	Not Controlled Action (Particular Manner)	Post-Approval
Hydrocarbon exploration wells	2003/1062	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
La Bella 3D Marine Seismic Survey, Otway Basin, VIC	2012/6683	Not Controlled Action (Particular Manner)	Post-Approval
Maintenance Dredging Program 2012-21 in Port of Melbourne	2012/6332	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
OTE10 2D Marine Seismic Survey	2009/5223	Not Controlled Action (Particular Manner)	Post-Approval
Otway Basin Exploration Drilling Campaign, Vic	2011/6125	Not Controlled Action (Particular Manner)	Post-Approval
Santos 2D Seismic Survey VIC/P44 & VIC/P51	2003/1213	Not Controlled Action (Particular Manner)	Post-Approval
Santos Otway 3d Seismic VIC/P44	2007/3367	Not Controlled Action (Particular Manner)	Post-Approval
Schomberg 3D Marine Seismic survey	2007/3868	Not Controlled Action (Particular Manner)	Post-Approval
Seismic Survey VIC-P46	2002/826	Not Controlled Action (Particular Manner)	Post-Approval
Shearwater 2D and 3D marine seismic survey	2005/2180	Not Controlled Action (Particular Manner)	Post-Approval
Southern Gas Pipeline Project	2002/619	Not Controlled Action (Particular Manner)	Post-Approval
Southern Margins T/35P and T/36P 3D Seismic Surveys	2007/3817	Not Controlled Action (Particular Manner)	Post-Approval
Speculant 3D Transition Zone Seismic Survey	2010/5558	Not Controlled Action (Particular Manner)	Post-Approval
Strike Oil NL Seismic Surveys	2000/107	Not Controlled Action (Particular Manner)	Post-Approval
Surface Geochemical Exploration Program, TAS	2010/5780	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, Vic	2012/6565	Not Controlled Action (Particular Manner)	Post-Approval
Thylacine-A Exploration Well	2000/81	Not Controlled Action (Particular Manner)	Post-Approval
Torquay Sub-basin (VIC/P62) OTE12-3D Seismic Survey	2012/6655	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5700	Not Controlled Action (Particular Manner)	Post-Approval
Vic/P37(v) and Vic/P44 3D marine seismic survey	2003/1102	Not Controlled Action (Particular Manner)	Post-Approval
VIC P44 Gas Exploration Wells	2002/662	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 2D seismic survey	2002/811	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 3D seismic survey	2002/799	Not Controlled Action (Particular Manner)	Post-Approval
Wolseley 3D seismic acquisition survey	2010/5703	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
2D & 3D Seismic Surveys - Permit Area - VIC/P50	2008/4517	Referral Decision	Completed
3D Marine Seismic Survey	2011/6156	Referral Decision	Completed
3D Seismic Survey	2008/4014	Referral Decision	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Referral decision			
Alteration Reconstruction Restoration and Repairs to Buildings	2008/4179	Referral Decision	Completed
Portland Wave Energy Project	2008/3946	Referral Decision	Completed
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, VIC	2012/6545	Referral Decision	Completed
Upgrade of Services Infrastructure Point Nepean Quarantine Station	2008/4591	Referral Decision	Completed
VICP61 2D Marine Seismic Survey	2008/3975	Referral Decision	Completed
Wolseley 3D Seismic Acquisition Survey in Permit T/32P	2010/5291	Referral Decision	Completed
Works to the buildings and surrounds at the former Point Nepean Quarantine Stati	2008/4156	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Bonney Coast Upwelling	South-east
West Tasmania Canyons	South-east

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Breeding	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Likely to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Eudyptula minor Little Penguin [1085]	Breeding	Known to occur
Eudyptula minor Little Penguin [1085]	Foraging	Known to occur
Morus serrator Australasian Gannet [1020]	Aggregation	Known to occur
Morus serrator Australasian Gannet [1020]	Foraging	Known to occur
Pelagodroma marina White-faced Storm-petrel [1016]	Breeding	Known to occur
Pelagodroma marina White-faced Storm-petrel [1016]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Breeding	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur
Phalacrocorax fuscescens Black-faced Cormorant [59660]	Breeding	Known to occur
Phalacrocorax fuscescens Black-faced Cormorant [59660]	Foraging	Known to occur
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur

Scientific Name	Behaviour	Presence
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Sharks		
Carcharodon carcharias White Shark [64470]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Known Foraging Area	Known to occur

Bioregional Assessments [Resource Information]

SubRegion	BioRegion	Website
Gippsland	Gippsland Basin	BA website

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

Appendix C Otway Basin Environmental Survey Report

SUPPLIER DOCUMENT COVER PAGE

Project Title	Beach Otway Offshore Wellsite Survey Services		
Supplier Name	Ramboll		
Contract/PO No	TBC		
Document Title	Infauna Laboratory Testing and Factual Report		
Fugro Document Number	135846-V01-05-REP-001	**Revision**	B
Client Document Number	S4100RU718410	**Revision**	A
Supplier Document Number	3180000803	**Revision**	B
Sub-Supplier Document Number		**Revision**	
VDRL Code			
Tag No			

Supplier/Contractor Internal Approvals (Supplier/Contractor use only)

Date	Rev	Reason for Issue	Prepared By	Checked By	Supplier/Contractor Approval
17/03/20	A	Issued for Review	E Jones	D McClary	J Miragliotta
23/04/20	B	Issued for Review	E Jones	D McClary	J Miragliotta

Review Status (Fugro use only)

Tick Box	Code	Review Status Description
☐	Code 1	Approved – Certified Final
☐	Code 2	Approved as noted – Revise and resubmit as final revision, work may/may not proceed
☐	Code 3	Not accepted – Revise and resubmit for review
☐	Code 4	Information only – Review not required
☐	Code 5	No Comments – Submit certified final
☐	Code 6	As Built

Acceptance in any of these categories in no way relieves the Supplier/Contractor of their responsibility for the due and proper performance of the works in accordance with the Contract/Purchase Order with Fugro.

Fugro Approval

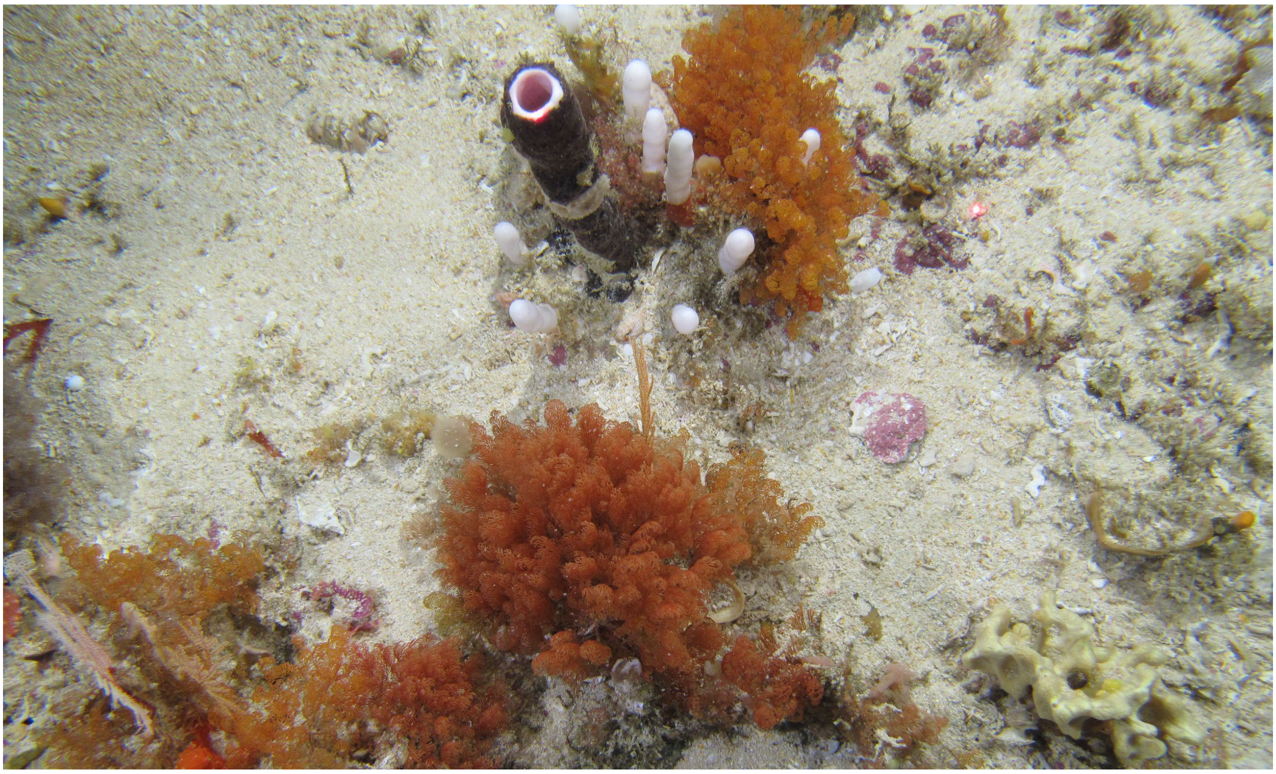
Name	
Signature	
Date	

Intended for
Fugro Australia Pty Ltd

Document type
Report

Date
March 2020

ENVIRONMENTAL SURVEY
OTWAY BASIN



Bright ideas. Sustainable change.

ENVIRONMENTAL SURVEY
OTWAY BASIN

Project name	**Beach Energy Otway Basin Survey**
Project no.	**318000803**
Recipient	**Chris Henderson**
Document type	**Report**
Version	**Rev B**
Date	**17/03/2020**
Prepared by	**Emily Jones**
Checked by	**Dan McClary**
Approved by	**John Miragliotta**
Description	**Results of the environmental survey at Otway Basin for Beach Energy**

Ramboll
41 St Georges Terrace
Perth, WA 6000
Australia

T +61 8 9225 5199
F +61 2 9954 8150
https://ramboll.com

CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1. INTRODUCTION

1.1 Background

This report presents the results of the environmental survey of offshore gas fields in Otway Basin for Beach Energy. Beach Energy is planning further development of the Otway offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The offshore Otway Basin gas exploration and development program may include drilling up to nine wells using a contracted semi-submersible drill rig, over a 12- to 18-month period. Additional seabed infrastructure would also be installed to tie-in new wells after the drilling phase.

As part of this plan, Fugro Australia Marine Pty Ltd (Fugro) carried out offshore geophysical and geotechnical surveys and Ramboll Australia Pty Ltd (Ramboll) were contracted by Fugro to carry out the environmental survey. These activities were in Commonwealth waters approximately 32 to 80 km from Port Campbell and in water depths ranging from 70 to 104 m.

1.2 Objective

The objective of the seabed site assessments was to determine suitable locations for anchoring and rig placement for drilling operations and the installation of infrastructure to connect new production wells to the existing platform or pipeline. Several different investigation techniques were used to examine and describe the seabed, as well as identify possible hazards from man-made, natural and geological features.

1.3 Report Scope

The scope of the environmental survey carried out in Otway Basin included investigations of:
- Water quality;
- Sediment quality;
- Benthic infauna; and
- Benthic epifauna.

Water quality assessments included laboratory analyses for:
- Suspended solids
- Nutrients
- Chlorophyll *a*
- Metals/metalloids
- Hydrocarbons

Sediment quality assessments included laboratory analyses for:
- Sediment particle size
- Total organic carbon
- Nutrients
- Metals/metalloids

Infauna were microscopically examined to determine taxonomic identification to Family level and morpho-species, and abundance was recorded. The composition and percent cover of epifauna was determined from seabed photographs.

2. SURVEY LOCATIONS

These investigations were based around five survey areas including:

- Thylacine;
- Artisan;
- La Bella;
- Geographe; and
- Hercules.

Other survey areas included two Hot Tap sites identified as HTX and HTY, and five routes selected for cone penetration tests (CPT) as part of the geotechnical survey plan identified as ARGE (Artisan to Geographe), ARHTX (Artisan to HTX), ARHTY (artisan to HTY), ARLB (Artisan to La Bella) and LBGE (La Bella to Geographe).

The collection of water and sediment/infauna samples for environmental assessment was cancelled by the client for the La Bella, Geographe and Hercules survey areas. Therefore, the collection of water and sediment/infauna samples for environmental assessment occurred only at the Thylacine and Artisan survey areas. Seabed photographs were taken as planned for all survey areas and routes. It is also noted that all survey areas were largely composed of outcropping rock with or without patches of uncemented sediments. Sampling of uncemented sediments was only possible with the grab sampler (as opposed to other devices) and of limited recovery because of the limited thickness of the surficial uncemented sediments.

The survey extent within Otway Basin, including these survey areas, hot taps and survey routes, is shown Figure 1. Environmental sampling sites were located in proximity to the proposed drilling rig mooring locations. The proposed anchor points for the drilling rig are listed in Table 1. The depth at each proposed mooring location was measure at the intersection of the anchor lines (Table 1). Sampling locations are listed in Section 3 for the relevant sampling methods.

Table 1 Location of proposed anchor points (GDA94 UTM 54 S) and water depth for drilling rig sites.

Survey Area	Anchor Point	Depth at Intersection (m LAT)	Easting	Northing
Thylacine	Thylacine 1	99	661398	5657534
	Thylacine 2		662879	5658389
	Thylacine 3		662361	5659286
	Thylacine 4		660880	5658431
	Thylacine 5	104	658235	5656067
	Thylacine 6		659717	5656923
	Thylacine 7		659198	5657820
	Thylacine 8		657717	5656965
Artisan	Artisan 1	70	662783	5692700
	Artisan 2		664261	5693554
	Artisan 3		663741	5694456
	Artisan 4		662262	5693602
Geographe	Geographe 1	83	668221	5668522
	Geographe 2		669699	5669374
	Geographe 3		669179	5670278
	Geographe 4		667700	5669424
La Bella	La Bella 1	93	647914	5681579
	La Bella 2		645915	5681579
	La Bella 3		647319	5682496
	La Bella 4		646437	5680702
Hercules	Hercules 1	73	664065	5688642
	Hercules 2		662065	5688638
	Hercules 3		663547	5689516
	Hercules 4		662596	5687757

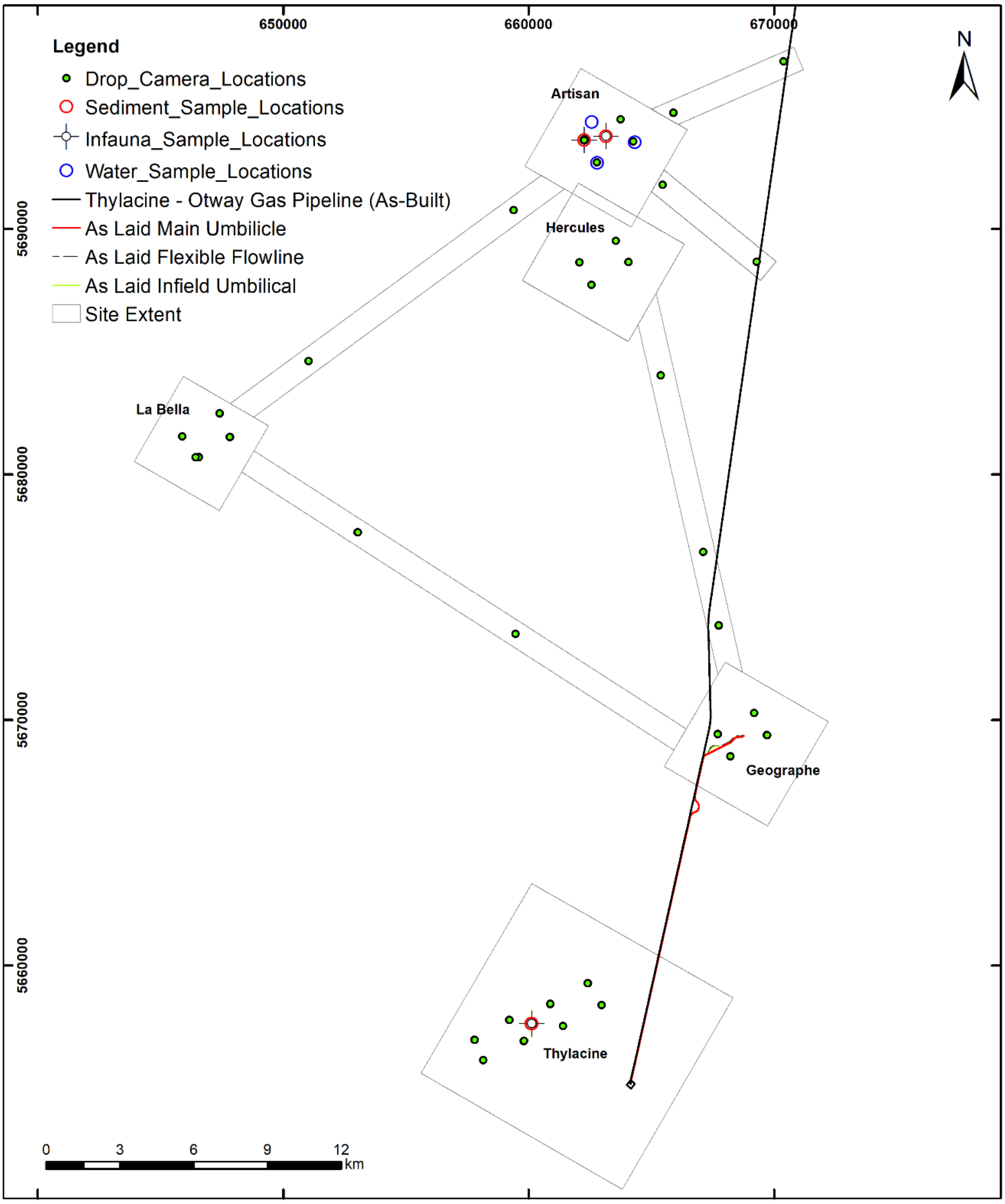


Figure 1 Locations of environmental survey site extents in Otway Basin. Provided by Fugro, April 2020.

3. METHOD

3.1 Survey Operations

The environmental survey was undertaken during several deployments from November 2019 to January 2020. The survey was carried out from the 60 m offshore supply ship *VOS SHINE*. The vessel mobilised from Portland, Victoria.

3.2 Water Quality

3.2.1 Sample Collection

Water quality samples were collected using a 2.2 L Van Dorn Beta water sampler. This sampler was used to obtain water samples from selected water depths. The sampler consisted of an open-ended, clear plastic cylinder with a rubber cap attached at each end. Before deployment, the end caps were held open, under tension, by triggers on the side of the cylinder. The sampler was attached to a rope and lowered by hand over the side of the vessel to the desired depth. A messenger weight attached to the rope was then released to trigger the end caps to close as the messenger contacted the sampler, sealing the water sample inside the cylinder. The sampler was then raised to the surface where the water sample was processed and stored for laboratory analysis.

On retrieval at the surface, the water sampler was inspected against the following sample acceptability criteria:

1. The sample bottle was full; and
2. Both end caps are fully closed; and
3. There was no obvious contamination (e.g. grease or paint chips on, or inside, the sampler).

Any sample that did not comply with these criteria was discarded and another sample was collected at the same site. All samples were recorded on the Environmental Sampling Log (Appendix 1) as per 135846-V01-01-PLA-001 Infauna Lab Testing & Reporting Plan.

Water samples were collected at two of the survey areas – at Artisan and Thylacine on 22 November 2019. Three replicate water samples were collected at each of the survey areas. The locations for water sample collection are listed in Table 2 and shown in Figure 2. Note that there is only one sampling site indicated for the Thylacine field as all samples were collected in close proximity (Figure 2 left). The process described above was carried out at each site and water samples were collected from a depth equal to half of the total water depth at that site.

Table 2 Location (GDA94 UTM 54 S) and depth of water sample collection sites.

Survey Area	Location	Replicate Sample Name	Easting	Northing	Water Depth (m)	Sample Depth (m)	Met Acceptability Criteria
Thylacine	1	1	660119	5657621	104	52	Yes
	1	2	660121	5657619	104	52	Yes
	1	3	660122	5657619	105	52.5	Yes
Artisan	1	1	662936	5692724	66	33	No
	1	2	662782	5692683	66	33	Yes
	2	1	664317	5693523	66	33	Yes
	5	1	662563	5694337	66	33	Yes

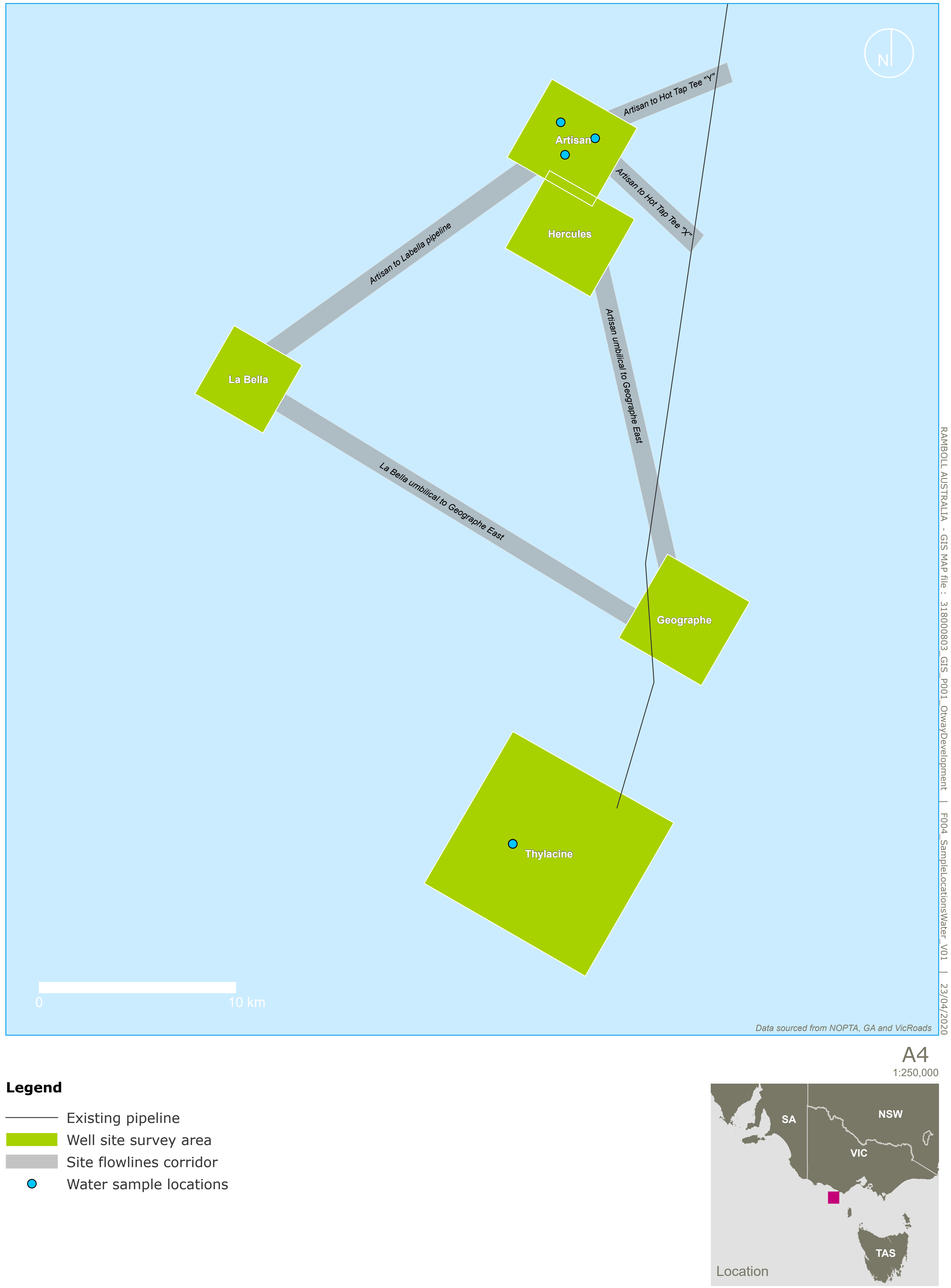


FIGURE 2 | Water sampling locations for Thylacine and Artisan survey areas.

3.2.2 Sample Processing and Analysis

Once a sample was confirmed to be acceptable for analysis, the subsamples were extracted from the water sampler and stored in pre-labelled sample jars provided by the analytical laboratory, Eurofins. The analytical laboratory was NATA accredited and accredited for compliance with ISO/IEC 17025 – Testing.

The water samples were subsampled as follows:

- 1 x 500 mL plastic bottle with no preservative
- 1 x 200 mL glass bottle with no preservative
- 1 x 60 mL plastic bottle with sulphuric acid
- 1 x 60 mL plastic bottle with nitric acid
- 2 x 40 mL glass vials with hydrogen chloride

All samples were stored in a cool, dark location prior to transfer to the laboratory.

One litre of the remaining water sample was then processed for chlorophyll analysis. A simple filtering system was set up which included a Büchner funnel with a rubber seal placed in the mouth of a conical flask and a rubber hose and vacuum hand pump attached to the side arm of the flask. Filter paper (11 µm particle retention at 98% efficiency) was used placed in the funnel and the 1L subsample was suctioned through the filtering system. The filter paper was carefully removed from the funnel using forceps, wrapped in aluminium foil, stored in a labelled sealable plastic bag and frozen prior to transfer to the laboratory.

The following measurements were then taken using a YSI EcoSense handheld meter from the remaining water sample:

- pH
- Dissolved oxygen (DO)
- Oxidation-reduction potential (ORP)
- Temperature (°C)

Sample information was recorded on the Environmental Sample Log (Appendix 1). All sample collection and processing equipment was then rinsed in sterile demineralised water before the next sample was collected.

All water quality subsamples were recorded on the Ramboll Chain of Custody (COC) form. These subsamples were then transferred to the laboratory on the vessel's return to shore. The water quality samples were delivered to the Eurofins laboratory in Melbourne on 26 November 2019.

The water samples were analysed for the presence and concentration of these analytes:

- Total suspended solids (TSS);
- Nutrients including total nitrogen (N), total Kjeldahl nitrogen (TKN), nitrogen oxides (NOx), nitrate (NO^{-}_3), ammonia (NH_3), total phosphorus (TP), and total reactive phosphorus (TRP);
- Chlorophyll *a*;
- Metals/metalloids including arsenic (As), cadmium (Cd), cobolt (Co), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), and zinc (Zn); and
- Hydrocarbons including total recoverable hydrogens (TRH), benzene, toluene, ethylbenzene and xylene compounds (BTEX), and polycyclic aromatic hydrocarbons (PAH).

The analytical methods for these analytes are included in the laboratory reports in Appendix 2.

3.3 Sediment Quality

3.3.1 Sample Collection

Seabed sediment samples were collected using a Double Van Veen grab sampler. The Double Van Veen grab is designed for sampling the top layer of consolidated sediment consisting of silt and/or sand. The capacity of each grab bucket is ~12 L. The double grab allows for comparable sampling where samples for sediment and biological analysis are required from the same location.

Prior to deployment, the jaws of both grabs were opened and fixed into position using a tension-based catch. The grab sampler was then winched over the stern of the vessel and lowered at a slow, steady rate to prevent the catch from being released too early. When the jaws made contact with the bottom, the release of tension caused the catch to be tripped, allowing the jaws to quickly close to capture the surface sediment. The quantity and quality of the sample was related to the compactness of the sediment whereby the grab sampler returned less sample content from more compacted sediments.

On retrieval at the surface, the grab sampler was inspected against the following sample acceptability criteria:

1. The jaws of the grab are closed; and
2. The surface of the sediment sample covers at least 70% of the grab; and
3. The surface of the sediment sample is undisturbed; and
4. There is no evidence of the sample being washed out; and
5. The sample is at least 20cm deep.

Samples that did not comply with these criteria were typically discarded and another sample was collected at the same site. However, some exceptions to these criteria were allowed on agreement with the client in order to obtain samples for analysis, given the difficulty of obtaining grab samples from the hard seabed substrate. Such instances are noted in the description of results in Section 4. At some sample locations a composite sample was made from several grab drops (up to three drops) to provide enough material for one sample. In these instances, the samples did not achieve a depth of 20 cm. The first sample replicate collected from the Thylacine survey area (Thylacine_1_1) was 15 cm deep and therefore did not meet the acceptance criteria; however, given the difficulty in obtaining suitable samples (owing to the hard seabed), this sample was retained for analysis as all other criteria were met and it was considered to be a useful sample by the field personnel. All samples were recorded on the Environmental Sampling Log (Appendix 1) as per 135846-V01-01-PLA-001 Infauna Lab Testing & Reporting Plan.

Sediment samples were collected at two of the survey areas – at Artisan and Thylacine on 22 November 2019. Three replicate sediment samples were to be collected at each of the survey areas, however, this was not always possible because of the compacted substrate. The resulting samples included four replicate samples from Thylacine and two replicate samples from Artisan. The locations for successful sediment sample collection are listed in Table 3 and shown in Figure 3. Note that there is only one sampling site indicated for the Thylacine field as all samples were collected in close proximity (Figure 3 left). Grab sample positions were provided by Fugro from the marine survey using Ultra Short Base Line positioning systems.

FIGURE 3 | Grab sample locations for sediment and infauna for Thylacine and Artisan survey areas.

Table 3 Location (GDA94 UTM 54 S) and depth of sediment sample collection sites.

Survey Area	Location	Sample Replicate Name	Easting	Northing	Water Depth (m)	Met Acceptability Criteria
Thylacine	1	0	660119	5657621	104	Sample was 15 cm deep, therefore not within acceptance criteria but considered suitable by field personnel. Incorrectly recorded in lab report as Location 2.
	1	1	660121	5657619	104	Yes
	1	2	660122	5657619	105	Yes
	1	3	660120	5657622	104	Yes
Artisan	1	1	663155	5693762	72	This sample was a composite of replicate samples 1, 3, 4 and 6 taken at the same location. Listed as Artisan_GS_A in lab report.
	1	2	663155	5693762	72	No
	1	3	663155	5693762	72	Composite as above.
	1	4	663155	5693762	72	Composite as above.
	1	5	663155	5693762	72	No
	1	6	663155	5693762	72	Composite as above.
	3	1	662264	5693604	75	No
	3	2	662264	5693604	72	No
	3	3	662265	5693604	73	Yes. Listed as Artisan_GS3 in lab report.
	3	4	662265	5693605	74	No sediment sample, infauna sample only.

3.3.2 Sample Processing and Analysis

Once a sample was confirmed to be acceptable for analysis, the sample was photographed, visual observations were recorded, and subsamples were extracted from the sample and stored in pre-labelled sample jars provided by the analytical laboratory.

All sediment grab samples were photographed with a sample identity plate. Notes of the uniformity of the surface, Munsell colour and odour were then recorded. The redox (reduction–oxidation reaction) potential depth (RPD) was measured using a YSI EcoSense handheld meter and probe. Redox potential is a measure of the tendency of a chemical species to acquire electrons from or lose electrons to an electrode and thereby be reduced or oxidised, respectively. Redox potential is measured in millivolts (mV). The redox potential of the sample was measured from the surface and at 10 mm increments to a depth of up to 110 mm, or until resistance was encountered when inserting the probe. The probe was rinsed in fresh water between each sample. Sample information was recorded on the Environmental Sample Log (Appendix 1).

Sediment was then extracted from one grab bucket for sediment quality sampling (with the contents of the other grab bucket being used for infauna sampling). Subsamples were collected by releasing the sample into a collection bin below the sampler. The entire sample was homogenised using a plastic scoop.

Two subsamples were stored in pre-labelled 250 mL glass sample jars for the analysis of contaminants and particle size distribution. All samples were stored in a cool, dark location prior to transfer to the laboratory. All sample collection and processing equipment was then rinsed in fresh water before the next sample was collected.

All sediment quality subsamples were recorded on the Ramboll COC form. These subsamples were then transferred to the laboratory on the vessel's return to shore. The sediment quality samples were delivered to the Eurofins laboratory in Melbourne on 26 November 2019.

The sediment samples were analysed for the presence and concentration of these analytes:

- Sediment particle size as clay-size fraction, silt and sand;
- Total organic carbon (TOC);
- Nutrients including nitrate and nitrite, TKN, total nitrogen, phosphorus, and silicon;
- Metals/metalloids including cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), tin (Sn), and zinc (Zn).
- Hydrocarbons including Total Petroleum Hydrocarbons (TPH) , total polycyclic aromatic hydrocarbons (PAH) and BTEX (benzene, toluene, ethylbenzene and xylenes, PCBs.

The analytical methods for these analytes are included in the laboratory reports in Appendix 3.

3.4 Infauna Ecology

3.4.1 Sample Collection

Seabed sediment samples for infauna were collected using a Double Van Veen grab sampler, as described in Section 3.2.1 and at the locations presented in Table 4 and Figure 3. The critiera for accepting grab samples for infauna analysis were as described in Section 3.2.1. All samples were recorded on the Environmental Sampling Log (Appendix 1) as per 135846-V01-01-PLA-001 Infauna Lab Testing & Reporting Plan.

3.4.2 Sample Processing and Analysis

Once a sample was confirmed to be acceptable for analysis, the sample was photographed with a sample identity plate. Sediment was then extracted from one grab bucket for infauna sampling (with the contents of the other grab bucket being used for sediment quality sampling). The entire sample was released into a collection bin below the sampler and then transferred to a sample washing system where the sample was placed in a perforated bin to be mixed and rinsed with seawater. The liquified sample was then passed through a series of sieves of 1mm mesh size (top) and 500 µm mesh size (bottom). The remaining infauna and debris were then rinsed into a labelled container and preserved in ethanol at a dilution factor of 2:1 to sample volume. Where a full grab sample was collected, the contents were subsampled to a 6L sample volume to limit the time required for infauna sample processing in the laboratory.

All samples were stored in a chemical locker and were recorded on the Ramboll COC form. These samples were then transferred to the taxonomic analyst on the vessel's return to shore. The laboratory in Gladstone, Queensland received the infauna samples in December 2019.

Infauna organisms present in the samples were identified and counted to Family morpho-species or genus level where possible. Descriptive statistics (e.g., species richness, organism abundance, diversity indices) were used to summarise the seabed biota present. This information is assessed and discussed in the context of the known communities present in the wider Otway Basin, noting the presence of any habitats/species of relevance to the EPBC Act. Multivariate measures were not used in the assessment because of the small dataset and paucity of organisms found in the samples.

Table 4 Location (GDA94 UTM 54 S) and depth of infauna sample collection sites.

Survey Area	Location	Sample Replicate Name	Easting	Northing	Water Depth (m)	Met Acceptability Criteria
Thylacine	1*	0	660119	5657621	104	Sample was 15 cm deep, therefore not within acceptance criteria but considered suitable by field personnel. Incorrectly recorded in lab report as Location 2.
	1	1	660121	5657619	104	Yes
	1	2	660122	5657619	105	Yes
	1	3	660120	5657622	104	Yes
Artisan	1	1	663155	5693762	72	No
	1	2	663155	5693762	72	No
	1	3	663155	5693762	72	No
	1	4	663155	5693762	72	Yes
	1	5	663155	5693762	72	No
	1	6	663155	5693762	72	No
	3	1	662264	5693604	75	No
	3	2	662264	5693604	72	No
	3	3	662265	5693604	73	Yes
	3	4	662265	5693605	74	Sample was 7 cm deep, therefore not within acceptance criteria but considered suitable by field personnel.

3.5 Epibenthic Ecology

3.5.1 Sample Collection

The composition and percent coverage of epifauna was assessed from photographs of the seafloor taken with the Fugro drop camera system. The drop camera system was fitted with a 14.7 megapixel (MP) Canon PowerShot G10 digital camera and a low latency, live video recorder. The system was equipped with twin lasers aimed within the camera field of view to enable calibration of the image size. The lasers were calibrated to a distance of 15 cm. The camera housing was an aluminium enclosure for use in water depths up to 300 m. A mini beacon was attached to the drop camera to accurately track locations during deployment.

The drop camera was deployed via a winch over the stern of the vessel. All data was transferred directly to the surface unit and saved into a dedicated Fugro server. A real-time video feed to the surface enabled preliminary observations of benthic fauna and substrate type to be made during operation.

At each sampling site the camera was lowered and then to three locations approximately 1-2 m apart to obtain a collection of representative samples. At least five photographs were taken at each location to provide a selection of photographs for analysis. Drop camera sites are listed in Appendix 4. Drop camera photographs were taken at all anchor points, hot tap sites and along CPT routes as shown in Figure 4. The average area of seabed in each photograph was 0.5 m^2.

3.5.2 Sample Processing and Analysis

All seafloor photographs were examined to determine their suitability for analysis, with photographs being excluded for the assessment based on the following reasons:

- Poor resolution or blurred image;
- Sediment blow out obscuring the image;
- More than a quarter of the image was in shadow or had poor lighting;
- Images were overlapping (in which case the best quality image was chosen); or
- Images were taken at oblique angles.

For each photograph, the percent coverage of epifauna was estimated and individual, mobile organisms were counted. Photographs were examined to provide a qualitative description of the epifauna communities. Sediment type and percent coverage was also estimated for each photograph.

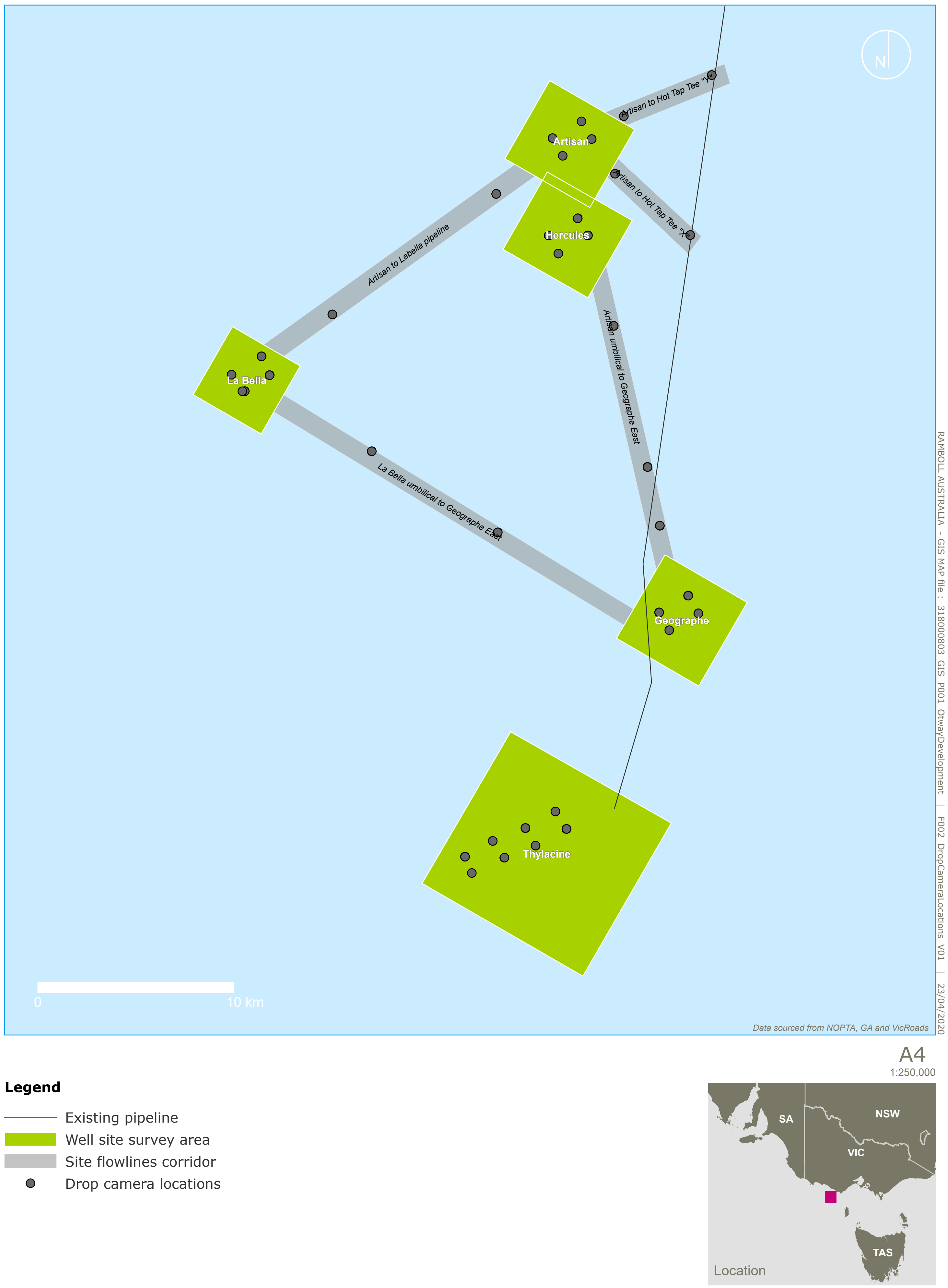


FIGURE 4 | Drop camera locations for all survey areas.

4. RESULTS

4.1 Water Quality

Measurements made *insitu* for water samples collected from the Thylacine and Artisan survey areas are presented in Table 5. Dissolved oxygen (DO) and pH were assessed against the default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems set out in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000). Trigger values are used to assess risk of adverse effects due to nutrients, biodegradable organic matter and pH in various ecosystem types.

Dissolved oxygen was between the lower and upper limits of 90 and 110% saturation for marine waters in all samples. Likewise, pH was between the lower and upper limits of 8.0 and 8.4 for all samples. The range of ORP measurements indicated a well oxygenated, ecologically healthy environment.

Table 5 Measurements made *insitu* for water samples at Thylacine and Artisan survey areas.

Sample Name	pH	DO (% saturation)	ORP (mV)
Thylacine_1_1	8.19	94.3	215.0
Thylacine_1_2	8.24	95.2	211.4
Thylacine_1_3	8.33	95.2	98.1
Artisan_1_2	8.16	94.0	172.7
Artisan_2_1	8.08	93.1	211.4
Artisan_5_1	8.34	93.8	164.5

The results of laboratory analyses for water samples from the Thylacine and Artisan survey areas are presented in Tables 6 to 11.

The analytes were compared to the relevant ANZECC (2000) – the default trigger values for physical and chemical stressors for nutrient analytes and the trigger values for toxicants at alternative levels of protection for all other analytes.

The concentration of ammonia, nitrite and reactive phosphorus was at or below LOR for all samples. Only one sample contained a concentration of nitrate-nitrite, NO^-_3, TKN and TN above the LOR. This was replicate Thylacine_1_3; however, none of the measurements exceeded ANZECC trigger values. Concentrations of TP were recorded in all samples, but all measurements were well below ANZECC trigger values. TSS was typically within the range expected for unmodified[1] marine ecosystems.

The concentrations of Cd, Cr, Co, Pb, Hg, and Ni were at or below LOR in all samples. The concentration of Cu was below, at or very close to the LOR for all samples.

The concentration of Zn against ANZECC protection level (or trigger values) is shown in Figure 5. All concentrations were below the 90% protection level but concentrations variously exceeded 95 or 99% protection levels. This result is consistent with a slightly disturbed marine system which is described in (ANZECC 2000) as an ecosystem in which biodiversity may have been affected to a

---

[1] Unmodified is a descriptive term used in reference to the quality of the environment and is used in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000). Effectively unmodified ecosystems, typically (but not always) occur in remote and/or inaccessible locations. While there are no aquatic ecosystems in Australia that are entirely without some human influence, the ecological integrity of unmodified ecosystems is regarded as intact.

small degree by human activity. Therefore, this result is likely reflective of the human activities occurring within and around the study area and the levels of environmental Zn are with a reasonable level of species protection for such an environment.

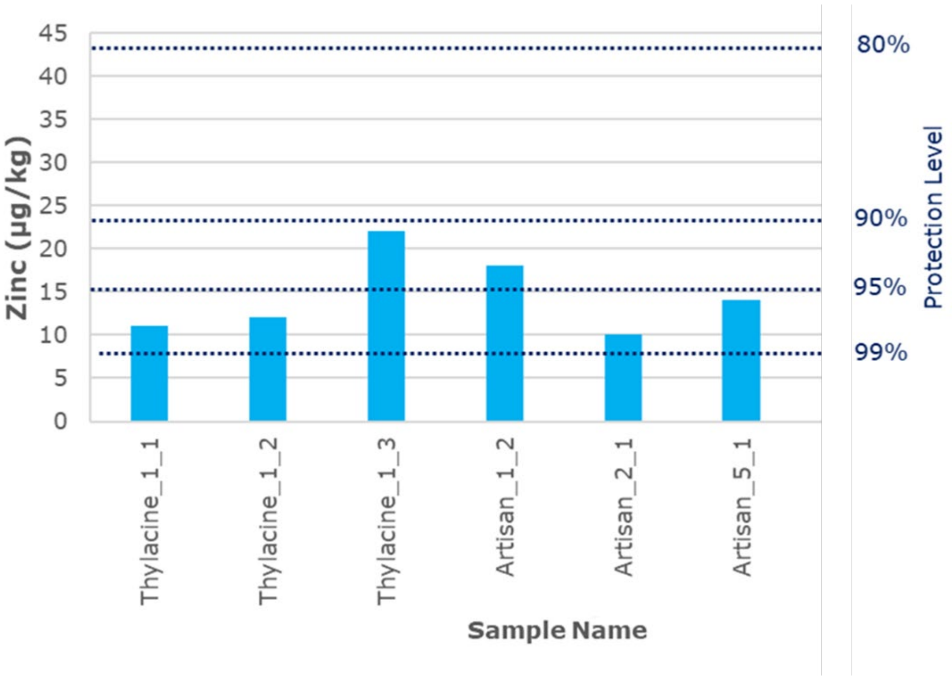


Figure 5 Concentration of Zn in water samples from Thylacine and Artisan survey areas.

BTEXs and PAHs were below the detection limit in all water samples. Very low traces of TRHs were detected in the Thylacine_1_2 water sample but were at levels of no concern. TRHs were below detection limits in all other samples. The level of chlorophyll *a* in filtered samples was below the detection level.

Table 6 Nutrients in water samples at Thylacine and Artisan survey areas.

Sample Name	mg/L								
	NH_3	Nitrate-Nitrite	NO^-_3	Nitrite	TP	RP	TKN	TN	TSS
Thylacine_1_1	< 0.01	< 0.05	0.03	< 0.02	0.03	< 0.01	< 0.2	< 0.2	3.4
Thylacine_1_2	< 0.01	< 0.05	0.02	< 0.02	0.02	< 0.01	< 0.2	< 0.2	9.7
Thylacine_1_3	< 0.01	0.10	0.10	< 0.02	0.02	< 0.01	2.4	2.5	2.4
Artisan_1_2	< 0.01	< 0.05	< 0.02	< 0.02	0.02	< 0.01	< 0.2	< 0.2	5.9
Artisan_2_1	< 0.01	< 0.05	< 0.02	< 0.02	0.01	0.01	< 0.2	< 0.2	4.6
Artisan_5_1	< 0.01	< 0.05	< 0.02	< 0.02	0.01	< 0.01	< 0.2	< 0.2	5.2

Table 7 Metals and metalloids in water samples at Thylacine and Artisan survey areas.

Sample Name	mg/L								
	Ar	Cd	Cr	Co	Cu	Pb	Hg	Ni	Zn
Thylacine_1_1	0.001	< 0.0002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.0001	< 0.001	0.011
Thylacine_1_2	0.004	< 0.0002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.0001	< 0.001	0.012
Thylacine_1_3	0.002	< 0.0002	< 0.001	< 0.001	0.002	< 0.001	< 0.0001	0.001	0.022
Artisan_1_2	0.003	< 0.0002	< 0.001	< 0.001	0.001	< 0.001	< 0.0001	< 0.001	0.018
Artisan_2_1	0.005	< 0.0002	< 0.001	< 0.001	0.001	< 0.001	< 0.0001	< 0.001	0.01
Artisan_5_1	0.010	< 0.0002	< 0.001	< 0.001	0.001	< 0.001	< 0.0001	< 0.001	0.014

Table 8 Polycyclic Aromatic Hydrocarbons (PAH) in water samples at Thylacine and Artisan survey areas.

Sample Name	mg/L					
	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b&j)fluoranthene
Thylacine_1_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thylacine_1_2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thylacine_1_3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Artisan_1_2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Artisan_2_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Artisan_5_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Sample Name	mg/L					
	Benzo(g.h.i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a.h)anthracene	Fluoranthene	Fluorene
Thylacine_1_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thylacine_1_2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thylacine_1_3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Artisan_1_2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Artisan_2_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Artisan_5_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Sample Name	mg/L					p-Terphenyl-d14 (%)	2-Fluorobiphenyl (%)
	Indeno(1.2.3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH		
Thylacine_1_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	134	111
Thylacine_1_2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	145	107
Thylacine_1_3	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	138	109
Artisan_1_2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	93	109
Artisan_2_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	102	114
Artisan_5_1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	101	117

Table 9 Total Recoverable Hydrocarbons (1999 NEPM Fractions) in water samples at Thylacine and Artisan survey areas.

Sample Name	mg/L				
	TRH C10-C14	TRH C10-C36 (Total)	TRH C15-C28	TRH C29-C36	TRH C6-C9
Thylacine_1_1	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02
Thylacine_1_2	0.05	0.15	0.1	< 0.1	< 0.02
Thylacine_1_3	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02
Artisan_1_2	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02
Artisan_2_1	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02
Artisan_5_1	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02

Table 10 Total Recoverable Hydrocarbons (2013 NEPM Fractions) in water samples at Thylacine and Artisan survey areas.

Sample Name	mg/L							
	Naphthalene	TRH >C10-C16	TRH >C10-C16 less Naphthalene (F2)	TRH >C10-C40 (total)*	TRH >C16-C34	TRH >C34-C40	TRH C6-C10	TRH C6-C10 less BTEX (F1)
Thylacine_1_1	< 0.01	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02	< 0.02
Thylacine_1_2	< 0.01	0.07	0.07	0.17	0.1	< 0.1	< 0.02	< 0.02
Thylacine_1_3	< 0.01	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02	< 0.02
Artisan_1_2	< 0.01	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02	< 0.02
Artisan_2_1	< 0.01	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02	< 0.02
Artisan_5_1	< 0.01	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	< 0.02	< 0.02

Table 11 BTEX in water samples at Thylacine and Artisan survey areas.

Sample Name	mg/L						4-Bromofluoro-benzene (%)
	Benzene	Ethylbenzene	m&p-Xylenes	o-Xylene	Toluene	Xylenes - Total	
Thylacine_1_1	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.003	106
Thylacine_1_2	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.003	94
Thylacine_1_3	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.003	107
Artisan_1_2	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.003	94
Artisan_2_1	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.003	102
Artisan_5_1	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.003	100

4.2 Sediment Quality

The particle size distribution of marine sediments in each sample is shown in Figure 6 with data recorded in Appendix 3. The particle size is <2 µm for the clay-size fraction, 2-20 µm for the silt fraction and 20-2000 µm for the sand fraction. Note that the sample for Artisan 1_1 was a composite of up to three drops of the grab sampler. The sediment within all samples and, therefore at both survey areas, was predominantly sand with a range of 95-97% as a proportion of each sample. There was very little silt and a maximum of 4.7% for the clay-size fraction. There were no discernible trends based on the location of sample collection. The Munsell colour of all samples as 10YR 8/4.

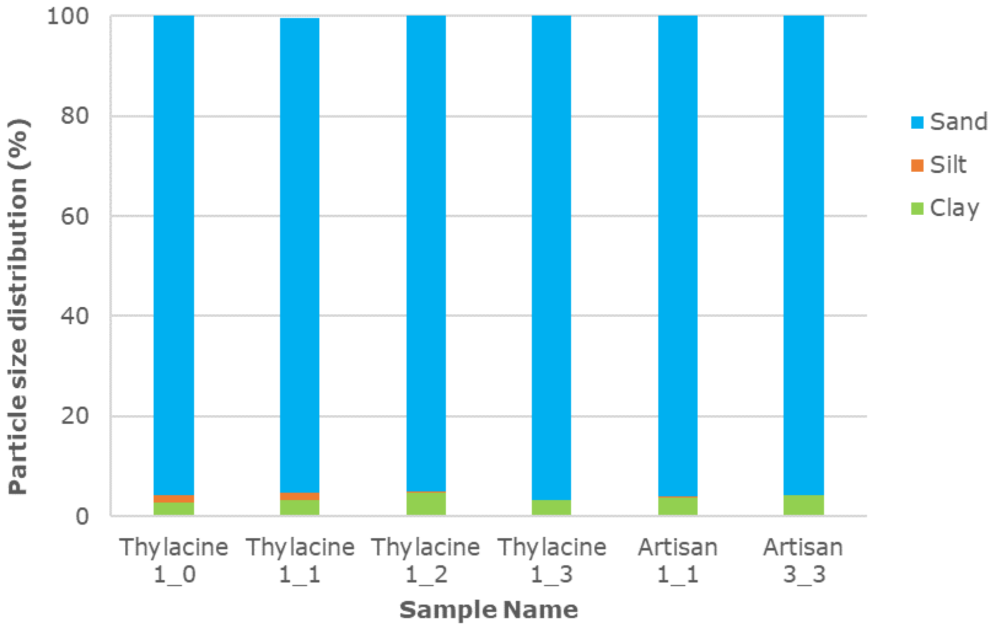


Figure 6 Particle size distribution (%) in sediment samples collected at Thylacine and Artisan survey areas.

The ORP (oxidation-reduction potential) or redox potential of sediments within the samples was measured and the results are presented in Table 12. Note that the measurement probe was inserted into the sediment until resistance prevented further insertion. Given that the substrate was predominantly sand, the probe was typically only inserted to 1-2 cm and no more than 3 cm into the sediment sample. The anoxic layer with low ORP was not detected in any of the sediments analysed and the range of measurements indicated that these sediments maintain a well oxygenated, unmodifed environment.

Table 12 Measurement of oxidation reduction potential in sediment samples at Thylacine and Artisan survey areas.

Sample Name	ORP Measurement Depth (mV)		
	1 cm	2 cm	3 cm
Thylacine_1_0	211	211	No further penetration
Thylacine_1_1	252.7	No further penetration	-
Thylacine_1_2	242.7	No further penetration	-
Thylacine_1_3	225.5	223	216.7
Artisan_1_1	Composite sample; measurement not possible		
Artisan_3_3	242.1	217.3	No further penetration

The results of nutrient analyses are shown in Table 13, Figure 7 and Figure 8. Nitrate-nitrite was not detected in any samples. There was a notable degree of variability in the samples collected in the Thylacine field, however the small number of samples means that a trend or pattern is not discernible. TOC and detectable nitrogen concentrations were slightly higher in the Artisan samples compared to the Thylacine samples. Generally, the concentrations of nutrients in the marine sediments were to be expected for this environment and type of sediment.

Table 13 Nutrients in sediment samples at Thylacine and Artisan survey areas.

Sample Name	mg/kg					Total Organic Carbon (%)
	Phosphorus	Silicon	Nitrate-Nitrite	Total Kjeldahl Nitrogen	Total Nitrogen	
Thylacine_1_0	750	850	< 5	230	230	1.3
Thylacine_1_1	620	1000	< 5	190	190	0.9
Thylacine_1_2	400	950	< 5	130	130	0.5
Thylacine_1_3	< 200	460	< 5	180	180	< 0.1
Average (± S.D.)	467.5 (± 284)	815 (± 245)	NA	183 (± 41)	183 (± 41)	1.0 (± 0.5)
Artisan_1_1	620	570	< 5	310	310	1.6
Artisan_3_3	530	810	< 5	270	270	2.4
Average (± S.D.)	575 (± 64)	690 (± 170)	NA	290 (± 28)	290 (± 28)	2.0 (± 1.0)

Level of Reporting (LOR): phosphorus 200 mg/kg; silicon 5 mg/kg; nitrate-nitrite 5 mg/kg; TKN 10 mg/kg; TN 10 mg/kg; TOC 0.1%.
S.D. = standard deviation. Note that average (± S.D.) calculations are made with half LOR where the sample result was < LOR.

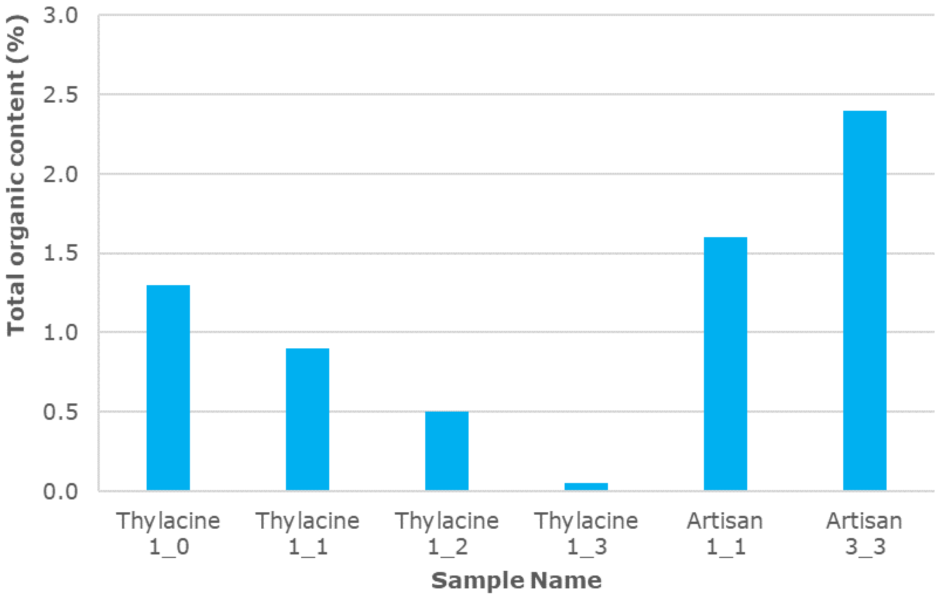


Figure 7 Total organic content (%) in sediment samples collected at Thylacine and Artisan survey areas.

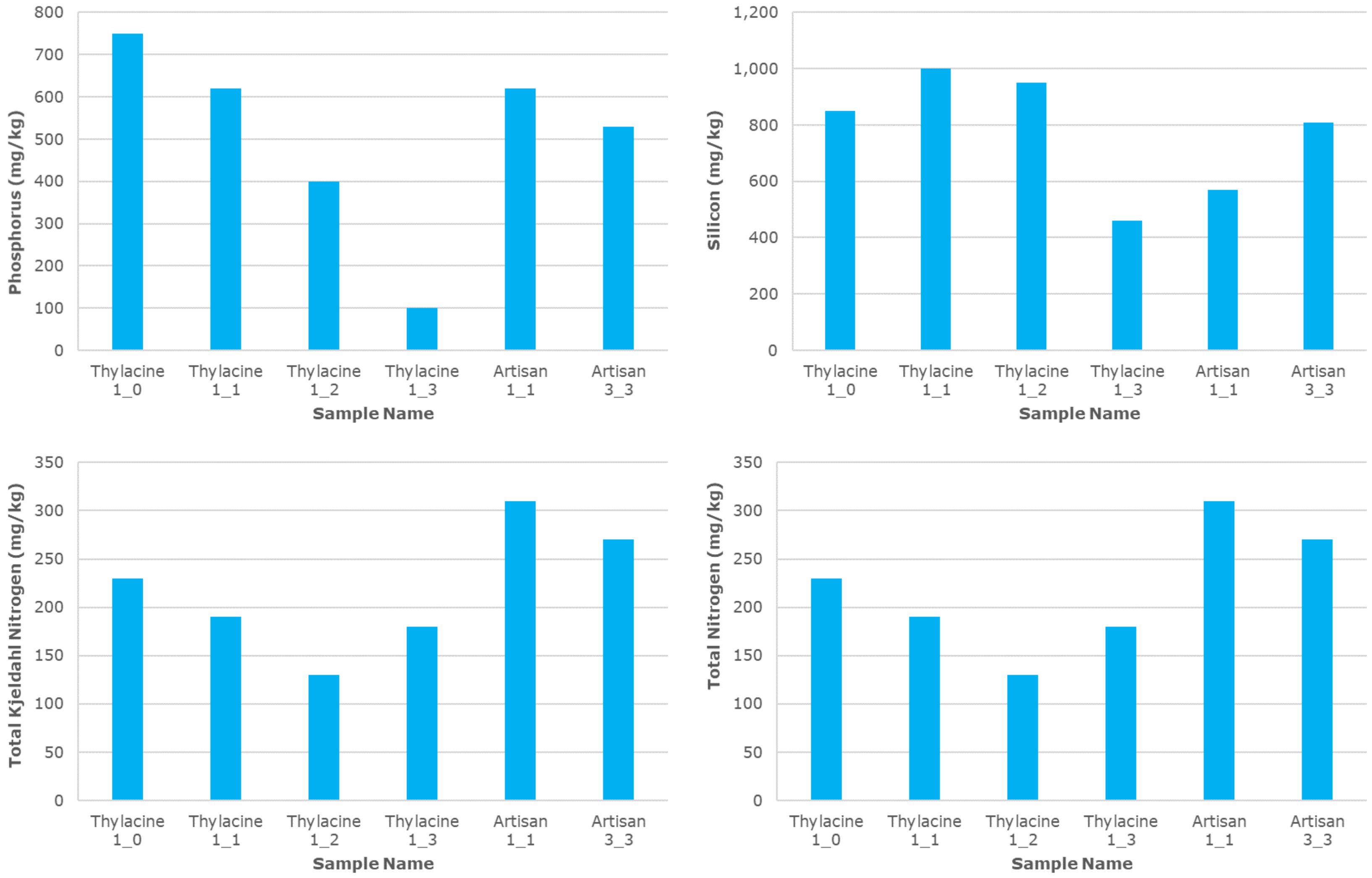


Figure 8 Nutrient concentrations (mg/kg) in sediment samples collected at Thylacine and Artisan survey areas, including phosphorus (top left), silicon (top right), total Kjeldahl nitrogen (bottom left) and total nitrogen (bottom right).

Table 14 presents the results of the analysis for metal compounds in the sediment samples. Of the inorganic compounds tested, Cd, Cu, Pb, Hg, Ni and Sn were below the detection limits (LOR) in all sediment samples. The concentration of Cr in sediments was low, and well below the Interim Sediment Quality Guidelines (ISQG) low trigger value of 80 mg/kg from the recommended sediment quality guidelines set out in ANZECC (2000). The concentration of Cr was slightly higher in the samples from Artisan than those from Thylacine. Zn was detected in two of the six samples (one sample from each field) and was well below the ISQC-Low trigger value of 200 mg/kg.

Table 14 Metals in sediment samples at Thylacine and Artisan survey areas.

Sample Name	mg/kg							
	Cd	**Cr**	**Cu**	**Pb**	**Hg**	**Ni**	**Sn**	**Zn**
Thylacine_1_0	< 0.4	6.2	< 5	< 5	< 0.1	< 5	< 10	7.2
Thylacine_1_1	< 0.4	6.6	< 5	< 5	< 0.1	< 5	< 10	< 5
Thylacine_1_2	< 0.4	6.4	< 5	< 5	< 0.1	< 5	< 10	< 5
Thylacine_1_3	< 0.4	< 5.0	< 5	< 5	< 0.1	< 5	< 10	< 5
Artisan_1_1	< 0.4	11	< 5	< 5	< 0.1	< 5	< 10	9.4
Artisan_3_3	< 0.4	8.1	< 5	< 5	< 0.1	< 5	< 10	< 5

Level of Reporting (LOR): Cd 0.4 mg/kg; Cr 5 mg/kg; Cu 5 mg/kg; Pb 5 mg/kg; Hg 0.1 mg/kg; Ni 5 mg/kg; Sn 10 mg/kg; Zn 5 mg/kg.

The results of laboratory analyses for hydrocarbons in sediment samples from the Thylacine and Artisan survey areas are presented in Tables 15 to 19. BTEXs, PAHs, PCBs and TRHs were either below the LOR or at levels of no concern.

Table 15 Polycyclic Aromatic Hydrocarbons (PAH) in sediment samples at Thylacine and Artisan survey areas.

Sample Name	mg/kg						
	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(a)pyrene TEQ (lower bound)	Benzo(a)pyrene TEQ (medium bound)
Thylacine_1_0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6
Thylacine_1_1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6
Thylacine_1_2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6
Thylacine_1_3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6
Artisan_1_1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6
Artisan_3_3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6

Sample Name	mg/kg						
	Benzo(a)pyrene TEQ (upper bound)	Benzo(b&j) fluoranthene	Benzo(g.h.i) perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a.h)anthracene	Fluoranthene
Thylacine_1_0	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Thylacine_1_1	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Thylacine_1_2	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Thylacine_1_3	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Artisan_1_1	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Artisan_3_3	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Sample Name	mg/kg						p-Terphenyl-d14 (%)	2-Fluorobiphenyl (%)
	Fluorene	Indeno(1.2.3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH*		
Thylacine_1_0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	83	79
Thylacine_1_1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	121	92
Thylacine_1_2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	137	87
Thylacine_1_3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	118	97
Artisan_1_1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	59	60
Artisan_3_3	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	147	58

Table 16 Total Recoverable Hydrocarbons (1999 NEPM Fractions) in sediment samples at Thylacine and Artisan survey areas.

Sample Name	mg/kg				
	TRH C10-C14	TRH C10-C36 (Total)	TRH C15-C28	TRH C29-C36	TRH C6-C9
Thylacine_1_0	< 20	< 50	< 50	< 50	< 20
Thylacine_1_1	< 20	< 50	< 50	< 50	< 20
Thylacine_1_2	< 20	< 50	< 50	< 50	< 20
Thylacine_1_3	< 20	< 50	< 50	< 50	< 20
Artisan_1_1	< 20	< 50	< 50	< 50	< 20
Artisan_3_3	< 20	< 50	< 50	< 50	< 20

Table 17 Total Recoverable Hydrocarbons (2013 NEPM Fractions) in sediment samples at Thylacine and Artisan survey areas.

Sample Name	mg/kg							
	Naphthalene	TRH >C10-C16	TRH >C10-C16 less Naphthalene (F2)	TRH >C10-C40 (total)*	TRH >C16-C34	TRH >C34-C40	TRH C6-C10	TRH C6-C10 less BTEX (F1)
Thylacine_1_0	< 0.5	< 50	< 50	< 100	< 100	< 100	< 20	< 20
Thylacine_1_1	< 0.5	< 50	< 50	< 100	< 100	< 100	< 20	< 20
Thylacine_1_2	< 0.5	< 50	< 50	< 100	< 100	< 100	< 20	< 20
Thylacine_1_3	< 0.5	< 50	< 50	< 100	< 100	< 100	< 20	< 20
Artisan_1_1	< 0.5	< 50	< 50	< 100	< 100	< 100	< 20	< 20
Artisan_3_3	< 0.5	< 50	< 50	< 100	< 100	< 100	< 20	< 20

Table 18 BTEX in sediment samples at Thylacine and Artisan survey areas.

Sample Name	mg/kg						4-Bromofluoro-benzene (%)
	Benzene	Ethylbenzene	m&p-Xylenes	o-Xylene	Toluene	Xylenes - Total	
Thylacine_1_0	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.3	55
Thylacine_1_1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.3	104
Thylacine_1_2	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.3	110
Thylacine_1_3	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.3	106
Artisan_1_1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.3	62
Artisan_3_3	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.3	106

Table 19 Polychlorinated Biphenyls in sediment samples at Thylacine and Artisan survey areas

Sample Name	mg/kg								Dibutylchlorendate (%)	Tetrachloro-m-xylene (%)
	Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260	Total PCB*		
Thylacine_1_0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	105	86
Thylacine_1_1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	132	77
Thylacine_1_2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	139	80
Thylacine_1_3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	78	77
Artisan_1_1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	73	64
Artisan_3_3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	115	54

4.3 Infauna Ecology

The benthic infauna recorded from the grab samples are presented in Table 20. The benthic infauna identified and counted from samples collected at the Thylacine and Artisan sites were relatively depauperate in both abundance and diversity. A total of 22 morpho-species were identified, from a total of 45 organisms collected from the grab samples. The samples Thylacine_1_1 and Artisan_1_4 had the greatest infauna abundance with nine organisms in each sample (Figure 9). The samples Artisan_1_4 and Artisan_3_4 had the greatest diversity with eight morpho-species) (Figure 10), most of which were polychaete worms or crustaceans (Figure 11).

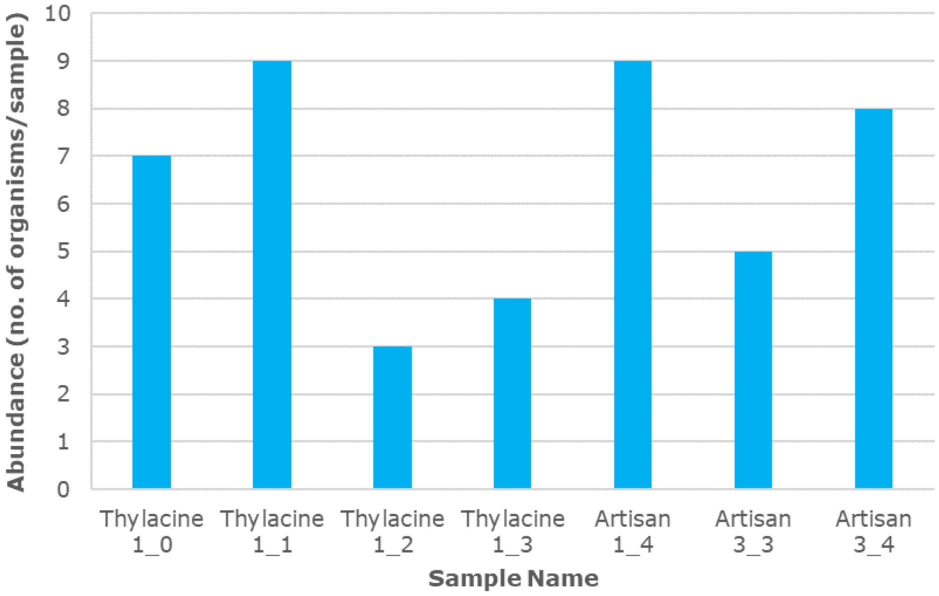


Figure 9 Abundance of benthic infauna in grab samples at Thylacine and Artisan survey areas.

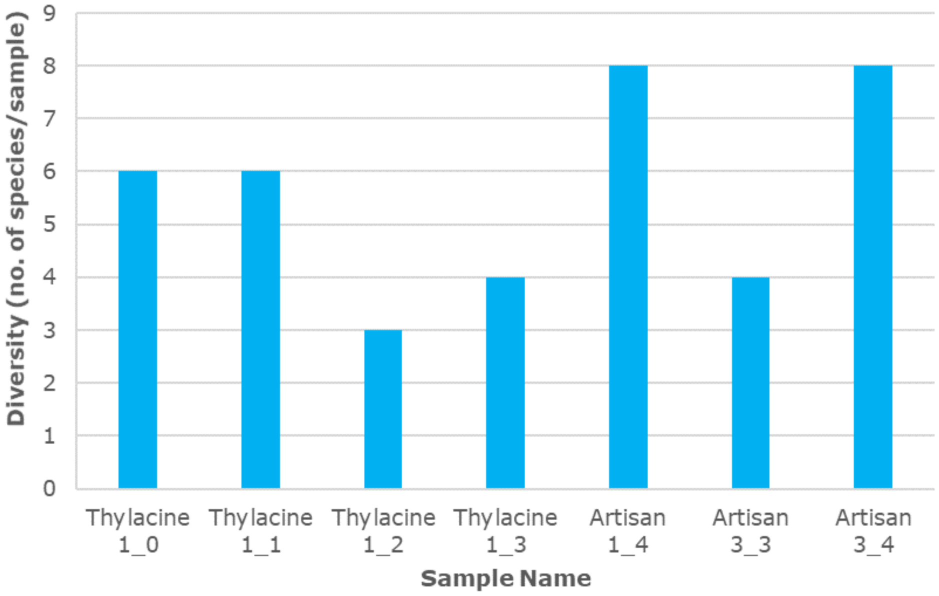


Figure 10 Diversity of benthic infauna in grab samples at Thylacine and Artisan survey areas.

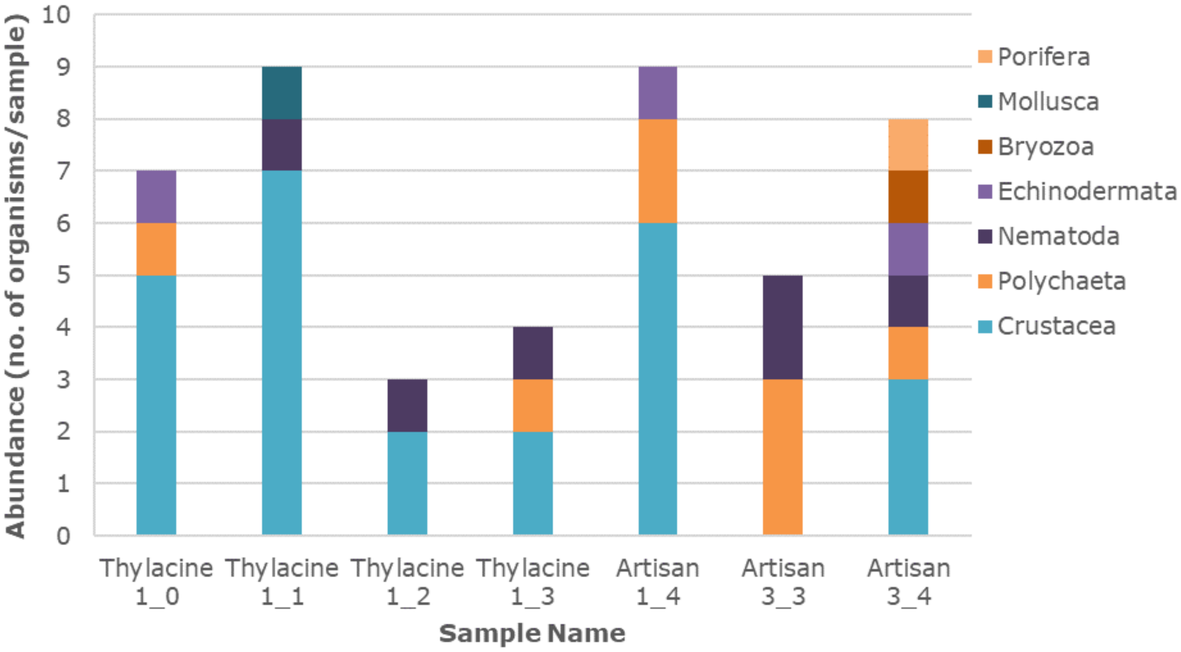


Figure 11 Abundance of benthic infauna by taxonomic group in grab samples at Thylacine and Artisan survey areas.

These results are reflective of the sedimentary environment at the Thylacine and Artisan survey areas, as described in Section 4.2. All sites were dominated by sand, which typically have a lower abundance and diversity of infauna given that this abrasive type of substrate tends to be more easily subjected to hydrodynamic conditions that move the sediment more dynamically than muddy substrates. The consequence of this is a physical environment that is not favourable for filter feeding and burrowing infauna species to inhabit. The observed species typically have a higher tolerance for dynamic environments.

There were no discernible spatial trends in the distribution of sediment particle size. Likewise, there were no clear trends in the abundance, diversity or composition of benthic infauna.

Table 20 Benthic infauna present in sediment samples collected at Thylacine and Artisan survey areas.

Phylum	Class/ Order	Family	Morpho-species	Thylacine				Artisan		
				1_0	**1_1**	**1_2**	**1_3**	**1_4**	**3_3**	**3_4**
Annelida	Polychaeta	Glyceridae	Glyceridae sp.	1			1	1	1	
		Goniadidae	Goniadidae sp.							1
		Pisionidae	Pisionidae sp.					1		
		Spionidae	Spionidae sp.						1	
		Syllidae	Syllidae sp.						1	
Crustacea	Amphipoda	Ampeliscidae	Ampeliscidae sp.		2	1				
		Ischyroceridae	Ischyroceridae sp.					1		1
		Lysianassidae	Lysianassidae sp.	2						
		Oedicerotidae	Oedicerotidae sp.		2					
		Phoxocephalidae	Phoxocephalidae sp.	1			1			
		Platyischnopidae	Platyischnopidae sp.	1		1				1
		Podoceridae	Podoceridae sp.					1		
Crustacea	Caridea	Pasiphaeidae	Pasiphaeidae sp.					1		
	Copepoda	Copepoda	Copepoda sp.					1		
	Cumacea	Bodotriidae	Bodotriidae sp.				1	2		
	Ostracoda	Ostracoda	Ostracoda sp.	1	2					
	Tanaidacea	Tanidae	Tanidae sp.		1					1
Echinodermata	Ophiuroidea	Ophiuroidea	Ophiuroidea sp.	1				1		1
Ectoprocta	Bryozoa	Bryozoa	Branching-sp.2							1
Mollusca	Gastropoda	Rissoidae	Rissoidae sp.		1					
Nematoda	Nematoda	Nematoda	Nematoda		1	1	1		2	1
Porifera	Porifera	Porifera	Solitary-Fan							1

4.4 Epibenthic Ecology

A total of 821 photographs were taken of the seafloor with the survey areas in Otway Basin. A total of 442 photographs used in this assessment (Appendix 5), with the remaining images excluded for the reasons as listed in Section 3.5.2. An average of 56 photographs were taken per survey area, 17 photographs per Hot Tap location and 15 photographs per umbilical route. Table 21 provides a summary of the number of photograph replicate samples used for the visual assessment, average (± standard deviation) for percent cover of epifauna, and total abundance of individual (and often mobile) epifauna organisms. Two example images from each survey area, Hot Tap and umbilical route are included in Appendix 6.

Figure 12 shows the average (± S.D.) percent cover of epifauna at each of the drop camera locations. Percent cover ranged from 0 to 80% of the sample photograph for all samples but on average the percent cover was typically no more than 37% cover. The seabed at Hot Tap X had the greatest average coverage of epibiota while the lowest coverage of epibiota was recorded along the CPT route between Artisan and Hot Tap Y (ARHTY) (Figure 12). Artisan and Hercules survey areas had a slighted greater coverage of epifauna, while the CPT routes between survey areas and Hot Tap Y had the least coverage of epifauna.

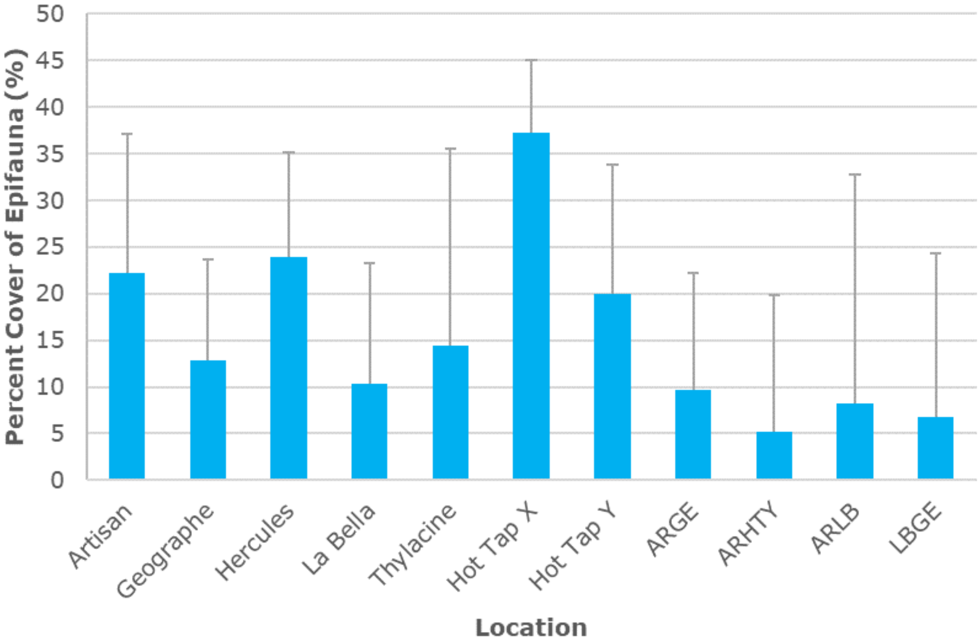


Figure 12 Percent cover of epifauna at drop camera location in Otway Basin.

Figure 13 provides information of the percent cover of epifauna at each drop camera site within these locations and shows the high variability of smaller-scale variability between drop camera sites. For example, the coverage of epifauna at most Thylacine drop camera sites was no more than 16% while at Thylacine 1 the percent cover was up 43% on average.

Of the individual epibenthic organisms, Gastropoda sp. 2 (a cone shell) and crionids (featherstars) were the most abundant (Table 21). Figure 14 shows an example of the seabed at Thylacine 1 (TH1) with a high percent cover of epifauna and a relatively high abundance of crinoids. Further examples are included in Appendix 6.

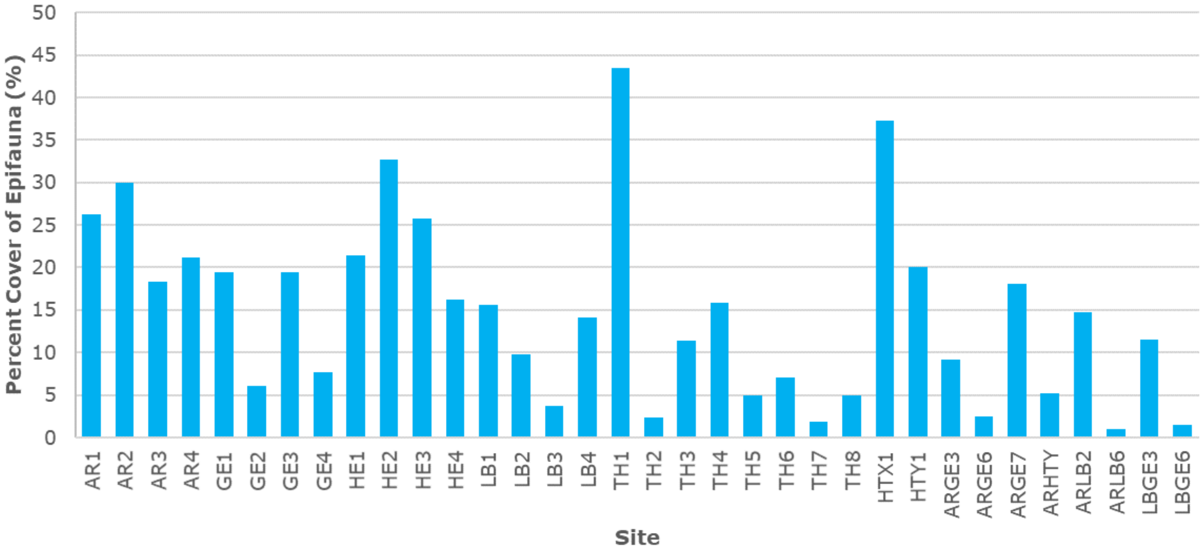


Figure 13 Percent cover of epifauna at drop camera sites in Otway Basin.

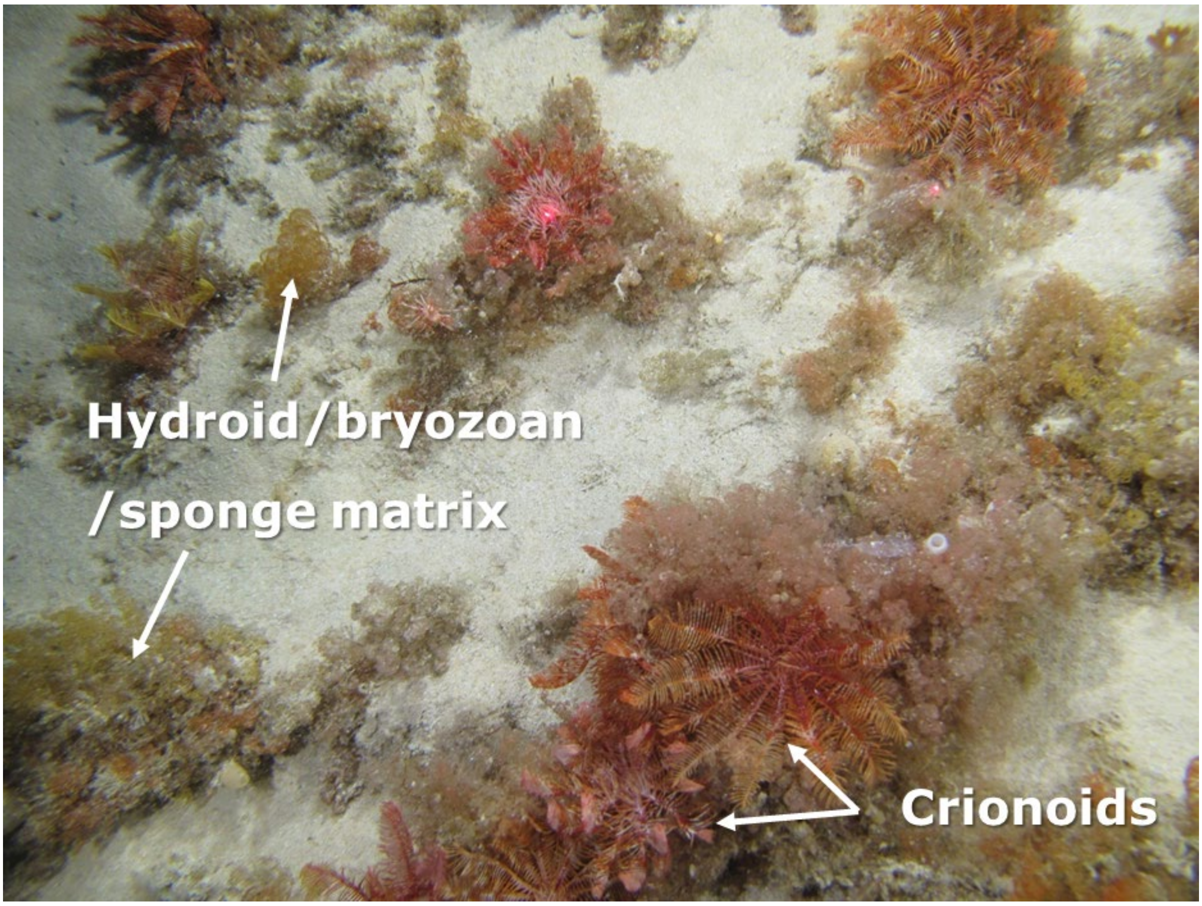


Figure 14 Example of the typical seabed epifauna with high percent cover at Thylacine 1 (TH1).

Table 21 Percent cover and total abundance of epibiota at drop camera sites.

Location	n	Percent cover of epifauna (%)		Total abundance of individual organisms								
				Crinoidea	Gastropoda spp.					Nudibranchia	Polychaeta	Teleostei
		Average	S.D.		Sp. 1	Sp. 2	Sp. 3	Sp. 4	Sp. 5			
AR1	4	26	15			4						
AR2	4	30	11			1						
AR3	9	18	11			1						
AR4	13	21	13			14						
GE1	9	19	21		2	2						
GE2	9	6	8		1							
GE3	9	19	14			1						
GE4	11	8	13			1						
HE1	14	21	15					2				
HE2	15	33	24		1	1		1				
HE3	14	26	18	1		2	1					
HE4	16	16	12		1							
LB1	9	16	10			1						
LB2	18	10	10									
LB3	15	4	2			4						
LB4	17	14	15			2		1				
TH1	16	43	14	40						1		
TH2	15	2	3		1	1						
TH3	21	11	7	8		7			2			
TH4	18	16	8	24								

Location	*n*	Percent cover of epifauna (%)		Total abundance of individual organisms								
				Crinoidea	Gastropoda spp.					Nudibranchia	Polychaeta	Teleostei
		Average	S.D.		Sp. 1	Sp. 2	Sp. 3	Sp. 4	Sp. 5			
TH5	1	5	-									
TH6	5	7	4									
TH7	8	2	3			1						
TH8	11	5	2			1						
HTX1	9	37	14		2	1		1				
HTY1	18	20	8			7		1	1			
ARGE3	12	9	8			6	1				1	
ARGE6	20	3	3			1						1
ARGE7	18	18	10			3		1				1
ARHTY	21	5	11	1	1	1				1		1
ARLB2	17	15	9			5	1					
ARLB6	15	1	2			7		1				
LBGE3	16	12	17			4						
LBGE6	14	1	2			1		1				

A composite, qualitative sample of epifauna from the Artisan field as examined and identified by the Benthic Australia invertebrate laboratory, with the results presented in Table 22. This epifauna was collected from grab samples at Artisan 1. This analysis shows that much of the epifauna is comprised of branching bryozoans, feather-like gorgonian cnidarians and sponges. This complex of encrusting/branching fauna provides refuge for macrofauna such as amphipods, isopods, polychaete worms and molluscs.

Table 22 Epifauna present in grab samples collected at the Artisan field.

Phylum	Class/ Order	Family	Morpho-species	Artisan_1_Epifauna
Annelida	Polychaeta	Amphinomidae	Hermodice spp.	1
		Eunicidae	Eunice spp.	1
		Phyllodocidae	Phyllodocidae sp.	1
		Syllidae	Syllidae sp.	2
		Terebellidae	Terebellidae sp.	1
Cnidaria	Alcyonacea	Alcyonacea	Gorgonian-Feather sp.	1
Crustacea	Amphipoda	Dexaminidae	Dexaminidae sp.	10
		Eusiridae	Eusiridae sp.	2
		Ischyroceridae	Ischyroceridae sp.	2
		Maeridae	Maeridae sp.1	3
			Maeridae sp.2	3
		Stegocephalidae	Stegocephalidae sp.	2
Crustacea	Isopoda	Valvifera	Valvifera sp.	1
Echinodermata	Ophiuroidea	Ophiuroidea	Ophiuroidea sp.	4
Ectoprocta	Bryozoa	Bryozoa	Branching-sp.1	7
			Branching-sp.2	2
Mollusca	Bivalvia	Glycymerididae	Glycymerididae sp.	1
	Gastropoda	c.f.Olividae	c.f.Olividae sp.	1
Porifera	Porifera	Porifera	Conglomerate-Branching sp.	3
			Conglomerate-Bulbous sp.1	4
			Conglomerate-Bulbous sp.2	2
			Solitary-Fan	4

5. DISCUSSION

The survey was conducted over in the Otway Basin covering five survey areas, two hot taps and five routes between those locations. The survey areas were located in offshore Commonwealth waters at 32 to 80 km from Port Campbell. Water depth ranged from 70 to 104 m.

The water quality at the Thylacine and Artisan survey areas indicated an undisturbed mid-depth environment, based on the six samples collected during the survey. There were low or undetectable levels of nutrients, metals/metalloids, BTEXs, PAHs and TRHs in the seawater samples. Metal and metalloids measurements were generally below ANZECC trigger values and within the range expected for unmodified, marine waters. The range of ORP measurements indicated a well oxygenated, ecologically healthy environment.

The sandy substrates described for Thylacine and Artisan survey areas are consistent with the reported description for the area of unconsolidated seabed sediments made up of carbonate sands (Barton et al., 2012; Murray-Wallace and Woodroffe, 2014). The sediment quality results were also consistent with Jones and Davies (1983) who described the grain size distribution as sand and gravel covering the entire shelf except for areas of silty sand in central Bass Strait and other locations more remote from the survey area. The authors noted a regional trend of 'reverse grading' whereby sediment tended to become coarser with distance from shore. Fine sand was reported to be the predominant sediment type along the inner shelf of Victoria and off much of Tasmania, grading seawards into medium-grain sand, and locally into coarse sand at the edge of the shelf (Jones and Davies, 1983). While the gravel fraction was not assessed, it is likely that some gravel occurs within the sediment as shown by some larger shell fragments observed in seabed photographs. Sediments had a high ORP and low or undetectable levels of toxicants indicating an unmodified seabed environment.

The Otway Basin is part of the Southeast Marine Bioregion which extends from the far south coast of New South Wales to Kangaroo Island (Commonwealth of Australia, 2015). Significant variation in seafloor features and water depth contribute to the high level of species diversity in the Region and the shelf habitats are reported to support a diverse range of species from a broad range of taxonomic groups (Commonwealth of Australia, 2015). However, there is no readily-available literature describing the seabed fauna of Otway Basin, meaning it is not possible to make a comparison of infauna and epifauna communities detected to prior studies. Most descriptions of the ecological values of the Basin or the Bioregion are at a broad scale and focus of key features such as cetaceans, birds, fisheries and macroalgae habitats (Commonwealth of Australia, 2015).

Based on the assessment of epifauna using seabed photographs, the general impression of the seafloor is of a unmodifed marine environment that supports a patchy complex of branching epibiota (i.e., bryozoans, gorgonian cnidarians and sponges). This complex was highly patchy, covering 0.25 m^2 on average but could be found in patches of at least 0.4 m^2.

A microscopic examination of a qualitative sample of this epibiota indicated that this complex of fauna provide microhabitat for a range of macrofauna such as amphipods, isopods, polychaete worms and molluscs. Such epifaunal habitats are known to provide refuge and other resources for benthic species (Jones, 2006). By comparison, there was a low abundance and diversity of infauna living within the sediment which reflects the coarse nature of the substrate. This type of substrate is highly mobile making it difficult for filter feeders and soft bodies invertebrates to survive and establish significant populations.

In summary, the epibiota on the seabed in the vicinity of the Thylacine and Artisan survey areas is representative of what is expected at depths around 70-100 m. The infauna was of relatively low abundance and diversity as expected for coarse sand substrates. No species or ecological communities listed as threatened under the Environmental Protection and Biodiversity Conservation Act 1999 (the EPBC Act) were observed.

6. REFERENCES

Barton, J.; Pope, A.; Howe S. (2012) Marine Natural Values Study Vol 2: Marine Protected Areas of the Otway Bioregion. Parks Victoria Technical series No. 75. Parks Victoria, Melbourne.

Commonwealth of Australia (2015) South-east marine region profile: A description of the ecosystems, conservation values and uses of the South-east Marine Region. 87 p. https://www.environment.gov.au/system/files/resources/7a110303-f9c7-44e4-b337-00cb2e4b9fbf/files/south-east-marine-region-profile.pdf [Accessed February 2020].

Jones, E.J. (2006) Bryozoan thickets on Otago shelf, New Zealand: a quantitative assessment of the epibenthos using underwater photography. MSc thesis. University of Otago, Dunedin, New Zealand. 213 p.

Jones, H.A.; Davies, P.J. (1983) Superficial sediments of the Tasmanian continental shelf and part of Bass Strait. Bureau of Mineral Resources, Geology and Geophysics bulletin no. 218. Canberra, Australian Government Publishing Service, 25 p.

Murray-Wallace, C.V.; Woodroffe, C.D. (2014) Quaternary sea-level changes: a global perspective. Cambridge University Press, Cambridge 484 p.

APPENDIX 1
ENVIRONMENTAL SAMPLE LOGS

SAMPLE MANAGEMENT ROUTINES

Project Code: 318000803	**Project Name: Otway Offshore Development**	
Vessel: Vos Shine **Location: Artisan and Thylacine, Otway Basin**	**Sampling Team: Irene Middleton** **Sampling Gear: Van Dorn 2.4L and Van Veen Double benthic grab sampler**	**Date: 22/11/2019**

☑	**All samples are stored on board as required for the analysis**	
☒	**Once ashore samples are transported by air with the sampling team to Perth**	**Not required, samples sent directly from port to lab.**
☑	**All Chain of Costody (COC) forms are copied and saved to cloud storage prior to sample dispatch**	
☑	**Samples for contaminants analyses (metals, metalloids, hydrocarbons) are shipped by courier to EUROFINS in Melbourne with COC documentation**	
☑	**Samples for infaunal analysis are shipped via courier to Benthic Australia, Gladstone, QLD with COC documentation**	
☑	**Image data is saved in its entireity to two separate storage drives, each transported by a different team member to Ramboll's office (holding a relevant COC)**	**Only one team member transported storage drives as only one enviro team member on board at one time. Additional image data sent to Ramboll by Fugro via sercure file transfer.**
☑	**Image data is saved in its entireity to Ramboll's secure servers once back in the office (noted on COC when complete)**	

Comments:

SAMPLING LOG

Project Code: 318000803	**Project Name: Otway Offshore Development**

Vessel: VOS Shine	**Sampling Team: Irene Middleton**	**Sky/Wind: 20 knots**	**Date: 22/11/2019**
Location: Artisan	**Sampling Gear: Van Dorn 2.4L water sampler**	**Sea State: 2 m swell**	**Shift: 04:00-20:00**

Site No.	**Local Time**	**Sample No.**	**Replicate No.**	**Image ID**	**Sample Acceptable?**	**pH**	**ORP (mV)**	**Temperature (°C)**	**Dissolved oxygen (%/ppb)**	**Conductivity (uS/cm)**	**Visual Contamination**
AR 2	6:21	2	1	N/A	YES, Sampler A	8.08	172.1	13.6	93.1/7.78	497679	None
AR 1a	6:49	1	1	N/A	NO, sample rejected	-	-	-	-	-	-
AR 1b	7:11	1	2	N/A	YES, Sampler A	8.16	172.7	13.9	93.8/7.89	50112	None
AR 5	7:26	1	1	N/A	YES, Sampler A	8.34	164.5	13.4	93.8/7.89	50502	None

Comments: Sampler B was contaminated by a greasy hand print so all samples came from Sampler A. Blank samples were collected from Sampler A (labelled Blank A) and Sampler B (labelled Blank B).

SAMPLING LOG

Project Code: 318000803	**Project Name: Otway Offshore Development**		
Vessel: VOS Shine	**Sampling Team: Irene Middleton**	**Sky/Wind: 20 knots**	**Date: 22/11/2019**
Location: Artisan	**Sampling Gear: Van Veen Double benthic grab sampler**	**Sea State: 2 m swell**	**Shift: 04:00-20:00**

Site No.	Local Time	Sample No.	Replicate No.	Image ID	Sample Acceptable?	Munsell Colour	ORP (mV)	Texture / Surface or Vertical Structure	Odour (describe)	Visual Contamination	Organic Fragments /Bioturbation /other Fauna
AR_GS-1	8:36	1	1	1-5	NO, not enough material	7.5YR 8/4	-	Sand and epibenthos/sponges	None	None	Sponges, bryozoans, ascidians
AR_GS-1	9:12	1	2	-	NO, grab not triggered	-	-	-	-	-	-
AR_GS-1	9:40	1	3	6-10	YES, small sample used for composite sample	10YR 8/4	Not able to be measured for small sample	Sand, some sponge	None	None	Sponge, coral fragments and tubeworms
AR_GS-1	10:05	1	4	11-13	YES, small sample (3 cm deep) used for composite sample	10YR 8/4	176.4 at 2 cm	Sand	None	None	No sponges, just shell
AR_GS-1	10:39	1	5	14-15	NO	-	-	Only some epifauna retained for examination	None	None	Sponges and bryozoans
AR_GS-1	10:56	1	6	16-19	YES, small sample used for composite sediment sample, no infauna sampled	10YR 8/4	176.3 at 1 cm	Sand	None	None	Bryozoans and corals
AR4_GS-3_1	12:25	3	1	-	NO, grab not triggered	-	-	-	-	-	-
AR4_GS-3_2	12:45	3	2	20-21	NO, small sample (3 cm deep) for sediment only. Infauna grab not triggered	10YR 8/4	217.3 at 2 cm	Shelly sand	None	None	-

AR4_GS-3_3	13:20	3	3	22-24	YES, good sample	10YR 8/4	241.2 at 1 cm	Shelly sand	None	None	-
AR4_GS-3_4	13:30	3	4	25-26	YES, infauna only, 7 cm deep	10YR 8/4	202.3 at 1 cm	Shell coarse hash	None	None	None

Comments: Sample quality was variable and did not always meet the acceptability criteria but allowances were made to get some material for processing.

SAMPLING LOG

Project Code: 318000803	**Project Name: Otway Offshore Development**

Vessel: VOS Shine	**Sampling Team: Irene Middleton**	**Sky/Wind: 20 knots**	**Date: 22/11/2019**
Location: Thylacine	**Sampling Gear: Van Veen Double benthic grab sampler**	**Sea State: 2 m swell**	**Shift: 04:00-20:00**

Site No.	**Local Time**	**Sample No.**	**Replicate No.**	**Image ID**	**Sample Acceptable?**	**Munsell Colour**	**ORP (mV)**	**Texture / Surface or Vertical Structure**	**Odour (describe)**	**Visual Contamination**	**Organic Fragments /Bioturbation /other Fauna**
TH_GS1	17:12	1	0	27-30	YES, 15 cm deep	10YR 8/4	216.7 at 3 cm	Shelly and	None	None	Shell coarse, sand
TH_GS1_1	17:42	1	1	31-33	YES	10YR 8/4	211.0 at 2 cm	Shelly sand	None	None	Shell coarse, sand
TH_GS1_2	18:04	1	2	34-36	YES	10YR 8/4	252.7 at 1 cm	Shelly sand	None	None	Shell coarse, sand
TH_GS1_3	18:26	1	3	37-40	YES	10YR 8/4	242.7 at 1cm	Shelly sand	None	None	Shell coarse, sand

Comments:

SAMPLING LOG

Project Code: 318000803	**Project Name: Otway Offshore Development**

Vessel: VOS Shine	**Sampling Team: Irene Middleton**	**Sky/Wind: 20 knots**	**Date: 22/11/2019**
Location: Artisan and Thylacine	**Sampling Gear: Van Dorn 2.4L water sampler**	**Sea State: 2 m swell**	**Shift: 04:00-20:00**

Site No.	**Local Time**	**Sample No.**	**Replicate No.**	**Image ID**	**Sample Acceptable?**	**pH**	**ORP (mV)**	**Temperature (°C)**	**Dissolved oxygen (%/ppb)**	**Conductivity (uS/cm)**	**Visual Contamination**
TH_GS1	19:13	1	1	N/A	YES, Sampler A	8.19	215	13.4	94.3/8.07	No clear/steady reading	None
TH_GS1	19:30	1	2	N/A	YES, Sampler A	8.24	211.4	13.2	95.2/8.33	No clear/steady reading	None
TH_GS1	19:40	1	3	N/A	YES, Sampler A	8.33	198.1	13.2	95.2/8.16	No clear/steady reading	None

Comments:

SAMPLING LOG _REDOX MEASUREMENTS

Project Code: 318000803

Project Name: Otway Offshore Development

Recorder: Irene Middleton

Sample Acceptable: Only acceptable samples used

Date: 22/11/2019

Time (local): 0400-2000

ORP Reading Depth (mm)

Site No.	Sample No.	Replicate No.	Surface	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Artisan GS	1	4	No surface measurements as hard sand surface gave indeterminate readings	176.2	176.4	No further penetration															
Artisan GS	1	6		176.3	No further penetration																
Artisan GS 3	2	1	As above	242.1	217.3	No further penetration															
Artisan GS 3	2	2	As above	241.2	No further penetration																
Artisan GS 3	2	3	As above	202.3	No further penetration																
Thylacine GS 2	1	1	As above	225.5	223.0	216.7	No further penetration														
Thylacine GS 1	1	1	As above	211.0	211.0	No further penetration															
Thylacine GS 1	1	1	As above	252.7	No further penetration																
Thylacine GS 1	1	1	As above	242.7	No further penetration																

Comments:

APPENDIX 2
WATER QUALITY LABORATORY REPORT

Certificate of Analysis

Ramboll Australia Pty Ltd
Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Dan McClary**

Report **690395-W**
Project name OTWAY OFFSHORE EBS
Project ID 318000803
Received Date Dec 04, 2019

Client Sample ID			**THYLACINE_GS1_1**	**THYLACINE_GS1_2**	**THYLACINE_G1_3**	**ARTISON_1**
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins Sample No.			**M19-No38322**	**M19-No38323**	**M19-No38324**	**M19-No38325**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH C10-C14	0.05	mg/L	< 0.05	0.05	< 0.05	< 0.05
TRH C15-C28	0.1	mg/L	< 0.1	0.1	< 0.1	< 0.1
TRH C29-C36	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C36 (Total)	0.1	mg/L	< 0.1	0.15	< 0.1	< 0.1
BTEX						
Benzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Ethylbenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
m&p-Xylenes	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Xylenes - Total	0.003	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
4-Bromofluorobenzene (surr.)	1	%	106	94	107	94
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH C6-C10 less BTEX (F1)[N04]	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TRH >C10-C16	0.05	mg/L	< 0.05	0.07	< 0.05	< 0.05
TRH >C10-C16 less Naphthalene (F2)[N01]	0.05	mg/L	< 0.05	0.07	< 0.05	< 0.05
TRH >C16-C34	0.1	mg/L	< 0.1	0.1	< 0.1	< 0.1
TRH >C34-C40	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C10-C40 (total)*	0.1	mg/L	< 0.1	0.17	< 0.1	< 0.1
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Acenaphthylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benz(a)anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(a)pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(b&j)fluoranthene[N07]	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(g.h.i)perylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(k)fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Chrysene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Dibenz(a.h)anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Fluorene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001

Client Sample ID			THYLACINE_GS1_1	THYLACINE_GS1_2	THYLACINE_G1_3	ARTISON_1
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins Sample No.			**M19-No38322**	**M19-No38323**	**M19-No38324**	**M19-No38325**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Polycyclic Aromatic Hydrocarbons						
Indeno(1.2.3-cd)pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Naphthalene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Phenanthrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Total PAH*	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
2-Fluorobiphenyl (surr.)	1	%	111	107	109	109
p-Terphenyl-d14 (surr.)	1	%	134	145	138	93
Ammonia (as N)	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Chlorophyll a	5	ug/L	< 10	< 10	< 10	< 10
Nitrate & Nitrite (as N)	0.05	mg/L	< 0.05	< 0.05	0.10	< 0.05
Nitrate (as N)	0.02	mg/L	0.03	0.02	0.10	< 0.02
Nitrite (as N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Phosphate total (as P)	0.01	mg/L	0.03	0.02	0.02	0.02
Phosphorus reactive (as P)	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	< 0.2	< 0.2	2.4	< 0.2
Total Nitrogen (as N)*	0.2	mg/L	< 0.2	< 0.2	2.5	< 0.2
Total Suspended Solids Dried at 103–105°C	1	mg/L	3.4	9.7	2.4	5.9
Heavy Metals						
Arsenic	0.001	mg/L	0.001	0.004	0.002	0.003
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Copper	0.001	mg/L	< 0.001	< 0.001	0.002	0.001
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	mg/L	< 0.001	< 0.001	0.001	< 0.001
Zinc	0.005	mg/L	0.011	0.012	0.022	0.018

Client Sample ID			ARTISON_2	ARTISON_5	BLANK A	BLANK B
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins Sample No.			**M19-No38326**	**M19-No38327**	**M19-No38328**	**M19-No38329**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	0.02	mg/L	< 0.02	< 0.02	0.03	< 0.02
TRH C10-C14	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH C15-C28	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C29-C36	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH C10-C36 (Total)	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
BTEX						
Benzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	0.001	mg/L	< 0.001	< 0.001	0.003	< 0.001
Ethylbenzene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
m&p-Xylenes	0.002	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Xylenes - Total	0.003	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
4-Bromofluorobenzene (surr.)	1	%	102	100	96	92

Client Sample ID			ARTISON_2	ARTISON_5	BLANK A	BLANK B
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins Sample No.			**M19-No38326**	**M19-No38327**	**M19-No38328**	**M19-No38329**
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
TRH C6-C10	0.02	mg/L	< 0.02	< 0.02	0.03	< 0.02
TRH C6-C10 less BTEX (F1)[N04]	0.02	mg/L	< 0.02	< 0.02	0.03	< 0.02
TRH >C10-C16	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C10-C16 less Naphthalene (F2)[N01]	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
TRH >C16-C34	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C34-C40	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
TRH >C10-C40 (total)*	0.1	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Acenaphthylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benz(a)anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(a)pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(b&j)fluoranthene[N07]	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(g.h.i)perylene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Benzo(k)fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Chrysene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Dibenz(a.h)anthracene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Fluoranthene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Fluorene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Indeno(1.2.3-cd)pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Naphthalene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Phenanthrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Pyrene	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Total PAH*	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
2-Fluorobiphenyl (surr.)	1	%	114	117	97	56
p-Terphenyl-d14 (surr.)	1	%	102	101	52	67
Ammonia (as N)	0.01	mg/L	< 0.01	< 0.01	0.03	< 0.01
Chlorophyll a	5	ug/L	< 10	< 10	-	-
Nitrate & Nitrite (as N)	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Nitrate (as N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Nitrite (as N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Phosphate total (as P)	0.01	mg/L	0.01	0.01	< 0.01	< 0.01
Phosphorus reactive (as P)	0.01	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	< 0.2	< 0.2	< 0.2	< 0.2
Total Nitrogen (as N)*	0.2	mg/L	< 0.2	< 0.2	< 0.2	< 0.2
Total Suspended Solids Dried at 103–105°C	1	mg/L	4.6	5.2	< 1	3.1
Heavy Metals						
Arsenic	0.001	mg/L	0.005	0.010	0.001	0.001
Cadmium	0.0002	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Copper	0.001	mg/L	0.001	0.001	< 0.001	0.040
Lead	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	0.005	mg/L	0.010	0.014	0.021	0.032

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Eurofins | mgt Suite B4			
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	Melbourne	Dec 09, 2019	7 Days
- Method: LTM-ORG-2010 TRH C6-C40			
BTEX	Melbourne	Dec 06, 2019	14 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Dec 06, 2019	7 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Dec 09, 2019	
- Method: LTM-ORG-2010 TRH C6-C40			
Polycyclic Aromatic Hydrocarbons	Melbourne	Dec 09, 2019	7 Days
- Method: LTM-ORG-2130 PAH and Phenols in Soil and Water			
Eurofins | mgt Suite B19E: Total N, TKN, NOx, NO2, NO3, NH3, Total P, Reactive P			
Ammonia (as N)	Melbourne	Dec 09, 2019	28 Days
- Method: LTM-INO-4200 Ammonia by Discrete Analyser			
Nitrate & Nitrite (as N)	Melbourne	Dec 09, 2019	28 Days
- Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA			
Nitrate (as N)	Melbourne	Dec 09, 2019	28 Days
- Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA			
Nitrite (as N)	Melbourne	Dec 09, 2019	2 Days
- Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA			
Phosphate total (as P)	Melbourne	Dec 09, 2019	28 Days
- Method: APHA 4500-P E. Phosphorus			
Phosphorus reactive (as P)	Melbourne	Dec 09, 2019	2 Days
- Method: APHA 4500-P			
Total Kjeldahl Nitrogen (as N)	Melbourne	Dec 09, 2019	7 Days
- Method: LTM-INO-4310 TKN in Waters & Soils by FIA			
Chlorophyll a	Melbourne	Dec 06, 2019	2 Days
- Method: LTM-INO-4340 Chlorophyll a in Waters			
Total Suspended Solids Dried at 103–105°C	Melbourne	Dec 09, 2019	7 Days
- Method: LTM-INO-4070 Analysis of Suspended Solids in Water by Gravimetry			
Heavy Metals	Sydney	Dec 11, 2019	180 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 690395
Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 10:56 AM
Due: Dec 11, 2019
Priority: 5 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Robert Johnston

Sample Detail						Arsenic	Cadmium	Chlorophyll a	Chromium	Cobalt	Copper	Lead	Mercury	Nickel	Pheophytin*	Total Suspended Solids Dried at 103–105°C	Zinc	Eurofins | mgt Suite B4	Eurofins | mgt Suite B19E: Total N, TKN, NOx, NO2, NO3, NH3, Total P, Reactive P
Melbourne Laboratory - NATA Site # 1254 & 14271								X							X	X		X	X
Sydney Laboratory - NATA Site # 18217 & 14271						X	X		X	X	X	X	X	X			X		
Brisbane Laboratory - NATA Site # 20794 & 14271																			
Perth Laboratory - NATA Site # 23736 & 14271																			
External Laboratory																			
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**														
1	THYLACINE_GS1_1	Nov 22, 2019		Water	M19-No38322	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	THYLACINE_GS1_2	Nov 22, 2019		Water	M19-No38323	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	THYLACINE_G1_3	Nov 22, 2019		Water	M19-No38324	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4	ARTISON_1	Nov 22, 2019		Water	M19-No38325	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5	ARTISON_2	Nov 22, 2019		Water	M19-No38326	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6	ARTISON_5	Nov 22, 2019		Water	M19-No38327	X	X	X	X	X	X	X	X	X		X	X	X	X
7	BLANK A	Nov 22, 2019		Water	M19-No38328	X	X	X	X	X	X	X	X	X		X	X	X	X
8	BLANK B	Nov 22, 2019		Water	M19-No38329	X	X	X	X	X	X	X	X	X		X	X	X	X

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 690395
Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 10:56 AM
Due: Dec 11, 2019
Priority: 5 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Robert Johnston

Sample Detail	Arsenic	Cadmium	Chlorophyll a	Chromium	Cobalt	Copper	Lead	Mercury	Nickel	Pheophytin*	Total Suspended Solids Dried at 103–105°C	Zinc	Eurofins | mgt Suite B4	Eurofins | mgt Suite B19E: Total N, TKN, NOx, NO2, NO3, NH3, Total P, Reactive P
Melbourne Laboratory - NATA Site # 1254 & 14271			X							X	X		X	X
Sydney Laboratory - NATA Site # 18217 & 14271	X	X		X	X	X	X	X	X			X		
Brisbane Laboratory - NATA Site # 20794 & 14271														
Perth Laboratory - NATA Site # 23736 & 14271														
Test Counts	8	8	8	8	8	8	8	8	8	5	8	8	8	8

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ug/L:** micrograms per litre
ppm: Parts per million	**ppb:** Parts per billion	**%:** Percentage
org/100mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100mL:** Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	mg/L	< 0.02			0.02	Pass	
TRH C10-C14	mg/L	< 0.05			0.05	Pass	
TRH C15-C28	mg/L	< 0.1			0.1	Pass	
TRH C29-C36	mg/L	< 0.1			0.1	Pass	
Method Blank							
BTEX							
Benzene	mg/L	< 0.001			0.001	Pass	
Toluene	mg/L	< 0.001			0.001	Pass	
Ethylbenzene	mg/L	< 0.001			0.001	Pass	
m&p-Xylenes	mg/L	< 0.002			0.002	Pass	
o-Xylene	mg/L	< 0.001			0.001	Pass	
Xylenes - Total	mg/L	< 0.003			0.003	Pass	
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	mg/L	< 0.01			0.01	Pass	
TRH C6-C10	mg/L	< 0.02			0.02	Pass	
TRH >C10-C16	mg/L	< 0.05			0.05	Pass	
TRH >C16-C34	mg/L	< 0.1			0.1	Pass	
TRH >C34-C40	mg/L	< 0.1			0.1	Pass	
Method Blank							
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	mg/L	< 0.001			0.001	Pass	
Acenaphthylene	mg/L	< 0.001			0.001	Pass	
Anthracene	mg/L	< 0.001			0.001	Pass	
Benz(a)anthracene	mg/L	< 0.001			0.001	Pass	
Benzo(a)pyrene	mg/L	< 0.001			0.001	Pass	
Benzo(b&j)fluoranthene	mg/L	< 0.001			0.001	Pass	
Benzo(g.h.i)perylene	mg/L	< 0.001			0.001	Pass	
Benzo(k)fluoranthene	mg/L	< 0.001			0.001	Pass	
Chrysene	mg/L	< 0.001			0.001	Pass	
Dibenz(a.h)anthracene	mg/L	< 0.001			0.001	Pass	
Fluoranthene	mg/L	< 0.001			0.001	Pass	
Fluorene	mg/L	< 0.001			0.001	Pass	
Indeno(1.2.3-cd)pyrene	mg/L	< 0.001			0.001	Pass	
Naphthalene	mg/L	< 0.001			0.001	Pass	
Phenanthrene	mg/L	< 0.001			0.001	Pass	
Pyrene	mg/L	< 0.001			0.001	Pass	
Method Blank							
Ammonia (as N)	mg/L	< 0.01			0.01	Pass	
Nitrate & Nitrite (as N)	mg/L	< 0.05			0.05	Pass	
Nitrate (as N)	mg/L	< 0.02			0.02	Pass	
Nitrite (as N)	mg/L	< 0.02			0.02	Pass	
Phosphate total (as P)	mg/L	< 0.01			0.01	Pass	
Phosphorus reactive (as P)	mg/L	< 0.01			0.01	Pass	
Total Kjeldahl Nitrogen (as N)	mg/L	< 0.2			0.2	Pass	
Total Suspended Solids Dried at 103–105°C	mg/L	< 1			1	Pass	
Method Blank							
Heavy Metals							
Arsenic	mg/L	< 0.001			0.001	Pass	
Cadmium	mg/L	< 0.0002			0.0002	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Chromium	mg/L	< 0.001			0.001	Pass	
Cobalt	mg/L	< 0.001			0.001	Pass	
Copper	mg/L	< 0.001			0.001	Pass	
Lead	mg/L	< 0.001			0.001	Pass	
Mercury	mg/L	< 0.0001			0.0001	Pass	
Nickel	mg/L	< 0.001			0.001	Pass	
Zinc	mg/L	< 0.005			0.005	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	%	94			70-130	Pass	
TRH C10-C14	%	115			70-130	Pass	
LCS - % Recovery							
BTEX							
Benzene	%	92			70-130	Pass	
Toluene	%	79			70-130	Pass	
Ethylbenzene	%	83			70-130	Pass	
m&p-Xylenes	%	76			70-130	Pass	
Xylenes - Total	%	78			70-130	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	%	77			70-130	Pass	
TRH C6-C10	%	94			70-130	Pass	
TRH >C10-C16	%	107			70-130	Pass	
LCS - % Recovery							
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	%	87			70-130	Pass	
Acenaphthylene	%	85			70-130	Pass	
Anthracene	%	72			70-130	Pass	
Benz(a)anthracene	%	99			70-130	Pass	
Benzo(a)pyrene	%	72			70-130	Pass	
Benzo(b&j)fluoranthene	%	72			70-130	Pass	
Benzo(g.h.i)perylene	%	75			70-130	Pass	
Benzo(k)fluoranthene	%	98			70-130	Pass	
Chrysene	%	99			70-130	Pass	
Dibenz(a.h)anthracene	%	80			70-130	Pass	
Fluoranthene	%	85			70-130	Pass	
Fluorene	%	100			70-130	Pass	
Indeno(1.2.3-cd)pyrene	%	98			70-130	Pass	
Naphthalene	%	86			70-130	Pass	
Phenanthrene	%	95			70-130	Pass	
Pyrene	%	86			70-130	Pass	
LCS - % Recovery							
Ammonia (as N)	%	100			70-130	Pass	
Nitrate & Nitrite (as N)	%	101			70-130	Pass	
Nitrate (as N)	%	101			70-130	Pass	
Nitrite (as N)	%	106			70-130	Pass	
Phosphate total (as P)	%	95			70-130	Pass	
Phosphorus reactive (as P)	%	95			70-130	Pass	
Total Kjeldahl Nitrogen (as N)	%	84			70-130	Pass	
Total Suspended Solids Dried at 103–105°C	%	98			70-130	Pass	
LCS - % Recovery							
Heavy Metals							
Arsenic	%	90			70-130	Pass	
Cadmium	%	92			70-130	Pass	

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Chromium			%	98			70-130	Pass	
Cobalt			%	100			70-130	Pass	
Copper			%	100			70-130	Pass	
Lead			%	101			70-130	Pass	
Mercury			%	96			70-130	Pass	
Nickel			%	99			70-130	Pass	
Zinc			%	98			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1					
TRH C10-C14	M19-De05914	NCP	%	111			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
TRH >C10-C16	M19-De05914	NCP	%	104			70-130	Pass	
Spike - % Recovery									
				Result 1					
Ammonia (as N)	M19-De03315	NCP	%	97			70-130	Pass	
Nitrate & Nitrite (as N)	M19-De03315	NCP	%	97			70-130	Pass	
Nitrate (as N)	M19-De03315	NCP	%	97			70-130	Pass	
Nitrite (as N)	B19-De03253	NCP	%	106			70-130	Pass	
Total Kjeldahl Nitrogen (as N)	N19-De04634	NCP	%	91			70-130	Pass	
Spike - % Recovery									
Polycyclic Aromatic Hydrocarbons				Result 1					
Acenaphthene	M19-No38324	CP	%	84			70-130	Pass	
Acenaphthylene	M19-No38324	CP	%	85			70-130	Pass	
Anthracene	M19-No38324	CP	%	74			70-130	Pass	
Benz(a)anthracene	M19-No38324	CP	%	72			70-130	Pass	
Benzo(a)pyrene	M19-No38324	CP	%	82			70-130	Pass	
Benzo(b&j)fluoranthene	M19-No38324	CP	%	79			70-130	Pass	
Benzo(g.h.i)perylene	M19-No38324	CP	%	89			70-130	Pass	
Benzo(k)fluoranthene	M19-No38324	CP	%	113			70-130	Pass	
Chrysene	M19-No38324	CP	%	106			70-130	Pass	
Dibenz(a.h)anthracene	M19-No38324	CP	%	83			70-130	Pass	
Fluoranthene	M19-No38324	CP	%	89			70-130	Pass	
Fluorene	M19-No38324	CP	%	101			70-130	Pass	
Indeno(1.2.3-cd)pyrene	M19-No38324	CP	%	82			70-130	Pass	
Naphthalene	M19-No38324	CP	%	81			70-130	Pass	
Phenanthrene	M19-No38324	CP	%	93			70-130	Pass	
Pyrene	M19-No38324	CP	%	94			70-130	Pass	
Spike - % Recovery									
				Result 1					
Phosphate total (as P)	M19-No38324	CP	%	92			70-130	Pass	
Spike - % Recovery									
Heavy Metals				Result 1					
Arsenic	M19-No38329	CP	%	95			70-130	Pass	
Cadmium	M19-No38329	CP	%	94			70-130	Pass	
Chromium	M19-No38329	CP	%	87			70-130	Pass	
Cobalt	M19-No38329	CP	%	88			70-130	Pass	
Copper	M19-No38329	CP	%	84			70-130	Pass	
Lead	M19-No38329	CP	%	90			70-130	Pass	
Mercury	M19-No38329	CP	%	80			70-130	Pass	
Nickel	M19-No38329	CP	%	85			70-130	Pass	
Zinc	M19-No38329	CP	%	88			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1	Result 2	RPD			
TRH C6-C9	B19-De02116	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
TRH C10-C14	M19-De05913	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
TRH C15-C28	M19-De05913	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
TRH C29-C36	M19-De05913	NCP	mg/L	< 0.1	< 0.1	<1	30%	Pass	
Duplicate									
BTEX				Result 1	Result 2	RPD			
Benzene	B19-De02116	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Toluene	B19-De02116	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Ethylbenzene	B19-De02116	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
m&p-Xylenes	B19-De02116	NCP	mg/L	< 0.002	< 0.002	<1	30%	Pass	
o-Xylene	B19-De02116	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Xylenes - Total	B19-De02116	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
Naphthalene	B19-De02116	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
TRH C6-C10	B19-De02116	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
TRH >C10-C16	M19-De05913	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
TRH >C16-C34	M19-De05913	NCP	mg/L	< 0.1		<1	30%	Pass	
TRH >C34-C40	M19-De05913	NCP	mg/L	< 0.1		<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Ammonia (as N)	B19-De03253	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Chlorophyll a	M19-De06051	NCP	ug/L	28	34	21	30%	Pass	
Nitrate & Nitrite (as N)	B19-De03253	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Nitrate (as N)	B19-De03253	NCP	mg/L	0.04	0.05	34	30%	Fail	Q15
Nitrite (as N)	B19-De03253	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Phosphate total (as P)	M19-De05566	NCP	mg/L	0.91	0.88	4.0	30%	Pass	
Total Kjeldahl Nitrogen (as N)	M19-De03633	NCP	mg/L	79	77	2.8	30%	Pass	
Total Suspended Solids Dried at 103–105°C	M19-De06128	NCP	mg/L	230	230	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	M19-No38322	CP	mg/L	0.001	0.001	2.0	30%	Pass	
Cadmium	M19-No38322	CP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass	
Chromium	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Copper	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Lead	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Mercury	M19-No38322	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Nickel	M19-No38322	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Zinc	M19-No38322	CP	mg/L	0.011	0.012	9.0	30%	Pass	
Duplicate									
Polycyclic Aromatic Hydrocarbons				Result 1	Result 2	RPD			
Acenaphthene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Acenaphthylene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Anthracene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benz(a)anthracene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(a)pyrene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(b&j)fluoranthene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(g.h.i)perylene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(k)fluoranthene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Chrysene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Dibenz(a.h)anthracene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	

Duplicate									
Polycyclic Aromatic Hydrocarbons				Result 1	Result 2	RPD			
Fluoranthene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Fluorene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Indeno(1.2.3-cd)pyrene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Naphthalene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Phenanthrene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Pyrene	M19-No38323	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
N01	F2 is determined by arithmetically subtracting the "naphthalene" value from the ">C10-C16" value. The naphthalene value used in this calculation is obtained from volatiles (Purge & Trap analysis).
N02	Where we have reported both volatile (P&T GCMS) and semivolatile (GCMS) naphthalene data, results may not be identical. Provided correct sample handling protocols have been followed, any observed differences in results are likely to be due to procedural differences within each methodology. Results determined by both techniques have passed all QAQC acceptance criteria, and are entirely technically valid.
N04	F1 is determined by arithmetically subtracting the "Total BTEX" value from the "C6-C10" value. The "Total BTEX" value is obtained by summing the concentrations of BTEX analytes. The "C6-C10" value is obtained by quantitating against a standard of mixed aromatic/aliphatic analytes.
N07	Please note:- These two PAH isomers closely co-elute using the most contemporary analytical methods and both the reported concentration (and the TEQ) apply specifically to the total of the two co-eluting PAHs
Q15	The RPD reported passes Eurofins Environment Testing's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

Authorised By

Robert Johnston	Analytical Services Manager
Gabriele Cordero	Senior Analyst-Metal (NSW)
Harry Bacalis	Senior Analyst-Volatile (VIC)
Joseph Edouard	Senior Analyst-Organic (VIC)
Julie Kay	Senior Analyst-Inorganic (VIC)

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Ramboll Australia Pty Ltd
Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Dan McClary**

Report **690387-A**
Project name OTWAY OFFSHORE EBS
Project ID 318000803
Received Date Dec 04, 2019

Client Sample ID			**ARTISON-1**	**ARTISON-5**	**ARTISON-2**	**THYLACINE GS1_3**
Sample Matrix			**Filter paper**	**Filter paper**	**Filter paper**	**Filter paper**
Eurofins Sample No.			**M19-No38257**	**M19-No38258**	**M19-No38259**	**M19-No38260**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Chlorophyll a	10	ug/L	< 10	< 10	< 10	< 10

Client Sample ID			**THYLACINE GS1_1**	**THYLACINE GS1_2**
Sample Matrix			**Filter paper**	**Filter paper**
Eurofins Sample No.			**M19-No38261**	**M19-No38262**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit		
Chlorophyll a	10	ug/L	< 10	< 10

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Chlorophyll a	Melbourne	Nov 27, 2019	2 Days
- Method:			

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**		**Received:**	Dec 4, 2019 1:54 PM
Address:	Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	**Report #:**	690387	**Due:**	Dec 5, 2019
		Phone:	08 9225 5199	**Priority:**	7 Day
		Fax:		**Contact Name:**	ALL INVOICES
Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
External Laboratory																					
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																
1	THYLACINE_GS1_3_MET1	Nov 22, 2019		Soil	M19-No38233	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
2	THYLACINE_GS1_3_MET2	Nov 22, 2019		Soil	M19-No38234	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
3	THYLACINE_GS1_3_PSD1	Nov 22, 2019		Soil	M19-No38235	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
4	THYLACINE_GS1_MET2	Nov 22, 2019		Soil	M19-No38236	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
5	THYLACINE_GS-1_MET1	Nov 22, 2019		Soil	M19-No38237	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
6	THYLACINE_	Nov 22, 2019		Soil	M19-No38238	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**		**Received:**	Dec 4, 2019 1:54 PM
Address:	Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	**Report #:**	690387	**Due:**	Dec 5, 2019
		Phone:	08 9225 5199	**Priority:**	7 Day
		Fax:		**Contact Name:**	ALL INVOICES
Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS-1_PSD1																				
7	THYLACINE_ GS1-2_PSD1	Nov 22, 2019		Soil	M19-No38239	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
8	THYLACINE_ GS1-2_MET1	Nov 22, 2019		Soil	M19-No38240	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
9	THYLACINE_ GS1-2_MET2	Nov 22, 2019		Soil	M19-No38241	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
10	THYLACINE_ GS2_PSD1	Nov 22, 2019		Soil	M19-No38242	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
11	THYLACINE_ GS2_MET1	Nov 22, 2019		Soil	M19-No38243	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
12	THYLACINE_ GS2_MET2	Nov 22, 2019		Soil	M19-No38244	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
13	ARTISON-	Nov 22, 2019		Soil	M19-No38245	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 690387
Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 1:54 PM
Due: Dec 5, 2019
Priority: 7 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS_A_PAR 4																				
14	ARTISON-GS_A_PAR 3	Nov 22, 2019		Soil	M19-No38246	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
15	ARTISON-GSA_MET1	Nov 22, 2019		Soil	M19-No38247	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
16	ARTISON-GSA_PAR1	Nov 22, 2019		Soil	M19-No38248	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
17	ARTISON-GSA_MET2	Nov 22, 2019		Soil	M19-No38249	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
18	ARTISON-GSA_PAR2	Nov 22, 2019		Soil	M19-No38250	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
19	ARTISON-GS3_PAR1	Nov 22, 2019		Soil	M19-No38251	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
20	ARTISON-	Nov 22, 2019		Soil	M19-No38252	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 690387
Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 1:54 PM
Due: Dec 5, 2019
Priority: 7 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS3_MET1																				
21	ARTISON-GS3_PAR 4	Nov 22, 2019		Soil	M19-No38253	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
22	ARTISON-GS3_PAR 2	Nov 22, 2019		Soil	M19-No38254	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
23	ARTISON-GS3_MET 2	Nov 22, 2019		Soil	M19-No38255	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
24	ARTISON-GS3_PAR 3	Nov 22, 2019		Soil	M19-No38256	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
25	ARTISON-1	Nov 22, 2019		Filter paper	M19-No38257					X											
26	ARTISON-5	Nov 22, 2019		Filter paper	M19-No38258					X											
27	ARTISON-2	Nov 22, 2019		Filter paper	M19-No38259					X											
28	THYLACINE GS1_3	Nov 22, 2019		Filter paper	M19-No38260					X											

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 690387
Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 1:54 PM
Due: Dec 5, 2019
Priority: 7 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
29	THYLACINE GS1_1	Nov 22, 2019		Filter paper	M19-No38261					X											
30	THYLACINE GS1_2	Nov 22, 2019		Filter paper	M19-No38262					X											
Test Counts						24	24	24	24	6	24	24	24	24	24	24	24	24	24	24	24

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram
ppm: Parts per million
org/100mL: Organisms per 100 millilitres
mg/L: milligrams per litre
ppb: Parts per billion
NTU: Nephelometric Turbidity Units
ug/L: micrograms per litre
%: Percentage
MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Robert Johnston	Analytical Services Manager
Julie Kay	Senior Analyst-Inorganic (VIC)
Scott Beddoes	Senior Analyst-Inorganic (VIC)

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

APPENDIX 3
SEDIMENT QUALITY LABORATORY REPORT

eurofins

Environment Testing

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

NATA
WORLD RECOGNISED ACCREDITATION

Ramboll Australia Pty Ltd
Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Attention: **Dan McClary**

Report **690387-S**
Project name OTWAY OFFSHORE EBS
Project ID 318000803
Received Date Dec 04, 2019

Client Sample ID			**THYLACINE_GS1_3_MET1**	**THYLACINE_GS1_3_MET2**	**THYLACINE_GS1_3_PSD1**	**THYLACINE_GS1_MET2**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M19-No38233**	**M19-No38234**	**M19-No38235**	**M19-No38236**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
% Clay	1	%	4.7	3.1	3.3	3.7
% Sand		%	95	95	97	96
% Silt		%	< 1	1.6	< 1	< 1
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Kjeldahl Nitrogen (as N)	10	mg/kg	130	71	110	160
Total Nitrogen (as N)*	10	mg/kg	130	71	110	160
Total Organic Carbon	0.1	%	0.5	1.8	2.7	4.8
Phosphorus	5	mg/kg	400	660	740	610
Silicon (Aqua regia extractable)	5	mg/kg	950	750	630	970
% Moisture	1	%	37	34	37	36
Heavy Metals						
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	6.4	5.7	5.6	6.7
Copper	5	mg/kg	< 5	< 5	< 5	< 5
Lead	5	mg/kg	< 5	< 5	< 5	< 5
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Tin	10	mg/kg	< 10	< 10	< 10	< 10
Zinc	5	mg/kg	< 5	< 5	7.8	< 5

Client Sample ID			**THYLACINE_GS-1_MET1**	**THYLACINE_GS-1_PSD1**	**THYLACINE_GS1-2_PSD1**	**THYLACINE_GS1-2_MET1**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M19-No38237**	**M19-No38238**	**M19-No38239**	**M19-No38240**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
% Clay	1	%	2.8	1.7	4.4	3.1
% Sand		%	96	98	96	95
% Silt		%	1.4	< 1	< 1	1.5
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Kjeldahl Nitrogen (as N)	10	mg/kg	230	210	310	190
Total Nitrogen (as N)*	10	mg/kg	230	210	310	190
Total Organic Carbon	0.1	%	1.3	0.4	1.9	0.9

Client Sample ID			THYLACINE_GS-1_MET1	THYLACINE_GS-1_PSD1	THYLACINE_GS1-2_PSD1	THYLACINE_GS1-2_MET1
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M19-No38237**	**M19-No38238**	**M19-No38239**	**M19-No38240**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Phosphorus	5	mg/kg	750	870	550	620
Silicon (Aqua regia extractable)	5	mg/kg	850	940	890	1000
% Moisture	1	%	34	35	37	38
Heavy Metals						
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	6.2	5.7	5.2	6.6
Copper	5	mg/kg	< 5	< 5	< 5	< 5
Lead	5	mg/kg	< 5	< 5	< 5	< 5
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Tin	10	mg/kg	< 10	< 10	< 10	< 10
Zinc	5	mg/kg	7.2	< 5	< 5	< 5

Client Sample ID			THYLACINE_GS1-2_MET2	THYLACINE_GS2_PSD1	THYLACINE_GS2_MET1	THYLACINE_GS2_MET2
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M19-No38241**	**M19-No38242**	**M19-No38243**	**M19-No38244**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
% Clay	1	%	3.9	2.5	3.3	2.9
% Sand		%	96	98	97	97
% Silt		%	< 1	< 1	< 1	< 1
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Kjeldahl Nitrogen (as N)	10	mg/kg	260	290	180	220
Total Nitrogen (as N)*	10	mg/kg	260	290	180	220
Total Organic Carbon	0.1	%	1.4	1.7	< 0.1	0.5
Phosphorus	5	mg/kg	630	830	< 200	500
Silicon (Aqua regia extractable)	5	mg/kg	980	700	460	600
% Moisture	1	%	38	39	35	38
Heavy Metals						
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	5.1	5.7	< 5	6.3
Copper	5	mg/kg	< 5	< 5	< 5	< 5
Lead	5	mg/kg	< 5	< 5	< 5	< 5
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Tin	10	mg/kg	< 10	< 10	< 10	< 10
Zinc	5	mg/kg	< 5	< 5	< 5	< 5

Client Sample ID			**ARTISON-GS_A_PAR 4**	**ARTISON-GS_A_PAR 3**	**ARTISON-GSA_MET1**	**ARTISON-GSA_PAR1**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M19-No38245**	**M19-No38246**	**M19-No38247**	**M19-No38248**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
% Clay	1	%	< 1	< 1	3.6	3.1
% Sand		%	100	97	96	95
% Silt		%	< 1	2.9	< 1	1.5
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Kjeldahl Nitrogen (as N)	10	mg/kg	340	370	310	250
Total Nitrogen (as N)*	10	mg/kg	340	370	310	250
Total Organic Carbon	0.1	%	< 0.1	< 0.1	1.6	0.4
Phosphorus	5	mg/kg	< 200	860	620	440
Silicon (Aqua regia extractable)	5	mg/kg	490	630	570	580
% Moisture	1	%	34	34	37	29
Heavy Metals						
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	8.0	7.4	11	6.9
Copper	5	mg/kg	< 5	< 5	< 5	< 5
Lead	5	mg/kg	< 5	< 5	< 5	< 5
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Tin	10	mg/kg	< 10	< 10	< 10	< 10
Zinc	5	mg/kg	5.2	9.0	9.4	< 5

Client Sample ID			**ARTISON-GSA_MET2**	**ARTISON-GSA_PAR2**	**ARTISON-GS3_PAR1**	**ARTISON-GS3_MET1**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M19-No38249**	**M19-No38250**	**M19-No38251**	**M19-No38252**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
% Clay	1	%	3.7	3.0	3.9	4.1
% Sand		%	96	97	96	96
% Silt		%	< 1	< 1	< 1	< 1
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Kjeldahl Nitrogen (as N)	10	mg/kg	370	340	440	270
Total Nitrogen (as N)*	10	mg/kg	370	340	440	270
Total Organic Carbon	0.1	%	< 0.1	1.1	< 0.1	2.4
Phosphorus	5	mg/kg	460	< 200	730	530
Silicon (Aqua regia extractable)	5	mg/kg	600	520	770	810
% Moisture	1	%	34	34	36	35
Heavy Metals						
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	6.0	6.4	6.6	8.1
Copper	5	mg/kg	< 5	< 5	< 5	< 5
Lead	5	mg/kg	6.9	< 5	< 5	< 5
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Tin	10	mg/kg	< 10	< 10	< 10	< 10
Zinc	5	mg/kg	25	5.4	< 5	< 5

Client Sample ID			**ARTISON-GS3_PAR 4**	**ARTISON-GS3_PAR 2**	**ARTISON-GS3_MET 2**	**ARTISON-GS3_PAR 3**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M19-No38253**	**M19-No38254**	**M19-No38255**	**M19-No38256**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
% Clay	1	%	4.8	3.5	3.6	4.0
% Sand		%	95	95	96	96
% Silt		%	< 1	1.8	< 1	< 1
Nitrate & Nitrite (as N)	5	mg/kg	< 5	< 5	< 5	< 5
Total Kjeldahl Nitrogen (as N)	10	mg/kg	310	270	150	310
Total Nitrogen (as N)*	10	mg/kg	310	270	150	310
Total Organic Carbon	0.1	%	0.6	4.9	1.6	1.8
Phosphorus	5	mg/kg	570	400	390	480
Silicon (Aqua regia extractable)	5	mg/kg	830	520	650	640
% Moisture	1	%	36	35	34	34
Heavy Metals						
Cadmium	0.4	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4
Chromium	5	mg/kg	9.0	8.1	9.5	8.0
Copper	5	mg/kg	< 5	< 5	< 5	< 5
Lead	5	mg/kg	< 5	< 5	< 5	< 5
Mercury	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Nickel	5	mg/kg	< 5	< 5	< 5	< 5
Tin	10	mg/kg	< 10	< 10	< 10	< 10
Zinc	5	mg/kg	< 5	< 5	< 5	< 5

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
% Clay	Brisbane	Dec 13, 2019	0 Days
- Method: LTM-GEN-7040			
% Sand	Brisbane	Dec 09, 2019	0 Days
- Method: LTM-GEN-7040			
% Silt	Brisbane	Dec 09, 2019	0 Days
- Method: LTM-GEN-7040			
Total Organic Carbon	Melbourne	Dec 16, 2019	28 Days
- Method: LTM-INO-4060 Total Organic Carbon in water and soil			
Silicon (Aqua regia extractable)	Melbourne	Dec 06, 2019	180 Days
- Method: LTM-MET-3010 Alkali Metals Sulfur Silicon and Phosphorus by ICP-AES			
Heavy Metals	Melbourne	Dec 06, 2019	180 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Total Nitrogen Set (as N)			
Nitrate & Nitrite (as N)	Melbourne	Dec 06, 2019	28 Days
- Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA			
Total Kjeldahl Nitrogen (as N)	Melbourne	Dec 06, 2019	28 Days
- Method: LTM-INO-4310 TKN in Waters & Soils by FIA			
Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P			
Phosphorus	Melbourne	Dec 06, 2019	180 Days
- Method: LTM-MET-3010 Alkali Metals Sulfur Silicon and Phosphorus by ICP-AES			
% Moisture	Melbourne	Nov 27, 2019	14 Days
- Method: LTM-GEN-7080 Moisture			

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**		**Received:**	Dec 4, 2019 1:54 PM
Address:	Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	**Report #:**	690387	**Due:**	Dec 5, 2019
		Phone:	08 9225 5199	**Priority:**	7 Day
		Fax:		**Contact Name:**	ALL INVOICES
Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
External Laboratory																					
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																
1	THYLACINE_ GS1_3_MET1	Nov 22, 2019		Soil	M19-No38233	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
2	THYLACINE_ GS1_3_MET2	Nov 22, 2019		Soil	M19-No38234	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
3	THYLACINE_ GS1_3_PSD1	Nov 22, 2019		Soil	M19-No38235	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
4	THYLACINE_ GS1_MET2	Nov 22, 2019		Soil	M19-No38236	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
5	THYLACINE_ GS-1_MET1	Nov 22, 2019		Soil	M19-No38237	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
6	THYLACINE_	Nov 22, 2019		Soil	M19-No38238	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 690387
Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 1:54 PM
Due: Dec 5, 2019
Priority: 7 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS-1_PSD1																				
7	THYLACINE_ GS1-2_PSD1	Nov 22, 2019		Soil	M19-No38239	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
8	THYLACINE_ GS1-2_MET1	Nov 22, 2019		Soil	M19-No38240	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
9	THYLACINE_ GS1-2_MET2	Nov 22, 2019		Soil	M19-No38241	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
10	THYLACINE_ GS2_PSD1	Nov 22, 2019		Soil	M19-No38242	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
11	THYLACINE_ GS2_MET1	Nov 22, 2019		Soil	M19-No38243	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
12	THYLACINE_ GS2_MET2	Nov 22, 2019		Soil	M19-No38244	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
13	ARTISON-	Nov 22, 2019		Soil	M19-No38245	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**		**Received:**	Dec 4, 2019 1:54 PM
Address:	Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	**Report #:**	690387	**Due:**	Dec 5, 2019
		Phone:	08 9225 5199	**Priority:**	7 Day
		Fax:		**Contact Name:**	ALL INVOICES
Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS_A_PAR 4																				
14	ARTISON-GS_A_PAR 3	Nov 22, 2019		Soil	M19-No38246	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
15	ARTISON-GSA_MET1	Nov 22, 2019		Soil	M19-No38247	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
16	ARTISON-GSA_PAR1	Nov 22, 2019		Soil	M19-No38248	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
17	ARTISON-GSA_MET2	Nov 22, 2019		Soil	M19-No38249	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
18	ARTISON-GSA_PAR2	Nov 22, 2019		Soil	M19-No38250	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
19	ARTISON-GS3_PAR1	Nov 22, 2019		Soil	M19-No38251	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
20	ARTISON-	Nov 22, 2019		Soil	M19-No38252	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**		**Received:**	Dec 4, 2019 1:54 PM
Address:	Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	**Report #:**	690387	**Due:**	Dec 5, 2019
		Phone:	08 9225 5199	**Priority:**	7 Day
		Fax:		**Contact Name:**	ALL INVOICES
Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
	GS3_MET1																				
21	ARTISON-GS3_PAR 4	Nov 22, 2019		Soil	M19-No38253	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
22	ARTISON-GS3_PAR 2	Nov 22, 2019		Soil	M19-No38254	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
23	ARTISON-GS3_MET 2	Nov 22, 2019		Soil	M19-No38255	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
24	ARTISON-GS3_PAR 3	Nov 22, 2019		Soil	M19-No38256	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
25	ARTISON-1	Nov 22, 2019		Filter paper	M19-No38257					X											
26	ARTISON-5	Nov 22, 2019		Filter paper	M19-No38258					X											
27	ARTISON-2	Nov 22, 2019		Filter paper	M19-No38259					X											
28	THYLACINE GS1_3	Nov 22, 2019		Filter paper	M19-No38260					X											

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 690387
Phone: 08 9225 5199
Fax:

Received: Dec 4, 2019 1:54 PM
Due: Dec 5, 2019
Priority: 7 Day
Contact Name: ALL INVOICES

Eurofins Analytical Services Manager : Swati Shahaney

Sample Detail						% Clay	% Sand	% Silt	Cadmium	Chlorophyll a	Chromium	Copper	Lead	Mercury	Nickel	Silicon (Aqua regia extractable)	Tin	Total Organic Carbon	Zinc	Moisture Set	Eurofins | mgt Suite B19A: Total N (TKN, NOx), Total P
Melbourne Laboratory - NATA Site # 1254 & 14271									X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																					
Brisbane Laboratory - NATA Site # 20794						X	X	X													
Perth Laboratory - NATA Site # 23736																					
29	THYLACINE GS1_1	Nov 22, 2019		Filter paper	M19-No38261					X											
30	THYLACINE GS1_2	Nov 22, 2019		Filter paper	M19-No38262					X											
Test Counts						24	24	24	24	6	24	24	24	24	24	24	24	24	24	24	24

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram
ppm: Parts per million
org/100mL: Organisms per 100 millilitres
mg/L: milligrams per litre
ppb: Parts per billion
NTU: Nephelometric Turbidity Units
ug/L: micrograms per litre
%: Percentage
MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank									
% Clay			%	< 1			1	Pass	
Nitrate & Nitrite (as N)			mg/kg	< 5			5	Pass	
Total Kjeldahl Nitrogen (as N)			mg/kg	< 10			10	Pass	
Total Organic Carbon			%	< 0.1			0.1	Pass	
Method Blank									
Heavy Metals									
Cadmium			mg/kg	< 0.4			0.4	Pass	
Chromium			mg/kg	< 5			5	Pass	
Copper			mg/kg	< 5			5	Pass	
Lead			mg/kg	< 5			5	Pass	
Mercury			mg/kg	< 0.1			0.1	Pass	
Nickel			mg/kg	< 5			5	Pass	
Tin			mg/kg	< 10			10	Pass	
Zinc			mg/kg	< 5			5	Pass	
LCS - % Recovery									
% Clay			%	93			70-130	Pass	
Total Organic Carbon			%	107			70-130	Pass	
LCS - % Recovery									
Heavy Metals									
Cadmium			%	101			80-120	Pass	
Chromium			%	117			80-120	Pass	
Copper			%	118			80-120	Pass	
Lead			%	114			80-120	Pass	
Mercury			%	112			75-125	Pass	
Nickel			%	114			80-120	Pass	
Tin			%	112			80-120	Pass	
Zinc			%	116			80-120	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
Heavy Metals				Result 1					
Cadmium	M19-No38239	CP	%	94			75-125	Pass	
Chromium	M19-No38239	CP	%	83			75-125	Pass	
Copper	M19-No38239	CP	%	84			75-125	Pass	
Lead	M19-No38239	CP	%	87			75-125	Pass	
Mercury	M19-No38239	CP	%	101			70-130	Pass	
Nickel	M19-No38239	CP	%	85			75-125	Pass	
Tin	M19-No38239	CP	%	87			75-125	Pass	
Zinc	M19-No38239	CP	%	83			75-125	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
% Moisture	M19-De07683	NCP	%	3.0	3.0	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
% Clay	M19-Oc40940	NCP	%	5.0	6.3	22	30%	Pass	
% Sand	M19-Oc40940	NCP	%	91	90	1.0	30%	Pass	
% Silt	M19-Oc40940	NCP	%	3.8	3.8	<1	30%	Pass	
Nitrate & Nitrite (as N)	M19-No38234	CP	mg/kg	< 5	< 5	<1	30%	Pass	

Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Cadmium	M19-No38238	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M19-No38238	CP	mg/kg	5.7	5.8	1.0	30%	Pass	
Copper	M19-No38238	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Lead	M19-No38238	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Mercury	M19-No38238	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M19-No38238	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Tin	M19-No38238	CP	mg/kg	< 10	< 10	<1	30%	Pass	
Zinc	M19-No38238	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Cadmium	M19-No38239	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M19-No38239	CP	mg/kg	5.2	5.5	6.0	30%	Pass	
Copper	M19-No38239	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Lead	M19-No38239	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Mercury	M19-No38239	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M19-No38239	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Tin	M19-No38239	CP	mg/kg	< 10	< 10	<1	30%	Pass	
Zinc	M19-No38239	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Cadmium	M19-No38248	CP	mg/kg	< 0.4	< 0.4	<1	30%	Pass	
Chromium	M19-No38248	CP	mg/kg	6.9	6.8	1.0	30%	Pass	
Copper	M19-No38248	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Lead	M19-No38248	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Mercury	M19-No38248	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Nickel	M19-No38248	CP	mg/kg	< 5	< 5	<1	30%	Pass	
Tin	M19-No38248	CP	mg/kg	< 10	< 10	<1	30%	Pass	
Zinc	M19-No38248	CP	mg/kg	< 5	6.3	54	30%	Fail	Q15
Duplicate									
				Result 1	Result 2	RPD			
Total Organic Carbon	M19-No38249	CP	%	< 0.1	< 0.1	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
Q15	The RPD reported passes Eurofins Environment Testing's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

Authorised By

Robert Johnston	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal (VIC)
Jonathon Angell	Senior Analyst-Inorganic (QLD)
Julie Kay	Senior Analyst-Inorganic (VIC)
Scott Beddoes	Senior Analyst-Inorganic (VIC)

Glenn Jackson

General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

eurofins | Environment Testing

Certificate of Analysis

Ramboll Australia Pty Ltd
Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Serena Orr**

Report **700321-S**
Project name OTWAY OFFSHORE EBS
Project ID 318000803
Received Date Feb 05, 2020

Client Sample ID			**THYLACINE_GS1_3_MET1**	**THYLACINE_GS1_3_MET2**	**THYLACINE_GS1_MET2**	**THYLACINE_GS-1_MET1**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Fe05003**	**M20-Fe05004**	**M20-Fe05005**	**M20-Fe05006**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	20	mg/kg	< 20	< 20	< 20	< 20
TRH C10-C14	20	mg/kg	< 20	< 20	< 20	< 20
TRH C15-C28	50	mg/kg	< 50	< 50	< 50	< 50
TRH C29-C36	50	mg/kg	< 50	< 50	< 50	< 50
TRH C10-C36 (Total)	50	mg/kg	< 50	< 50	< 50	< 50
BTEX						
Benzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Toluene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Ethylbenzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
m&p-Xylenes	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
o-Xylene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Xylenes - Total	0.3	mg/kg	< 0.3	< 0.3	< 0.3	< 0.3
4-Bromofluorobenzene (surr.)	1	%	106	86	112	104
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
TRH C6-C10	20	mg/kg	< 20	< 20	< 20	< 20
TRH C6-C10 less BTEX (F1)[N04]	20	mg/kg	< 20	< 20	< 20	< 20
TRH >C10-C16	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C10-C16 less Naphthalene (F2)[N01]	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C16-C34	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C34-C40	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C10-C40 (total)*	100	mg/kg	< 100	< 100	< 100	< 100
Polycyclic Aromatic Hydrocarbons						
Benzo(a)pyrene TEQ (lower bound) *	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene TEQ (medium bound) *	0.5	mg/kg	0.6	0.6	0.6	0.6
Benzo(a)pyrene TEQ (upper bound) *	0.5	mg/kg	1.2	1.2	1.2	1.2
Acenaphthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphthylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benz(a)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(b&j)fluoranthene[N07]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(g.h.i)perylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(k)fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Chrysene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5

Client Sample ID			THYLACINE_GS1_3_MET1	THYLACINE_GS1_3_MET2	THYLACINE_GS1_MET2	THYLACINE_GS-1_MET1
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Fe05003**	**M20-Fe05004**	**M20-Fe05005**	**M20-Fe05006**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Polycyclic Aromatic Hydrocarbons						
Dibenz(a.h)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluorene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Indeno(1.2.3-cd)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Naphthalene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Phenanthrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Total PAH*	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
2-Fluorobiphenyl (surr.)	1	%	97	54	83	92
p-Terphenyl-d14 (surr.)	1	%	118	81	103	121
Polychlorinated Biphenyls						
Aroclor-1016	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1221	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1232	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1242	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1248	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1254	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1260	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Total PCB*	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Dibutylchlorendate (surr.)	1	%	78	99	78	132
Tetrachloro-m-xylene (surr.)	1	%	77	51	55	77
% Moisture	1	%	33	35	36	32

Client Sample ID			THYLACINE_GS1-2_MET1	THYLACINE_GS1-2_MET2	THYLACINE_GS2_MET1	THYLACINE_GS2_MET2
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Fe05007**	**M20-Fe05008**	**M20-Fe05009**	**M20-Fe05010**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	20	mg/kg	< 20	< 20	< 20	< 20
TRH C10-C14	20	mg/kg	< 20	< 20	< 20	< 20
TRH C15-C28	50	mg/kg	< 50	< 50	< 50	< 50
TRH C29-C36	50	mg/kg	< 50	< 50	< 50	< 50
TRH C10-C36 (Total)	50	mg/kg	< 50	< 50	< 50	< 50
BTEX						
Benzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Toluene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Ethylbenzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
m&p-Xylenes	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
o-Xylene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Xylenes - Total	0.3	mg/kg	< 0.3	< 0.3	< 0.3	< 0.3
4-Bromofluorobenzene (surr.)	1	%	110	62	55	61

Client Sample ID			THYLACINE_GS1-2_MET1	THYLACINE_GS1-2_MET2	THYLACINE_GS2_MET1	THYLACINE_GS2_MET2
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Fe05007**	**M20-Fe05008**	**M20-Fe05009**	**M20-Fe05010**
Date Sampled			Nov 22, 2019	Nov 22, 2019	Nov 22, 2019	Nov 22, 2019
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
TRH C6-C10	20	mg/kg	< 20	< 20	< 20	< 20
TRH C6-C10 less BTEX (F1)[N04]	20	mg/kg	< 20	< 20	< 20	< 20
TRH >C10-C16	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C10-C16 less Naphthalene (F2)[N01]	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C16-C34	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C34-C40	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C10-C40 (total)*	100	mg/kg	< 100	< 100	< 100	< 100
Polycyclic Aromatic Hydrocarbons						
Benzo(a)pyrene TEQ (lower bound) *	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene TEQ (medium bound) *	0.5	mg/kg	0.6	0.6	0.6	0.6
Benzo(a)pyrene TEQ (upper bound) *	0.5	mg/kg	1.2	1.2	1.2	1.2
Acenaphthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphthylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benz(a)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(b&j)fluoranthene[N07]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(g.h.i)perylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(k)fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Chrysene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Dibenz(a.h)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluorene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Indeno(1.2.3-cd)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Naphthalene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Phenanthrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Total PAH*	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
2-Fluorobiphenyl (surr.)	1	%	87	75	79	91
p-Terphenyl-d14 (surr.)	1	%	137	88	83	57
Polychlorinated Biphenyls						
Aroclor-1016	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1221	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1232	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1242	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1248	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1254	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1260	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Total PCB*	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Dibutylchlorendate (surr.)	1	%	139	112	105	64
Tetrachloro-m-xylene (surr.)	1	%	80	90	86	75
% Moisture	1	%	37	35	33	35

Client Sample ID			**ARTISON-GSA_MET1**	**ARTISON-GSA_MET2**	**ARTISON-GS3_MET1**	**ARTISON-GS3_MET 2**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Fe05011**	**M20-Fe05012**	**M20-Fe05013**	**M20-Fe05014**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Total Recoverable Hydrocarbons - 1999 NEPM Fractions						
TRH C6-C9	20	mg/kg	< 20	< 20	< 20	< 20
TRH C10-C14	20	mg/kg	< 20	< 20	< 20	< 20
TRH C15-C28	50	mg/kg	< 50	< 50	< 50	< 50
TRH C29-C36	50	mg/kg	< 50	< 50	< 50	< 50
TRH C10-C36 (Total)	50	mg/kg	< 50	< 50	< 50	< 50
BTEX						
Benzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Toluene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Ethylbenzene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
m&p-Xylenes	0.2	mg/kg	< 0.2	< 0.2	< 0.2	< 0.2
o-Xylene	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Xylenes - Total	0.3	mg/kg	< 0.3	< 0.3	< 0.3	< 0.3
4-Bromofluorobenzene (surr.)	1	%	62	57	106	55
Total Recoverable Hydrocarbons - 2013 NEPM Fractions						
Naphthalene[N02]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
TRH C6-C10	20	mg/kg	< 20	< 20	< 20	< 20
TRH C6-C10 less BTEX (F1)[N04]	20	mg/kg	< 20	< 20	< 20	< 20
TRH >C10-C16	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C10-C16 less Naphthalene (F2)[N01]	50	mg/kg	< 50	< 50	< 50	< 50
TRH >C16-C34	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C34-C40	100	mg/kg	< 100	< 100	< 100	< 100
TRH >C10-C40 (total)*	100	mg/kg	< 100	< 100	< 100	< 100
Polycyclic Aromatic Hydrocarbons						
Benzo(a)pyrene TEQ (lower bound) *	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene TEQ (medium bound) *	0.5	mg/kg	0.6	0.6	0.6	0.6
Benzo(a)pyrene TEQ (upper bound) *	0.5	mg/kg	1.2	1.2	1.2	1.2
Acenaphthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphthylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benz(a)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(b&j)fluoranthene[N07]	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(g.h.i)perylene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(k)fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Chrysene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Dibenz(a.h)anthracene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluoranthene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Fluorene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Indeno(1.2.3-cd)pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Naphthalene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Phenanthrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Pyrene	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Total PAH*	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
2-Fluorobiphenyl (surr.)	1	%	60	77	58	67
p-Terphenyl-d14 (surr.)	1	%	59	125	147	56

Environment Testing

Client Sample ID			ARTISON-GSA_MET1	ARTISON-GSA_MET2	ARTISON-GS3_MET1	ARTISON-GS3_MET 2
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**M20-Fe05011**	**M20-Fe05012**	**M20-Fe05013**	**M20-Fe05014**
Date Sampled			**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**	**Nov 22, 2019**
Test/Reference	LOR	Unit				
Polychlorinated Biphenyls						
Aroclor-1016	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1221	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1232	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1242	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1248	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1254	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Aroclor-1260	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Total PCB*	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Dibutylchlorendate (surr.)	1	%	73	89	115	110
Tetrachloro-m-xylene (surr.)	1	%	64	88	54	72
% Moisture	1	%	33	30	34	34

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Total Recoverable Hydrocarbons - 1999 NEPM Fractions	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Total Recoverable Hydrocarbons - 2013 NEPM Fractions	Melbourne	Feb 05, 2020	
- Method: LTM-ORG-2010 TRH C6-C40			
BTEX	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-ORG-2010 TRH C6-C40			
Polycyclic Aromatic Hydrocarbons	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-ORG-2130 PAH and Phenols in Soil and Water			
Polychlorinated Biphenyls	Melbourne	Feb 05, 2020	28 Days
- Method: LTM-ORG-2220 OCP & PCB in Soil and Water (USEPA 8082)			
% Moisture	Melbourne	Feb 05, 2020	14 Days
- Method: LTM-GEN-7080 Moisture			

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 700321
Phone: 08 9225 5199
Fax:

Received: Feb 5, 2020 3:36 AM
Due: Feb 12, 2020
Priority: 5 Day
Contact Name: Serena Orr

Eurofins Analytical Services Manager : Robert Johnston

Sample Detail						Polycyclic Aromatic Hydrocarbons	Polychlorinated Biphenyls	BTEX	Moisture Set	Total Recoverable Hydrocarbons
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X
Sydney Laboratory - NATA Site # 18217										
Brisbane Laboratory - NATA Site # 20794										
Perth Laboratory - NATA Site # 23736										
External Laboratory										
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**					
1	THYLACINE_GS1_3_MET1	Nov 22, 2019		Soil	M20-Fe05003	X	X	X	X	X
2	THYLACINE_GS1_3_MET2	Nov 22, 2019		Soil	M20-Fe05004	X	X	X	X	X
3	THYLACINE_GS1_MET2	Nov 22, 2019		Soil	M20-Fe05005	X	X	X	X	X
4	THYLACINE_GS-1_MET1	Nov 22, 2019		Soil	M20-Fe05006	X	X	X	X	X
5	THYLACINE_GS1-2_MET1	Nov 22, 2019		Soil	M20-Fe05007	X	X	X	X	X
6	THYLACINE_GS1-2_MET2	Nov 22, 2019		Soil	M20-Fe05008	X	X	X	X	X

Company Name: Ramboll Australia Pty Ltd
Address: Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

Project Name: OTWAY OFFSHORE EBS
Project ID: 318000803

Order No.:
Report #: 700321
Phone: 08 9225 5199
Fax:

Received: Feb 5, 2020 3:36 AM
Due: Feb 12, 2020
Priority: 5 Day
Contact Name: Serena Orr

Eurofins Analytical Services Manager : Robert Johnston

Sample Detail						Polycyclic Aromatic Hydrocarbons	Polychlorinated Biphenyls	BTEX	Moisture Set	Total Recoverable Hydrocarbons
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X	X	X	X
Sydney Laboratory - NATA Site # 18217										
Brisbane Laboratory - NATA Site # 20794										
Perth Laboratory - NATA Site # 23736										
7	THYLACINE_GS2_MET1	Nov 22, 2019		Soil	M20-Fe05009	X	X	X	X	X
8	THYLACINE_GS2_MET2	Nov 22, 2019		Soil	M20-Fe05010	X	X	X	X	X
9	ARTISON-GSA_MET1	Nov 22, 2019		Soil	M20-Fe05011	X	X	X	X	X
10	ARTISON-GSA_MET2	Nov 22, 2019		Soil	M20-Fe05012	X	X	X	X	X
11	ARTISON-GS3_MET1	Nov 22, 2019		Soil	M20-Fe05013	X	X	X	X	X
12	ARTISON-GS3_MET 2	Nov 22, 2019		Soil	M20-Fe05014	X	X	X	X	X
Test Counts						12	12	12	12	12

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram
ppm: Parts per million
org/100mL: Organisms per 100 millilitres
mg/L: milligrams per litre
ppb: Parts per billion
NTU: Nephelometric Turbidity Units
ug/L: micrograms per litre
%: Percentage
MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	mg/kg	< 20			20	Pass	
TRH C10-C14	mg/kg	< 20			20	Pass	
TRH C15-C28	mg/kg	< 50			50	Pass	
TRH C29-C36	mg/kg	< 50			50	Pass	
Method Blank							
BTEX							
Benzene	mg/kg	< 0.1			0.1	Pass	
Toluene	mg/kg	< 0.1			0.1	Pass	
Ethylbenzene	mg/kg	< 0.1			0.1	Pass	
m&p-Xylenes	mg/kg	< 0.2			0.2	Pass	
o-Xylene	mg/kg	< 0.1			0.1	Pass	
Xylenes - Total	mg/kg	< 0.3			0.3	Pass	
Method Blank							
Total Recoverable Hydrocarbons - 2013 NEPM Fractions							
Naphthalene	mg/kg	< 0.5			0.5	Pass	
TRH C6-C10	mg/kg	< 20			20	Pass	
TRH >C10-C16	mg/kg	< 50			50	Pass	
TRH >C16-C34	mg/kg	< 100			100	Pass	
TRH >C34-C40	mg/kg	< 100			100	Pass	
Method Blank							
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	mg/kg	< 0.5			0.5	Pass	
Acenaphthylene	mg/kg	< 0.5			0.5	Pass	
Anthracene	mg/kg	< 0.5			0.5	Pass	
Benz(a)anthracene	mg/kg	< 0.5			0.5	Pass	
Benzo(a)pyrene	mg/kg	< 0.5			0.5	Pass	
Benzo(b&j)fluoranthene	mg/kg	< 0.5			0.5	Pass	
Benzo(g.h.i)perylene	mg/kg	< 0.5			0.5	Pass	
Benzo(k)fluoranthene	mg/kg	< 0.5			0.5	Pass	
Chrysene	mg/kg	< 0.5			0.5	Pass	
Dibenz(a.h)anthracene	mg/kg	< 0.5			0.5	Pass	
Fluoranthene	mg/kg	< 0.5			0.5	Pass	
Fluorene	mg/kg	< 0.5			0.5	Pass	
Indeno(1.2.3-cd)pyrene	mg/kg	< 0.5			0.5	Pass	
Naphthalene	mg/kg	< 0.5			0.5	Pass	
Phenanthrene	mg/kg	< 0.5			0.5	Pass	
Pyrene	mg/kg	< 0.5			0.5	Pass	
Method Blank							
Polychlorinated Biphenyls							
Aroclor-1016	mg/kg	< 0.1			0.1	Pass	
Aroclor-1221	mg/kg	< 0.1			0.1	Pass	
Aroclor-1232	mg/kg	< 0.1			0.1	Pass	
Aroclor-1242	mg/kg	< 0.1			0.1	Pass	
Aroclor-1248	mg/kg	< 0.1			0.1	Pass	
Aroclor-1254	mg/kg	< 0.1			0.1	Pass	
Aroclor-1260	mg/kg	< 0.1			0.1	Pass	
Total PCB*	mg/kg	< 0.1			0.1	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons - 1999 NEPM Fractions							
TRH C6-C9	%	96			70-130	Pass	

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
TRH C10-C14			%	85			70-130	Pass	
LCS - % Recovery									
BTEX									
Benzene			%	100			70-130	Pass	
Toluene			%	98			70-130	Pass	
Ethylbenzene			%	91			70-130	Pass	
m&p-Xylenes			%	93			70-130	Pass	
Xylenes - Total			%	94			70-130	Pass	
LCS - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions									
Naphthalene			%	120			70-130	Pass	
TRH C6-C10			%	91			70-130	Pass	
TRH >C10-C16			%	81			70-130	Pass	
LCS - % Recovery									
Polycyclic Aromatic Hydrocarbons									
Acenaphthene			%	109			70-130	Pass	
Acenaphthylene			%	117			70-130	Pass	
Anthracene			%	124			70-130	Pass	
Benz(a)anthracene			%	120			70-130	Pass	
Benzo(a)pyrene			%	96			70-130	Pass	
Benzo(b&j)fluoranthene			%	108			70-130	Pass	
Benzo(g.h.i)perylene			%	90			70-130	Pass	
Benzo(k)fluoranthene			%	86			70-130	Pass	
Chrysene			%	95			70-130	Pass	
Dibenz(a.h)anthracene			%	103			70-130	Pass	
Fluoranthene			%	120			70-130	Pass	
Fluorene			%	119			70-130	Pass	
Indeno(1.2.3-cd)pyrene			%	99			70-130	Pass	
Naphthalene			%	107			70-130	Pass	
Phenanthrene			%	110			70-130	Pass	
Pyrene			%	120			70-130	Pass	
LCS - % Recovery									
Polychlorinated Biphenyls									
Aroclor-1260			%	105			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1					
TRH C6-C9	N20-Fe00759	NCP	%	89			70-130	Pass	
TRH C10-C14	N20-Fe03039	NCP	%	79			70-130	Pass	
Spike - % Recovery									
BTEX				Result 1					
Benzene	N20-Fe00759	NCP	%	93			70-130	Pass	
Toluene	N20-Fe00759	NCP	%	93			70-130	Pass	
Ethylbenzene	N20-Fe00759	NCP	%	84			70-130	Pass	
m&p-Xylenes	N20-Fe00759	NCP	%	86			70-130	Pass	
o-Xylene	N20-Fe00759	NCP	%	91			70-130	Pass	
Xylenes - Total	N20-Fe00759	NCP	%	88			70-130	Pass	
Spike - % Recovery									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1					
Naphthalene	N20-Fe00759	NCP	%	100			70-130	Pass	
TRH C6-C10	N20-Fe00759	NCP	%	87			70-130	Pass	
TRH >C10-C16	N20-Fe03039	NCP	%	77			70-130	Pass	
Spike - % Recovery									
Polycyclic Aromatic Hydrocarbons				Result 1					

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Acenaphthene	S20-Ja29582	NCP	%	87			70-130	Pass	
Acenaphthylene	S20-Ja29582	NCP	%	91			70-130	Pass	
Anthracene	S20-Ja29582	NCP	%	94			70-130	Pass	
Benz(a)anthracene	S20-Ja29582	NCP	%	87			70-130	Pass	
Benzo(a)pyrene	S20-Ja29582	NCP	%	113			70-130	Pass	
Benzo(b&j)fluoranthene	S20-Ja29582	NCP	%	102			70-130	Pass	
Benzo(g.h.i)perylene	S20-Ja29582	NCP	%	101			70-130	Pass	
Benzo(k)fluoranthene	S20-Ja29582	NCP	%	84			70-130	Pass	
Chrysene	S20-Ja29582	NCP	%	95			70-130	Pass	
Dibenz(a.h)anthracene	S20-Ja29582	NCP	%	105			70-130	Pass	
Fluoranthene	S20-Ja29582	NCP	%	90			70-130	Pass	
Fluorene	S20-Ja29582	NCP	%	95			70-130	Pass	
Indeno(1.2.3-cd)pyrene	S20-Ja29582	NCP	%	112			70-130	Pass	
Naphthalene	S20-Ja29582	NCP	%	128			70-130	Pass	
Phenanthrene	S20-Ja29582	NCP	%	85			70-130	Pass	
Pyrene	S20-Ja29582	NCP	%	86			70-130	Pass	
Spike - % Recovery									
Polychlorinated Biphenyls				Result 1					
Aroclor-1016	M20-Ja30810	NCP	%	88			70-130	Pass	
Aroclor-1260	M20-Ja30810	NCP	%	90			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
Polycyclic Aromatic Hydrocarbons				Result 1	Result 2	RPD			
Acenaphthene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Acenaphthylene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Anthracene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benz(a)anthracene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(a)pyrene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(b&j)fluoranthene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(g.h.i)perylene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Benzo(k)fluoranthene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Chrysene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Dibenz(a.h)anthracene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Fluoranthene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Fluorene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Indeno(1.2.3-cd)pyrene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Naphthalene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Phenanthrene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Pyrene	M20-Fe03903	NCP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
% Moisture	M20-Fe05006	CP	%	32	32	<1	30%	Pass	
Duplicate									
Polychlorinated Biphenyls				Result 1	Result 2	RPD			
Aroclor-1016	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Aroclor-1221	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Aroclor-1232	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Aroclor-1242	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Aroclor-1248	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Aroclor-1254	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Aroclor-1260	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Total PCB*	S20-Fe01881	NCP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1	Result 2	RPD			
TRH C6-C9	M20-Fe05012	CP	mg/kg	< 20	< 20	<1	30%	Pass	

Duplicate									
BTEX				Result 1	Result 2	RPD			
Benzene	M20-Fe05012	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Toluene	M20-Fe05012	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Ethylbenzene	M20-Fe05012	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
m&p-Xylenes	M20-Fe05012	CP	mg/kg	< 0.2	< 0.2	<1	30%	Pass	
o-Xylene	M20-Fe05012	CP	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
Xylenes - Total	M20-Fe05012	CP	mg/kg	< 0.3	< 0.3	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
Naphthalene	M20-Fe05012	CP	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
TRH C6-C10	M20-Fe05012	CP	mg/kg	< 20	< 20	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 1999 NEPM Fractions				Result 1	Result 2	RPD			
TRH C10-C14	M20-Fe05014	CP	mg/kg	< 20	< 20	<1	30%	Pass	
TRH C15-C28	M20-Fe05014	CP	mg/kg	< 50	< 50	<1	30%	Pass	
TRH C29-C36	M20-Fe05014	CP	mg/kg	< 50	< 50	<1	30%	Pass	
Duplicate									
Total Recoverable Hydrocarbons - 2013 NEPM Fractions				Result 1	Result 2	RPD			
TRH >C10-C16	M20-Fe05014	CP	mg/kg	< 50	< 50	<1	30%	Pass	
TRH >C16-C34	M20-Fe05014	CP	mg/kg	< 100	< 100	<1	30%	Pass	
TRH >C34-C40	M20-Fe05014	CP	mg/kg	< 100	< 100	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	No
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
N01	F2 is determined by arithmetically subtracting the "naphthalene" value from the ">C10-C16" value. The naphthalene value used in this calculation is obtained from volatiles (Purge & Trap analysis).
N02	Where we have reported both volatile (P&T GCMS) and semivolatile (GCMS) naphthalene data, results may not be identical. Provided correct sample handling protocols have been followed, any observed differences in results are likely to be due to procedural differences within each methodology. Results determined by both techniques have passed all QAQC acceptance criteria, and are entirely technically valid.
N04	F1 is determined by arithmetically subtracting the "Total BTEX" value from the "C6-C10" value. The "Total BTEX" value is obtained by summing the concentrations of BTEX analytes. The "C6-C10" value is obtained by quantitating against a standard of mixed aromatic/aliphatic analytes.
N07	Please note:- These two PAH isomers closely co-elute using the most contemporary analytical methods and both the reported concentration (and the TEQ) apply specifically to the total of the two co-eluting PAHs

Authorised By

Robert Johnston	Analytical Services Manager
Harry Bacalis	Senior Analyst-Volatile (VIC)
Joseph Edouard	Senior Analyst-Organic (VIC)

Glenn Jackson

General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

APPENDIX 4
DROP CAMERA SITES (GDA94 UTM 54 S)

Date	Site	Easting	Northing	Depth (m LAT)
31/10/2019	DC_AR2	664260	5693556	69.5
	DC_AR3	663741	5694457	69.6
	DC_AR4	662262	5693605	70.8
	DC_AR1	662782	5692701	70.9
20/11/2019	DC_TH5	658145	5656139	107.1
21/11/2019	DC_TH8	657791	5656967	104.9
	DC_TH8_4m	657796	5656969	104.9
	DC_TH8_8m	657800	5656972	104.9
	DC_TH6	659801	5656919	101.9
	DC_TH6_4m	659810	5656925	101.9
	DC_TH6_8m	659810	5656923	101.9
	DC_TH7	659211	5657774	103.5
	DC_TH7_4m	659213	5657774	103.5
9/12/2019	DC_TH4	660880	5658431	98.9
	DC_TH4_2m	660880	5658428	98.9
	DC_TH4_5m	660881	5658432	98.9
	DC_TH1	661398	5657534	96.8
	DC_TH1_2m	661397	5657532	96.8
	DC_TH1_5m	661397	5657539	96.8
	DC_TH2	662970	5658384	96.9
	DC_TH2_2m	662972	5658383	96.9
	DC_TH2_5m	662975	5658387	96.9
	DC_TH3	662409	5659275	98.2
	DC_TH3_2m	662412	5659274	98.2
	DC_TH3_5m	662406	5659277	98.2
25/12/2019	DC_GE1	668217	5668519	85.6
	DC_GE2	669700	5669375	85.0
	DC_GE2_2m	669703	5669375	85.0
	DC_GE2_5m	669704	5669377	85.0
	DC_GE3	669179	5670280	82.3
	DC_GE3_2m	669180	5670279	82.3
	DC_GE3_5m	669184	5670277	82.3
	DC_GE4	667699	5669424	83.4
	DC_GE4_2m	667700	5669424	83.4
	DC_GE4_5m	667704	5669422	83.4
28/12/2019	DC_LB1	647832	5681521	92.5
	DC_LB1_2m	647831	5681519	92.5
	DC_LB1_5m	647831	5681516	92.5
	DC_LB4	646558	5680703	97.8
	DC_LB4_2m	646560	5680702	97.8

Date	Site	Easting	Northing	Depth (m LAT)
	DC_LB4_5m	646560	5680700	97.8
	DC_LB4_Extra	646438	5680699	97.8
21/01/2020	DC_LB2R	645891	5681544	93.1
	DC_LB2R_2m	645889	5681543	93.1
	DC_LB2R_5m	645891	5681541	93.1
	DC_LB3R	647415	5682484	93.6
	DC_LB3R_2m	647415	5682479	93.6
	DC_LB3R_5m	647418	5682479	93.6
	DC_HE4R	662560	5687719	74.3
	DC_HE4R_1m	662560	5687719	74.3
	DC_HE4R_3m	662557	5687717	74.3
	DC_HE2	662068	5688635	74.3
	DC_HE2_1m	662066	5688636	74.3
	DC_HE2_3m	662064	5688637	74.3
	DC_HE1	664068	5688640	73.4
	DC_HE1_1m	664068	5688643	73.4
	DC_HE1_3m	664066	5688641	73.4
	DC_HE3	663548	5689514	73.8
	DC_HE3_1m	663548	5689515	73.8
	DC_HE3_3m	663544	5689514	73.8
	DC_HTX1R	669286	5688662	72.9
	DC_HTX1R_1m	669286	5688661	72.9
	DC_HTX1R_2m	669290	5688661	72.9
22/01/2020	DC_ARHTX1R	665451	5691790	70.5
	DC_ARHTX1R_2m	665452	5691788	70.5
	DC_ARHTX1R_5m	665452	5691788	70.5
29/01/2020	DC_ARHTY1R	665896	5694722	69.3
	DC_ARHTY1R_B	665895	5694725	69.3
	DC_ARHTY1R_C	665899	5694726	69.3
	DC_HTY1R_A	670385	5696817	67.9
	DC_HTY1R_B	670382	5696816	67.9
	DC_HTY1R_C	670384	5696816	67.9
	DC_ARGE3R_A	665383	5684033	76.4
	DC_ARGE3R_B	665383	5684033	76.8
	DC_ARGE3R_C	665382	5684030	76.7
	DC_ARGE3R_D	665381	5684028	76.2
	DC_ARGE6R_A	667106	5676840	76.9
	DC_ARGE6R_B	667108	5676837	74.7
	DC_ARGE6R_C	667109	5676835	77.6
	DC_ARGE7R_A	667735	5673842	79.4

Date	Site	Easting	Northing	Depth (m LAT)
30/01/2020	DC_ARGE7R_B	667735	5673845	79.4
	DC_ARGE7R_C	667736	5673849	79.4
	DC_ARLB2R_A	659391	5690760	73.6
	DC_ARLB2R_B	659390	5690760	73.6
	DC_ARLB2R_C	659391	5690757	73.6
	DC_ARLB6R_A	651030	5684616	87.1
	DC_ARLB6R_B	651030	5684615	87.1
	DC_ARLB6R_C	651031	5684613	87.1
	DC_LBGE3R_A	653038	5677641	98.5
	DC_LBGE3R_B	653039	5677640	98.5
	DC_LBGE3R_C	653040	5677638	98.5
	DC_LBGE6R_A	659466	5673506	88.2
	DC_LBGE6R_B	659467	5673504	88.2
	DC_LBGE6R_C	659468	5673503	88.2

APPENDIX 5
SEABED PHOTOGRAPH ASSESSMENT DATA

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
ARGE	Routes_ARGE_ARGE3R_A_00001	20									
ARGE	Routes_ARGE_ARGE3R_A_00002	10							1		
ARGE	Routes_ARGE_ARGE3R_A_00005	15		5	1						
ARGE	Routes_ARGE_ARGE3R_A_00006	25									
ARGE	Routes_ARGE_ARGE3R_A_00007	5		1							
ARGE	Routes_ARGE_ARGE3R_B_00005	15									
ARGE	Routes_ARGE_ARGE3R_B_00006	5									
ARGE	Routes_ARGE_ARGE3R_B_00007	5									
ARGE	Routes_ARGE_ARGE3R_C_00001	0									
ARGE	Routes_ARGE_ARGE3R_C_00003	5									
ARGE	Routes_ARGE_ARGE3R_C_00004	0									
ARGE	Routes_ARGE_ARGE3R_C_00005	5									
ARGE	Routes_ARGE_ARGE6R_A_00001	0									
ARGE	Routes_ARGE_ARGE6R_A_00002	0									
ARGE	Routes_ARGE_ARGE6R_A_00003	5									
ARGE	Routes_ARGE_ARGE6R_A_00004	0									
ARGE	Routes_ARGE_ARGE6R_A_00005	0									
ARGE	Routes_ARGE_ARGE6R_A_00006	0									
ARGE	Routes_ARGE_ARGE6R_A_00007	5									
ARGE	Routes_ARGE_ARGE6R_B_00001	0									
ARGE	Routes_ARGE_ARGE6R_B_00002	5									
ARGE	Routes_ARGE_ARGE6R_B_00003	5									
ARGE	Routes_ARGE_ARGE6R_B_00005	5									
ARGE	Routes_ARGE_ARGE6R_B_00006	5									
ARGE	Routes_ARGE_ARGE6R_B_00007	5									
ARGE	Routes_ARGE_ARGE6R_B_00008	0									
ARGE	Routes_ARGE_ARGE6R_B_00009	5									
ARGE	Routes_ARGE_ARGE6R_C_00001	5									
ARGE	Routes_ARGE_ARGE6R_C_00002	0									
ARGE	Routes_ARGE_ARGE6R_C_00003	5									
ARGE	Routes_ARGE_ARGE6R_C_00004	0									1
ARGE	Routes_ARGE_ARGE6R_C_00005	0		1							
ARGE	Routes_ARGE_ARGE7R_A_00001	5									
ARGE	Routes_ARGE_ARGE7R_A_00002	15									
ARGE	Routes_ARGE_ARGE7R_A_00004	10									
ARGE	Routes_ARGE_ARGE7R_A_00005	25		1							
ARGE	Routes_ARGE_ARGE7R_B_00004	5									
ARGE	Routes_ARGE_ARGE7R_B_00005	10									
ARGE	Routes_ARGE_ARGE7R_B_00006	20									
ARGE	Routes_ARGE_ARGE7R_B_00007	15									
ARGE	Routes_ARGE_ARGE7R_B_00008	20									
ARGE	Routes_ARGE_ARGE7R_B_00009	20									
ARGE	Routes_ARGE_ARGE7R_B_00011	25		1							
ARGE	Routes_ARGE_ARGE7R_B_00012	15				1					

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
ARGE	Routes_ARGE_ARGE7R_B_00015	25									
ARGE	Routes_ARGE_ARGE7R_C_00001	35									
ARGE	Routes_ARGE_ARGE7R_C_00002	10									
ARGE	Routes_ARGE_ARGE7R_C_00004	35									
ARGE	Routes_ARGE_ARGE7R_C_00005	5									1
ARGE	Routes_ARGE_ARGE7R_C_00006	30		1							
ARHTY	Routes_ARHTY_ARHTYR1_A_00001	0									
ARHTY	Routes_ARHTY_ARHTYR1_A_00002	0									
ARHTY	Routes_ARHTY_ARHTYR1_A_00003	20									
ARHTY	Routes_ARHTY_ARHTYR1_A_00004	25									
ARHTY	Routes_ARHTY_ARHTYR1_A_00005	0									
ARHTY	Routes_ARHTY_ARHTYR1_A_00006	0									
ARHTY	Routes_ARHTY_ARHTYR1_A_00008	0									1
ARHTY	Routes_ARHTY_ARHTYR1_A_00009	0						1			
ARHTY	Routes_ARHTY_ARHTYR1_B_00001	0									
ARHTY	Routes_ARHTY_ARHTYR1_B_00003	0									
ARHTY	Routes_ARHTY_ARHTYR1_B_00004	0									
ARHTY	Routes_ARHTY_ARHTYR1_B_00005	0									
ARHTY	Routes_ARHTY_ARHTYR1_B_00006	0									
ARHTY	Routes_ARHTY_ARHTYR1_B_00008	0									
ARHTY	Routes_ARHTY_ARHTYR1_C_00001	40	1								
ARHTY	Routes_ARHTY_ARHTYR1_C_00002	0									
ARHTY	Routes_ARHTY_ARHTYR1_C_00004	20									
ARHTY	Routes_ARHTY_ARHTYR1_C_00006	5									
ARHTY	Routes_ARHTY_ARHTYR1_C_00007	0		1							
ARHTY	Routes_ARHTY_ARHTYR1_C_00008	0									
ARHTY	Routes_ARHTY_ARHTYR1_C_00009	0								1	
ARLB	Routes_ARLB_ARLB2R_A_00001	20									
ARLB	Routes_ARLB_ARLB2R_A_00005	20									
ARLB	Routes_ARLB_ARLB2R_A_00006	20									
ARLB	Routes_ARLB_ARLB2R_A_00007	30									
ARLB	Routes_ARLB_ARLB2R_A_00008	15		1							
ARLB	Routes_ARLB_ARLB2R_A_00009	20									
ARLB	Routes_ARLB_ARLB2R_A_00010	20									
ARLB	Routes_ARLB_ARLB2R_B_00001	5									
ARLB	Routes_ARLB_ARLB2R_B_00002	20									
ARLB	Routes_ARLB_ARLB2R_B_00003	20		2	1						
ARLB	Routes_ARLB_ARLB2R_B_00004	20									
ARLB	Routes_ARLB_ARLB2R_B_00005	20									
ARLB	Routes_ARLB_ARLB2R_C_00001	5		1							
ARLB	Routes_ARLB_ARLB2R_C_00003	5									
ARLB	Routes_ARLB_ARLB2R_C_00004	0									
ARLB	Routes_ARLB_ARLB2R_C_00005	5									
ARLB	Routes_ARLB_ARLB2R_C_00006	5		1							

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
ARLB	Routes_ARLB_ARLB6R_A_00002	0									
ARLB	Routes_ARLB_ARLB6R_A_00003	5				1					
ARLB	Routes_ARLB_ARLB6R_A_00004	0									
ARLB	Routes_ARLB_ARLB6R_A_00005	5		1							
ARLB	Routes_ARLB_ARLB6R_B_00001	0									
ARLB	Routes_ARLB_ARLB6R_B_00002	0									
ARLB	Routes_ARLB_ARLB6R_B_00004	0									
ARLB	Routes_ARLB_ARLB6R_B_00005	0									
ARLB	Routes_ARLB_ARLB6R_B_00006	0		3							
ARLB	Routes_ARLB_ARLB6R_C_00001	0									
ARLB	Routes_ARLB_ARLB6R_C_00002	0									
ARLB	Routes_ARLB_ARLB6R_C_00003	0									
ARLB	Routes_ARLB_ARLB6R_C_00004	0									
ARLB	Routes_ARLB_ARLB6R_C_00005	0		1							
ARLB	Routes_ARLB_ARLB6R_C_00007	5		2							
Artisan	Artisan_AR1_00015	30									
Artisan	Artisan_AR1_00017	5									
Artisan	Artisan_AR1_00029	40		3							
Artisan	Artisan_AR1_00035	30		1							
Artisan	Artisan_AR2_00007	35									
Artisan	Artisan_AR2_00008	15									
Artisan	Artisan_AR2_00011	40									
Artisan	Artisan_AR2_00012	30		1							
Artisan	Artisan_AR3_00004	20									
Artisan	Artisan_AR3_00006	15									
Artisan	Artisan_AR3_00008	5									
Artisan	Artisan_AR3_00015	40									
Artisan	Artisan_AR3_00017	25									
Artisan	Artisan_AR3_00018	20		1							
Artisan	Artisan_AR3_00019	10									
Artisan	Artisan_AR3_00022	5									
Artisan	Artisan_AR3_00023	25									
Artisan	Artisan_AR4_00004	30		3							
Artisan	Artisan_AR4_00005	5									
Artisan	Artisan_AR4_00007	20		2							
Artisan	Artisan_AR4_00009	10									
Artisan	Artisan_AR4_00012	45									
Artisan	Artisan_AR4_00013	30									
Artisan	Artisan_AR4_00016	10		1							
Artisan	Artisan_AR4_00017	30		1							
Artisan	Artisan_AR4_00018	20		1							
Artisan	Artisan_AR4_00019	5		1							
Artisan	Artisan_AR4_00025	15		2							
Artisan	Artisan_AR4_00031	15		3							

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
Artisan	Artisan_AR4_00034	40									
Geographe	Geographe_GE1_A_00004	55									
Geographe	Geographe_GE1_A_00007	35									
Geographe	Geographe_GE1_A_00008	45		2							
Geographe	Geographe_GE1_B_00001	0									
Geographe	Geographe_GE1_B_00002	0	1								
Geographe	Geographe_GE1_B_00004	5									
Geographe	Geographe_GE1_B_00005	5									
Geographe	Geographe_GE1_C_00001	5									
Geographe	Geographe_GE1_C_00005	25	1								
Geographe	Geographe_GE2_A_00001	5									
Geographe	Geographe_GE2_A_00002	5									
Geographe	Geographe_GE2_A_00003	10	1								
Geographe	Geographe_GE2_A_00005	25									
Geographe	Geographe_GE2_B_00002	5									
Geographe	Geographe_GE2_B_00003	5									
Geographe	Geographe_GE2_C_00002	0									
Geographe	Geographe_GE2_C_00004	0									
Geographe	Geographe_GE2_C_00005	0									
Geographe	Geographe_GE3_A_00001	5									
Geographe	Geographe_GE3_A_00003	5									
Geographe	Geographe_GE3_A_00005	25									
Geographe	Geographe_GE3_B_00001	5									
Geographe	Geographe_GE3_B_00003	20									
Geographe	Geographe_GE3_B_00005	30									
Geographe	Geographe_GE3_C_00002	35									
Geographe	Geographe_GE3_C_00005	40		1							
Geographe	Geographe_GE3_C_00006	10									
Geographe	Geographe_GE4_A_00002	35									
Geographe	Geographe_GE4_A_00004	5									
Geographe	Geographe_GE4_A_00005	30									
Geographe	Geographe_GE4_A_00006	0		1							
Geographe	Geographe_GE4_B_00002	5									
Geographe	Geographe_GE4_B_00003	5									
Geographe	Geographe_GE4_B_00005	0									
Geographe	Geographe_GE4_C_00001	5									
Geographe	Geographe_GE4_C_00002	0									
Geographe	Geographe_GE4_C_00003	0									
Geographe	Geographe_GE4_C_00005	0									
Hercules	Hercules_HE1_A_00002	20									
Hercules	Hercules_HE1_A_00003	0									
Hercules	Hercules_HE1_A_00004	35									
Hercules	Hercules_HE1_A_00005	0									
Hercules	Hercules_HE1_A_00006	35									

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
Hercules	Hercules_HE1_B_00001	45									
Hercules	Hercules_HE1_B_00002	35									
Hercules	Hercules_HE1_B_00004	15									
Hercules	Hercules_HE1_B_00005	5									
Hercules	Hercules_HE1_C_00001	5									
Hercules	Hercules_HE1_C_00002	20									
Hercules	Hercules_HE1_C_00005	25									
Hercules	Hercules_HE1_C_00006	30				1					
Hercules	Hercules_HE1_C_00007	30				1					
Hercules	Hercules_HE2_A_00001	30				1					
Hercules	Hercules_HE2_A_00002	5									
Hercules	Hercules_HE2_A_00003	30	1								
Hercules	Hercules_HE2_A_00004	5									
Hercules	Hercules_HE2_A_00005	60									
Hercules	Hercules_HE2_A_00006	25									
Hercules	Hercules_HE2_B_00002	60									
Hercules	Hercules_HE2_B_00004	80									
Hercules	Hercules_HE2_B_00005	25		1							
Hercules	Hercules_HE2_B_00006	75									
Hercules	Hercules_HE2_C_00002	5									
Hercules	Hercules_HE2_C_00003	25									
Hercules	Hercules_HE2_C_00004	20									
Hercules	Hercules_HE2_C_00007	20									
Hercules	Hercules_HE2_C_00009	25									
Hercules	Hercules_HE3_A_00001	50									
Hercules	Hercules_HE3_A_00003	45									
Hercules	Hercules_HE3_A_00005	40		1							
Hercules	Hercules_HE3_B_00001	30									
Hercules	Hercules_HE3_B_00002	40									
Hercules	Hercules_HE3_B_00004	15									
Hercules	Hercules_HE3_B_00005	25									
Hercules	Hercules_HE3_B_00006	30		1							
Hercules	Hercules_HE3_C_00001	5									
Hercules	Hercules_HE3_C_00002	40									
Hercules	Hercules_HE3_C_00003	0						1			
Hercules	Hercules_HE3_C_00005	35			1						
Hercules	Hercules_HE3_C_00007	0									
Hercules	Hercules_HE3_C_00008	5									
Hercules	Hercules_HE4_A_00001	5									
Hercules	Hercules_HE4_A_00002	25									
Hercules	Hercules_HE4_A_00004	15									
Hercules	Hercules_HE4_A_00005	0									
Hercules	Hercules_HE4_B_00001	30									
Hercules	Hercules_HE4_B_00003	15									

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
Hercules	Hercules_HE4_B_00004	40									
Hercules	Hercules_HE4_B_00005	15									
Hercules	Hercules_HE4_B_00008	15									
Hercules	Hercules_HE4_B_00009	20									
Hercules	Hercules_HE4_B_00010	25									
Hercules	Hercules_HE4_C_00001	30									
Hercules	Hercules_HE4_C_00002	0									
Hercules	Hercules_HE4_C_00003	0	1								
Hercules	Hercules_HE4_C_00004	20									
Hercules	Hercules_HE4_C_00005	5									
Hot Tap X	HotTap_HTX_HTX1R_A_00006	40									
Hot Tap X	HotTap_HTX_HTX1R_B_00004	25		1							
Hot Tap X	HotTap_HTX_HTX1R_B_00005	15									
Hot Tap X	HotTap_HTX_HTX1R_B_00007	50	1								
Hot Tap X	HotTap_HTX_HTX1R_C_00002	30	1								
Hot Tap X	HotTap_HTX_HTX1R_C_00003	45									
Hot Tap X	HotTap_HTX_HTX1R_C_00005	55									
Hot Tap X	HotTap_HTX_HTX1R_C_00006	50				1					
Hot Tap X	HotTap_HTX_HTX1R_C_00007	25									
Hot Tap Y	HotTap_HTY_HTY1R_A_00001	25				1					
Hot Tap Y	HotTap_HTY_HTY1R_A_00004	20									
Hot Tap Y	HotTap_HTY_HTY1R_A_00005	25									
Hot Tap Y	HotTap_HTY_HTY1R_A_00007	40					1				
Hot Tap Y	HotTap_HTY_HTY1R_A_00009	15									
Hot Tap Y	HotTap_HTY_HTY1R_A_00010	15									
Hot Tap Y	HotTap_HTY_HTY1R_A_00013	20									
Hot Tap Y	HotTap_HTY_HTY1R_A_00014	35									
Hot Tap Y	HotTap_HTY_HTY1R_B_00001	25		1							
Hot Tap Y	HotTap_HTY_HTY1R_B_00004	20									
Hot Tap Y	HotTap_HTY_HTY1R_B_00006	10		1							
Hot Tap Y	HotTap_HTY_HTY1R_B_00008	10		5							
Hot Tap Y	HotTap_HTY_HTY1R_B_00009	15									
Hot Tap Y	HotTap_HTY_HTY1R_C_00001	25									
Hot Tap Y	HotTap_HTY_HTY1R_C_00002	15									
Hot Tap Y	HotTap_HTY_HTY1R_C_00004	15									
Hot Tap Y	HotTap_HTY_HTY1R_C_00005	20									
Hot Tap Y	HotTap_HTY_HTY1R_C_00006	10									
La Bella	LaBella_LB1_A_00001	30		1							
La Bella	LaBella_LB1_A_00004	5									
La Bella	LaBella_LB1_A_00006	30									
La Bella	LaBella_LB1_B_00008	5									
La Bella	LaBella_LB1_B_00009	5									
La Bella	LaBella_LB1_B_00013	15									
La Bella	LaBella_LB1_C_00001	15									

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
La Bella	LaBella_LB1_C_00003	15									
La Bella	LaBella_LB1_C_00004	20									
La Bella	LaBella_LB2_A_00014	15									
La Bella	LaBella_LB2_A_00017	10									
La Bella	LaBella_LB2_A_00021	0									
La Bella	LaBella_LB2_A_00024	10									
La Bella	LaBella_LB2_A_00026	0									
La Bella	LaBella_LB2_A_00028	0									
La Bella	LaBella_LB2_B_00029	35									
La Bella	LaBella_LB2_B_00030	20									
La Bella	LaBella_LB2_B_00033	20									
La Bella	LaBella_LB2_B_00035	15									
La Bella	LaBella_LB2_B_00036	25									
La Bella	LaBella_LB2_B_00040	5									
La Bella	LaBella_LB2_B_00041	5									
La Bella	LaBella_LB2_C_00043	5									
La Bella	LaBella_LB2_C_00044	5									
La Bella	LaBella_LB2_C_00045	0									
La Bella	LaBella_LB2_C_00047	0									
La Bella	LaBella_LB2_C_00048	5									
La Bella	LaBella_LB3_A_00001	5									
La Bella	LaBella_LB3_A_00003	0		1							
La Bella	LaBella_LB3_A_00005	5									
La Bella	LaBella_LB3_A_00007	5									
La Bella	LaBella_LB3_A_00009	5									
La Bella	LaBella_LB3_A_00010	0									
La Bella	LaBella_LB3_B_00002	5									
La Bella	LaBella_LB3_B_00004	5		1							
La Bella	LaBella_LB3_B_00006	5		1							
La Bella	LaBella_LB3_B_00007	5									
La Bella	LaBella_LB3_B_00009	0									
La Bella	LaBella_LB3_C_00002	5		1							
La Bella	LaBella_LB3_C_00003	5									
La Bella	LaBella_LB3_C_00005	5									
La Bella	LaBella_LB3_C_00007	0									
La Bella	LaBella_LB4_A_00001	0									
La Bella	LaBella_LB4_A_00003	0				1					
La Bella	LaBella_LB4_A_00005	5									
La Bella	LaBella_LB4_B_00004	5									
La Bella	LaBella_LB4_B_00005	0									
La Bella	LaBella_LB4_C_00001	0		1							
La Bella	LaBella_LB4_C_00004	0									
La Bella	LaBella_LB4_C_00005	5									
La Bella	LaBella_LB4_C_00006	0									

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
La Bella	LaBella_LB4_D_00001	35									
La Bella	LaBella_LB4_D_00002	25									
La Bella	LaBella_LB4_D_00003	30									
La Bella	LaBella_LB4_D_00004	15									
La Bella	LaBella_LB4_D_00005	20									
La Bella	LaBella_LB4_D_00006	25									
La Bella	LaBella_LB4_D_00007	35									
La Bella	LaBella_LB4_D_00008	40		1							
LBGE	Routes_LBGE_LBGE3R_A_00001	40									
LBGE	Routes_LBGE_LBGE3R_A_00002	45		2							
LBGE	Routes_LBGE_LBGE3R_A_00004	5									
LBGE	Routes_LBGE_LBGE3R_A_00005	5									
LBGE	Routes_LBGE_LBGE3R_A_00006	15									
LBGE	Routes_LBGE_LBGE3R_A_00008	45		1							
LBGE	Routes_LBGE_LBGE3R_B_00001	15									
LBGE	Routes_LBGE_LBGE3R_B_00002	5									
LBGE	Routes_LBGE_LBGE3R_B_00003	0									
LBGE	Routes_LBGE_LBGE3R_B_00004	0									
LBGE	Routes_LBGE_LBGE3R_B_00005	10		1							
LBGE	Routes_LBGE_LBGE3R_C_00001	0									
LBGE	Routes_LBGE_LBGE3R_C_00002	0									
LBGE	Routes_LBGE_LBGE3R_C_00003	0									
LBGE	Routes_LBGE_LBGE3R_C_00004	0									
LBGE	Routes_LBGE_LBGE3R_C_00005	0									
LBGE	Routes_LBGE_LBGE6R_A_00002	0									
LBGE	Routes_LBGE_LBGE6R_A_00003	5									
LBGE	Routes_LBGE_LBGE6R_A_00004	0									
LBGE	Routes_LBGE_LBGE6R_A_00005	5				1					
LBGE	Routes_LBGE_LBGE6R_A_00006	0									
LBGE	Routes_LBGE_LBGE6R_B_00001	0									
LBGE	Routes_LBGE_LBGE6R_B_00003	5		1							
LBGE	Routes_LBGE_LBGE6R_B_00004	5									
LBGE	Routes_LBGE_LBGE6R_B_00005	0									
LBGE	Routes_LBGE_LBGE6R_C_00001	0									
LBGE	Routes_LBGE_LBGE6R_C_00002	0									
LBGE	Routes_LBGE_LBGE6R_C_00003	0									
LBGE	Routes_LBGE_LBGE6R_C_00004	0									
LBGE	Routes_LBGE_LBGE6R_C_00005	0									
Thylacine	Thylacine_TH1_A_00002	65									
Thylacine	Thylacine_TH1_A_00003	55						9			
Thylacine	Thylacine_TH1_A_00006	25									
Thylacine	Thylacine_TH1_A_00007	20						2		1	
Thylacine	Thylacine_TH1_A_00008	30						6			
Thylacine	Thylacine_TH1_A_00009	30						3			

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
Thylacine	Thylacine_TH1_B_00015	45						3			
Thylacine	Thylacine_TH1_B_00016	55						3			
Thylacine	Thylacine_TH1_B_00017	60						1			
Thylacine	Thylacine_TH1_B_00018	60						5			
Thylacine	Thylacine_TH1_B_00021	55						2			
Thylacine	Thylacine_TH1_B_00023	45									
Thylacine	Thylacine_TH1_C_00028	40									
Thylacine	Thylacine_TH1_C_00029	45						3			
Thylacine	Thylacine_TH1_C_00031	25						1			
Thylacine	Thylacine_TH1_C_00033	40						2			
Thylacine	Thylacine_TH2_A_00001	0									
Thylacine	Thylacine_TH2_A_00003	0									
Thylacine	Thylacine_TH2_A_00005	5									
Thylacine	Thylacine_TH2_A_00009	5									
Thylacine	Thylacine_TH2_B_00010	5									
Thylacine	Thylacine_TH2_B_00011	0									
Thylacine	Thylacine_TH2_B_00012	0									
Thylacine	Thylacine_TH2_B_00013	5	1								
Thylacine	Thylacine_TH2_B_00014	5									
Thylacine	Thylacine_TH2_C_00015	0									
Thylacine	Thylacine_TH2_C_00016	5									
Thylacine	Thylacine_TH2_C_00017	0									
Thylacine	Thylacine_TH2_C_00018	5		1							
Thylacine	Thylacine_TH2_C_00019	0									
Thylacine	Thylacine_TH2_C_00021	0									
Thylacine	Thylacine_TH3_A_00001	15		2							
Thylacine	Thylacine_TH3_A_00003	10									
Thylacine	Thylacine_TH3_A_00004	30						4			
Thylacine	Thylacine_TH3_A_00005	25									
Thylacine	Thylacine_TH3_A_00007	20		1				1			
Thylacine	Thylacine_TH3_A_00009	20		1							
Thylacine	Thylacine_TH3_A_00010	5									
Thylacine	Thylacine_TH3_A_00011	5		2							
Thylacine	Thylacine_TH3_A_00014	10		1							
Thylacine	Thylacine_TH3_B_00015	10									
Thylacine	Thylacine_TH3_B_00018	10									
Thylacine	Thylacine_TH3_B_00020	10						1			
Thylacine	Thylacine_TH3_B_00022	10									
Thylacine	Thylacine_TH3_C_00023	15						2			
Thylacine	Thylacine_TH3_C_00024	5					1				
Thylacine	Thylacine_TH3_C_00025	5									
Thylacine	Thylacine_TH3_C_00026	10					1				
Thylacine	Thylacine_TH3_C_00027	5									
Thylacine	Thylacine_TH3_C_00030	5									

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
Thylacine	Thylacine_TH3_C_00031	5									
Thylacine	Thylacine_TH3_C_00033	10									
Thylacine	Thylacine_TH4_A_00005	15						3			
Thylacine	Thylacine_TH4_A_00007	15						2			
Thylacine	Thylacine_TH4_A_00008	10						1			
Thylacine	Thylacine_TH4_A_00009	10						1			
Thylacine	Thylacine_TH4_A_00010	15									
Thylacine	Thylacine_TH4_A_00011	15						4			
Thylacine	Thylacine_TH4_B_00016	30						5			
Thylacine	Thylacine_TH4_B_00018	25									
Thylacine	Thylacine_TH4_B_00019	30						3			
Thylacine	Thylacine_TH4_B_00020	20						2			
Thylacine	Thylacine_TH4_B_00022	10									
Thylacine	Thylacine_TH4_C_00023	10									
Thylacine	Thylacine_TH4_C_00024	25						1			
Thylacine	Thylacine_TH4_C_00025	15									
Thylacine	Thylacine_TH4_C_00028	20						2			
Thylacine	Thylacine_TH4_C_00029	5									
Thylacine	Thylacine_TH4_C_00030	5									
Thylacine	Thylacine_TH4_C_00033	10									
Thylacine	Thylacine_TH5_00014	5									
Thylacine	Thylacine_TH6_00003	5									
Thylacine	Thylacine_TH6_00005	5									
Thylacine	Thylacine_TH6_00006	5									
Thylacine	Thylacine_TH6_00011	5									
Thylacine	Thylacine_TH6_00016	15									
Thylacine	Thylacine_TH7_00009	0									
Thylacine	Thylacine_TH7_00012(2)	5		1							
Thylacine	Thylacine_TH7_00013(2)	5									
Thylacine	Thylacine_TH7_00014(2)	5									
Thylacine	Thylacine_TH7_00015	0									
Thylacine	Thylacine_TH7_00017	0									
Thylacine	Thylacine_TH7_00018	0									
Thylacine	Thylacine_TH7_00022	0									
Thylacine	Thylacine_TH8_00009	5									
Thylacine	Thylacine_TH8_00011	5		1							
Thylacine	Thylacine_TH8_00013	5									
Thylacine	Thylacine_TH8_00015	10									
Thylacine	Thylacine_TH8_00019	5									
Thylacine	Thylacine_TH8_00021	5									
Thylacine	Thylacine_TH8_00022	5									
Thylacine	Thylacine_TH8_00025	0									
Thylacine	Thylacine_TH8_00027	5									
Thylacine	Thylacine_TH8_00028	5									

Location	Image Name	Percnet coverage of epifauna (%)	Gastropoda sp. 1	Gastropoda sp. 2	Gastropoda sp. 3	Gastropoda sp. 4	Gastropoda sp. 5	Crinoidea	Polychaeta	Nudibranchia	Teleostei
Thylacine	Thylacine_TH8_00030	5									

APPENDIX 6
EXAMPLE SEABED PHOTOGRAPHS


Artisan – AR4


Artisan – AR4


Geographe – GE2


Geographe – GE4


Hercules – HE1


Hercules – HE3


La Bella – LB2


La Bella – LB4 Extra DC


Thylacine – TH2

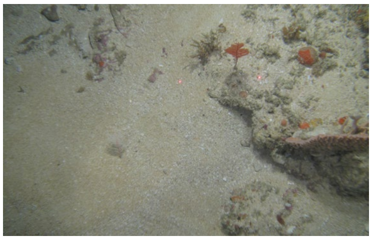

Thylacine – TH4


Thylacine – TH6


Thylacine – TH8


Hot Tap – HTX – HTX1R


Hot Tap – HTX – HTX1R


Hot Tap – HTY – HTY1R

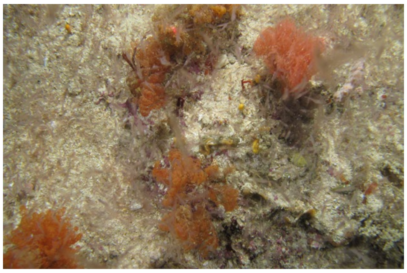

Hot Tap – HTY – HTY1R


Routes – ARGE – ARGE3R


Routes – ARGE – ARGE6R


Routes – ARGE – ARGE7R


Routes – ARHTX – ARHTX1R


Routes – ARHTX – ARHTX1R


Routes – ARHTY – ARHTY1R


Routes – ARHTY – ARHTY1R


Routes – ARLB – ARLB2R


Routes – ARLB – ARLB6R


Routes – LBGE – LBGE3R


Routes – LBGE – LBGE6R

Appendix D Beach Fair Ocean Access Procedure Information Sheet

Fair Ocean Access

Minimising fishing impacts from offshore operations

Information Sheet | June 2021

Introduction

Licenced commercial fishers and petroleum title holders have lawful rights and obligations to carry out their activities safely and without interference. Beach is committed to *Fair Ocean Access* by minimising impacts from its offshore activities to commercial fishers.

Beach's *Fair Ocean Access Procedure* sets out commitments by Beach to genuine consultation with fishers to understand and minimise safety, environmental and economic impacts.

Where impacts cannot be minimised by Beach, and a fisher has acted to avoid risks and impacts to a Beach project, Beach's *Fair Ocean Access Procedure* includes a simple and fair process for a fisher to claim compensation for an economic loss, and a rapid approval and payment process.

Safety

Safety is Beach's first priority and operating safely will sometimes require restricted access for relatively small offshore areas over short periods. Beach will consult with fishers to seek to minimise potential disturbance to areas that are regular fishing grounds and where the fisher has no alternative fishing options.

Environmental Protection

Beach's projects are subject to stringent assessment and mitigation of potential environmental impacts. Beach must prepare Environment Plans for its offshore projects. These identify all environmental and socio-economic impacts and set out mitigation measures to reduce impacts, so they are "as low as reasonably practicable" and acceptable by regulators. Mitigation measures may include compensation where impacts on the commercial fishing industry cannot be minimised and where these impacts cause an economic loss.

Assessment of impacts includes identifying State and Commonwealth commercial fisheries that are actively fished in Beach's project areas and any biological or economic impacts to those fisheries. Consultation with commercial fishers is an important part of Beach's environmental assessment process.

Genuine consultation

Beach will consult with openness, transparency and mutual respect with fishers who may be directly impacted by Beach's projects. Beach will use its best endeavours to consult with all potentially impacted fishers during preparation of its Environment Plan for a project, and before projects commence.

Respecting the representative role of fishing associations, Beach will seek engagement with potentially impacted fishers via the relevant association. Beach will also engage directly with a fisher if they are not a member of an association, or where they request direct engagement with Beach.

Where a fishing association or fisher believes they will be impacted by a Beach project, Beach will share its fishing impact assessments, validate that with fishers, and discuss their specific circumstances with the objective of minimising potential impacts.

If project avoidance and impact minimisation is not possible, Beach will provide a copy of its full *Fair Ocean Access Procedure* and discuss mitigation options set out in the procedure, as appropriate to the individual fisher or association.

Economic loss

Beach is committed to the principle that a fisher should not suffer an economic loss as a direct result of a Beach project. Losses may occur for different reasons such as:

- reduced catch from fishing in a new area in order to avoid a Beach project
- reduced catch due to impacts to a fishery from the project activities
- steaming costs to avoid a Beach project area
- costs to repair or replace fishing gear.

Acting in good faith

Beach is committed to a fair, simple and transparent process for a fisher to claim compensation, where the fisher has consulted with Beach in good faith before a project, and provided the fisher has:

- acted to avoid risks and impacts to a Beach project
- acted to mitigate any economic losses to their business that may arise from avoiding risks and impacts to a Beach project
- evidence of fishing in the Beach project area during the same time of year as the project timing, for at least three years within the last five years, unless there are genuine fishery or fishing practice reasons for lesser periods
- historical and current catch and effort evidence and the ability to demonstrate an economic loss, as set out in Beach's *Fair Ocean Access Procedure*.

Making a claim

The *Fair Ocean Access Procedure* sets out a simple claim form and describes the evidence required for a claim, such as historical catch and effort records, current catch and effort records, and fish prices.

Claims must be made within 60 days of completion of a Beach project unless there is evidence that the project has caused an impact to the fishery which has impacted future catch and caused an economic loss.

The *Fair Ocean* Access *Procedure* sets out timeframes for the rapid assessment and payment of successful claims and for ensuring the fisher is kept informed.

Beach will nominate a single point of contact at Beach for a fisher to liaise with.

Claims and evidence will be managed in accordance with Beach's Privacy Policy which can be found on Beach's website.

If a claim is not approved, Beach will provide written reasons for the decision.

Resolving disagreements

Where a fisher and Beach cannot agree on a fisher's claim, the *Fair Ocean Access Procedure* includes steps for appointing an independent expert to resolve the matter. Beach will pay the reasonable costs of the independent expert, as set out in the *Fair Ocean Access Procedure*.

We welcome your questions and feedback

P: 1800 797 011
E: community@beachenergy.com.au

beachenergy.com.au

Appendix E EPBC Protected Matters Search Tool Report – Light and Flaring EMBAs

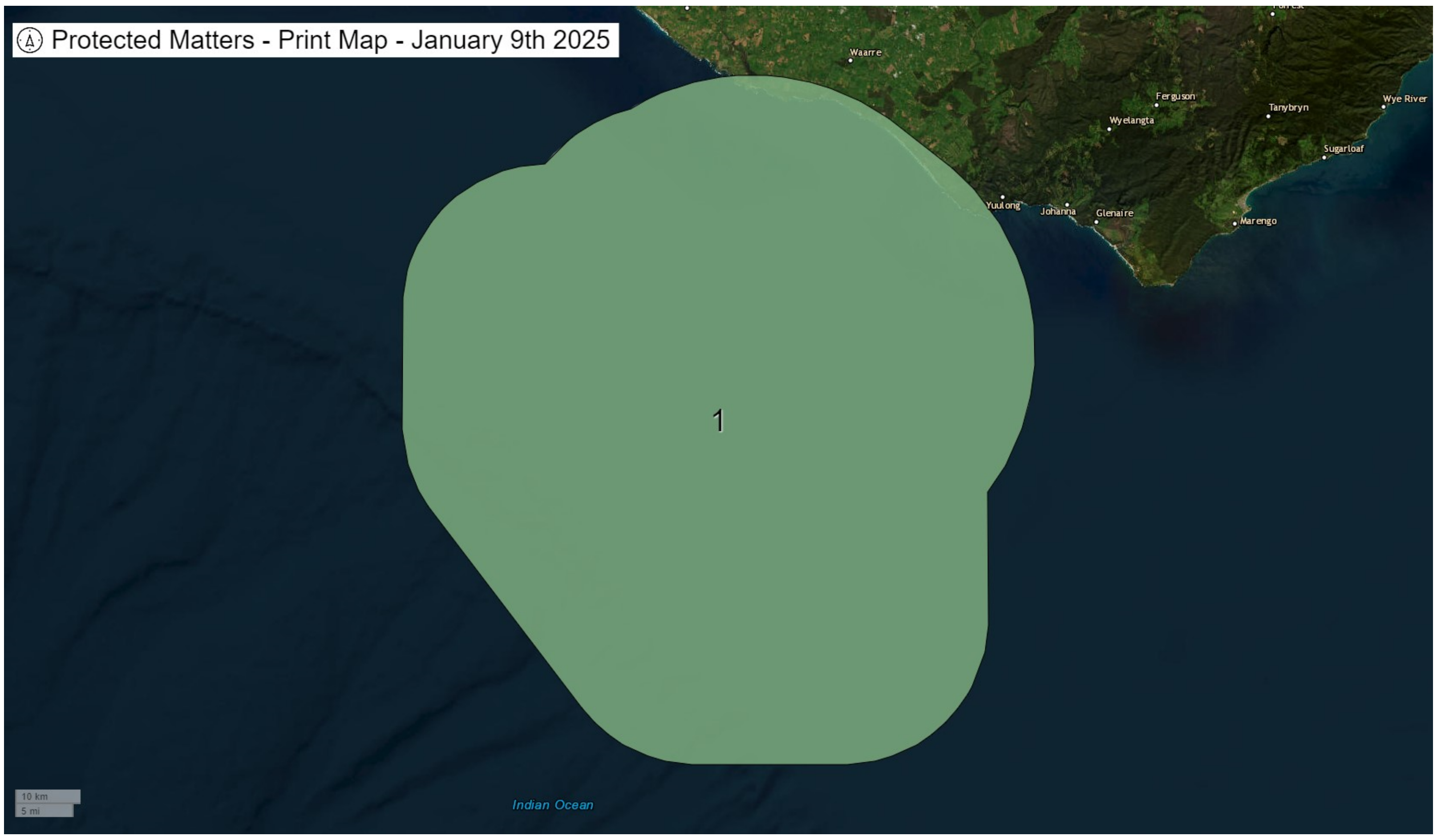
Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 09-Jan-2025



Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	85
Listed Migratory Species:	53

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	89
Whales and Other Cetaceans:	28
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	7
Regional Forest Agreements:	1
Nationally Important Wetlands:	1
EPBC Act Referrals:	47
Key Ecological Features (Marine):	1
Biologically Important Areas:	13
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places [Resource Information]

Name	State	Legal Status
Historic		
Great Ocean Road and Scenic Environs	VIC	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	Endangered	Community likely to occur within area
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Climacteris picumnus victoriae Brown Treecreeper (south-eastern) [67062]	Vulnerable	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area

Scientific Name	Threatened Category	Presence Text
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area
FISH		
Hoplostethus atlanticus Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Nannoperca obscura		
Yarra Pygmy Perch [26177]	Endangered	Species or species habitat may occur within area
Prototroctes maraena		
Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Seriolella brama		
Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
FROG		
Litoria raniformis		
Southern Bell Frog,, Growling Grass Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Antechinus minimus maritimus		
Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Endangered	Species or species habitat known to occur within area
Miniopterus orianae bassanii Southern Bent-wing Bat [87645]	Critically Endangered	Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat likely to occur within area
Potorous tridactylus trisulcatus Long-nosed Potoroo (southern mainland) [86367]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys fumeus Smoky Mouse, Konoom [88]	Endangered	Species or species habitat may occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
PLANT		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat may occur within area
Caladenia concolor Crimson Spider-orchid, Maroon Spider-orchid [5505]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Eucalyptus strzeleckii Strzelecki Gum [55400]	Vulnerable	Species or species habitat known to occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat likely to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat known to occur within area
Lepidium aschersonii Spiny Peppercress [10976]	Vulnerable	Species or species habitat may occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat may occur within area
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat known to occur within area
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat may occur within area
Pterostylis cucullata Leafy Greenhood [15459]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis tenuissima Swamp Greenhood, Dainty Swamp Orchid [13139]	Vulnerable	Species or species habitat known to occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat known to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Thelymitra orientalis Hoary Sun-orchid [88011]	Critically Endangered	Species or species habitat may occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Lissolepis coventryi Swamp Skink, Eastern Mourning Skink [84053]	Endangered	Species or species habitat known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Migration route known to occur within area
Centrophorus uyato Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharias taurus Grey Nurse Shark [64469]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Migration route known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris as Puffinus tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area overfly marine area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato)		
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Stercorarius antarcticus as Catharacta skua		
Brown Skua [85039]		Species or species habitat may occur within area
Sterna striata		
White-fronted Tern [799]		Foraging, feeding or related behaviour likely to occur within area
Sternula albifrons as Sterna albifrons		
Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri		
Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei as Thalassarche sp. nov.		
Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma		
Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus as Thinornis rubricollis Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area
Thinornis cucullatus cucullatus as Thinornis rubricollis rubricollis Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area overfly marine area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Current Scientific Name	Status	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves

[Resource Information]

Protected Area Name	Reserve Type	State
Bay of Islands Coastal Park	Conservation Park	VIC
Great Otway	National Park	VIC
Latrobe B.R.	Natural Features Reserve	VIC
Port Campbell	National Park	VIC
Princetown W.R	Natural Features Reserve	VIC
The Arches	Marine Sanctuary	VIC
Twelve Apostles	Marine National Park	VIC

Regional Forest Agreements

[Resource Information]

Note that all areas with completed RFAs have been included. Please see the associated resource information for specific caveats and use limitations associated with RFA boundary information.

RFA Name	State
West Victoria RFA	Victoria

Nationally Important Wetlands

[Resource Information]

Wetland Name	State
Princetown Wetlands	VIC

EPBC Act Referrals

[Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status

Title of referral	Reference	Referral Outcome	Assessment Status
Decommissioning of the Minerva Pipeline in Victorian state waters	2024/09879		Completed
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia East	2024/09795		Completed
Otway Astrolabe 3D Marine Seismic Survey, Otway Basin	2012/6421		Completed
Controlled action			
Alston-1 petroleum exploration well, permit VIC/P44	2003/1315	Controlled Action	Post-Approval
Casino Gas Field Development	2003/1295	Controlled Action	Post-Approval
Otway Development	2002/621	Controlled Action	Post-Approval
Schomberg 3D Marine Seismic Survey	2007/3754	Controlled Action	Completed
Strike Oil Gas Exploration Well, Otway Basin (VIC/P44)	2000/97	Controlled Action	Completed
Twelve Apostles Saddle Lookout	2019/8571	Controlled Action	Post-Approval
VICP61 2D Marine Seismic Survey	2008/4075	Controlled Action	Completed
Not controlled action			
Enterprise 1 Exploration Drilling Program, near Port Campbell, Vic	2019/8438	Not Controlled Action	Completed
Exploration drilling for liquid/gaseous hydrocarbons	2004/1681	Not Controlled Action	Completed
Gas Field Development	2006/2635	Not Controlled Action	Completed
Henry-1 Exploration Well, Petroleum Permit Area VIC/P44	2005/2147	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Minerva Cut Back Project, Vic	2017/8036	Not Controlled Action	Completed
Offshore exploration drilling within permit area VIC/P 37(v)	2004/1466	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Port Campbell Headland Walking Trail Realignment	2012/6676	Not Controlled Action	Completed
Track construction - Great Ocean Walk	2002/793	Not Controlled Action	Completed
VIC-P44 Stage 2 Gas Field Development	2007/3767	Not Controlled Action	Completed
Victorian Generator Project	2005/1984	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Moonlight Head' 3D seismic survey, VIC/P38(V), VIC/P43 and VIC/RL8	2005/2236	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2005/2295	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2003/1214	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey near King Island	2004/1461	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic program VIC/P38(v), VIC/P43 and VIC/RL8	2003/1137	Not Controlled Action (Particular Manner)	Post-Approval
Astrolabe 3D Marine Seismic Survey	2011/6048	Not Controlled Action (Particular Manner)	Post-Approval
BHPBilliton Otway 3D Seismic Survey	2007/3443	Not Controlled Action (Particular Manner)	Post-Approval
Deepwater Sorell Basin 2001 Non-Exclusive 2D Seismic Survey	2001/156	Not Controlled Action (Particular Manner)	Post-Approval
Drill and Profile Exploration Well Somerset 1, License Area T34P	2009/5037	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Enterprise Three-dimensional Transition Zone Seismic Survey, Victoria	2016/7800	Not Controlled Action (Particular Manner)	Post-Approval
Geographe-A gas exploration well	2000/82	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
La Bella 3D Marine Seismic Survey, Otway Basin, VIC	2012/6683	Not Controlled Action (Particular Manner)	Post-Approval
Otway Basin Exploration Drilling Campaign, Vic	2011/6125	Not Controlled Action (Particular Manner)	Post-Approval
Santos Otway 3d Seismic VIC/P44	2007/3367	Not Controlled Action (Particular Manner)	Post-Approval
Schomberg 3D Marine Seismic survey	2007/3868	Not Controlled Action (Particular Manner)	Post-Approval
Strike Oil NL Seismic Surveys	2000/107	Not Controlled Action (Particular Manner)	Post-Approval
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, Vic	2012/6565	Not Controlled Action (Particular Manner)	Post-Approval
Thylacine-A Exploration Well	2000/81	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5700	Not Controlled Action (Particular Manner)	Post-Approval
Vic/P37(v) and Vic/P44 3D marine seismic survey	2003/1102	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
VIC P44 Gas Exploration Wells	2002/662	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 2D seismic survey	2002/811	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, VIC	2012/6545	Referral Decision	Completed
VICP61 2D Marine Seismic Survey	2008/3975	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
West Tasmania Canyons	South-east

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Likely to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

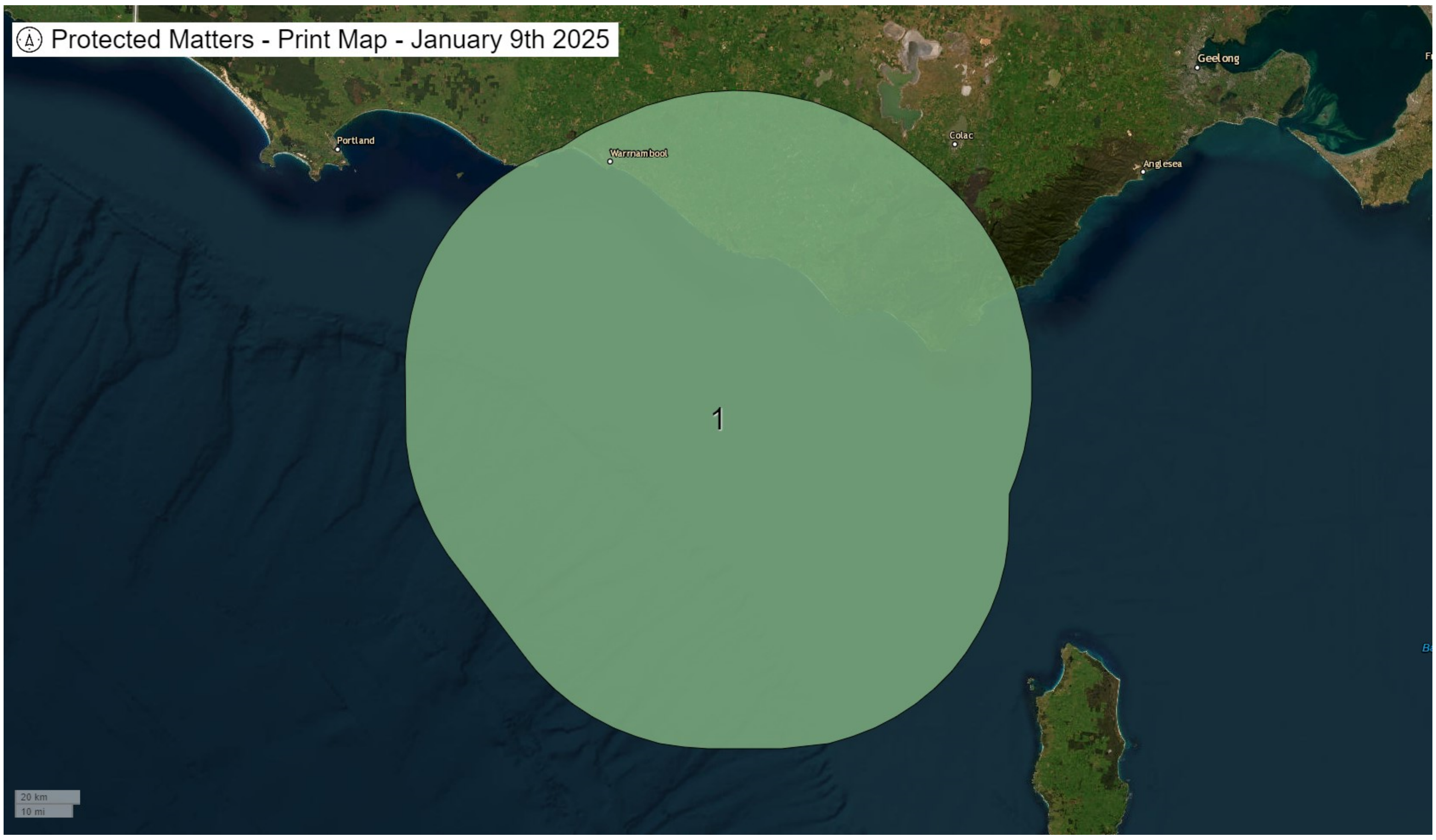
Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 09-Jan-2025



Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance (Ramsar	2
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	8
Listed Threatened Species:	107
Listed Migratory Species:	64

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	3
Commonwealth Heritage Places:	1
Listed Marine Species:	108
Whales and Other Cetaceans:	29
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	3
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	53
Regional Forest Agreements:	1
Nationally Important Wetlands:	8
EPBC Act Referrals:	86
Key Ecological Features (Marine):	2
Biologically Important Areas:	17
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places [Resource Information]

Name	State	Legal Status
Historic		
Great Ocean Road and Scenic Environs	VIC	Listed place

Wetlands of International Importance (Ramsar Wetlands) [Resource Information]

Ramsar Site Name	Proximity
Port phillip bay (western shoreline) and bellarine peninsula	50 - 100km upstream from Ramsar site
Western district lakes	Within Ramsar site

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	Endangered	Community likely to occur within area
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area
Grassy Eucalypt Woodland of the Victorian Volcanic Plain	Critically Endangered	Community known to occur within area
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	Community may occur within area
Natural Temperate Grassland of the Victorian Volcanic Plain	Critically Endangered	Community likely to occur within area

Community Name	Threatened Category	Presence Text
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	Critically Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour may occur within area
Aphelocephala leucopsis Southern Whiteface [529]	Vulnerable	Species or species habitat may occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Climacteris picumnus victoriae Brown Treecreeper (south-eastern) [67062]	Vulnerable	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Melanodryas cucullata cucullata South-eastern Hooded Robin, Hooded Robin (south-eastern) [67093]	Endangered	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat known to occur within area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Pedionomus torquatus Plains-wanderer [906]	Critically Endangered	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
CRUSTACEAN		
Euastacus bispinosus Glenelg Spiny Freshwater Crayfish, Pricklyback [81552]	Endangered	Species or species habitat likely to occur within area
FISH		
Hoplostethus atlanticus Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Nannoperca obscura Yarra Pygmy Perch [26177]	Endangered	Species or species habitat known to occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Seriolella brama Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
FROG		
Litoria raniformis Southern Bell Frog,, Growling Grass Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat known to occur within area
INSECT		
Synemon plana Golden Sun Moth [25234]	Vulnerable	Species or species habitat likely to occur within area
MAMMAL		
Antechinus minimus maritimus Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Endangered	Species or species habitat known to occur within area
Miniopterus orianae bassanii Southern Bent-wing Bat [87645]	Critically Endangered	Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Petauroides volans Greater Glider (southern and central) [254]	Endangered	Species or species habitat likely to occur within area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus trisulcatus Long-nosed Potoroo (southern mainland) [86367]	Vulnerable	Species or species habitat known to occur within area
Pseudomys fumeus Smoky Mouse, Konoom [88]	Endangered	Species or species habitat may occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
PLANT		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Astelia australiana Tall Astelia [10851]	Vulnerable	Species or species habitat known to occur within area
Caladenia concolor Crimson Spider-orchid, Maroon Spider-orchid [5505]	Vulnerable	Species or species habitat may occur within area
Dianella amoena Matted Flax-lily [64886]	Endangered	Species or species habitat likely to occur within area
Dodonaea procumbens Trailing Hop-bush [12149]	Vulnerable	Species or species habitat may occur within area
Eucalyptus strzeleckii Strzelecki Gum [55400]	Vulnerable	Species or species habitat known to occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat known to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat known to occur within area
Lachnagrostis adamsonii Adamson's Blown-grass, Adamson's Blowngrass [76211]	Endangered	Species or species habitat may occur within area
Leiocarpa gatesii Wrinkled Buttons [76212]	Vulnerable	Species or species habitat may occur within area
Lepidium aschersonii Spiny Peppercress [10976]	Vulnerable	Species or species habitat likely to occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pimelea spinescens subsp. spinescens Plains Rice-flower, Spiny Rice-flower, Prickly Pimelea [21980]	Critically Endangered	Species or species habitat may occur within area
Poa sallacustris Salt-lake Tussock-grass [24424]	Vulnerable	Species or species habitat likely to occur within area
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat known to occur within area
Prasophyllum suaveolens Fragrant Leek-orchid [64956]	Endangered	Species or species habitat may occur within area
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat may occur within area
Pterostylis cucullata Leafy Greenhood [15459]	Vulnerable	Species or species habitat known to occur within area
Pterostylis tenuissima Swamp Greenhood, Dainty Swamp Orchid [13139]	Vulnerable	Species or species habitat known to occur within area
Rutidosis leptorhynchoides Button Wrinklewort [67251]	Endangered	Species or species habitat may occur within area
Senecio macrocarpus Large-fruit Fireweed, Large-fruit Groundsel [16333]	Vulnerable	Species or species habitat may occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat known to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Thelymitra matthewsii Spiral Sun-orchid [4168]	Endangered	Species or species habitat may occur within area
Thelymitra orientalis Hoary Sun-orchid [88011]	Critically Endangered	Species or species habitat may occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Delma impar Striped Legless Lizard, Striped Snake-lizard [1649]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eulamprus tympanum marnieae Corangamite Water Skink, Dreeite Water Skink [64487]	Endangered	Species or species habitat known to occur within area
Lissolepis coventryi Swamp Skink, Eastern Mourning Skink [84053]	Endangered	Species or species habitat known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Centrophorus uyato Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharias taurus Grey Nurse Shark [64469]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area

Scientific Name	Threatened Category	Presence Text
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eubalaena australis as Balaena glacialis australis		
Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isurus oxyrinchus		
Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus		
Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus		
Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus		
Sperm Whale [59]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus		
White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		

Scientific Name	Threatened Category	Presence Text
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area

Scientific Name	Threatened Category	Presence Text
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Defence	
Defence - WARRNAMBOOL TRAINING DEPOT [21111]	VIC
Unknown	
Commonwealth Land - [21492]	VIC
Commonwealth Land - [21583]	VIC

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Camperdown Post Office	VIC	Listed place

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Ardenna tenuirostris as Puffinus tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Breeding likely to occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area overfly marine area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area overfly marine area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area overfly marine area
Stercorarius antarcticus as Catharacta skua Brown Skua [85039]		Species or species habitat may occur within area
Sterna striata White-fronted Tern [799]		Foraging, feeding or related behaviour likely to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche bulleri platei as Thalassarche sp. nov.		
Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma		
Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini		
Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thalasseus bergii as Sterna bergii		
Greater Crested Tern [83000]		Breeding known to occur within area
Thinornis cucullatus as Thinornis rubricollis		
Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Thinornis cucullatus cucullatus as Thinornis rubricollis rubricollis		
Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Tringa brevipes as Heteroscelus brevipes		
Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola		
Wood Sandpiper [829]		Roosting known to occur within area overfly marine area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area overfly marine area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area
Fish		
Heraldia nocturna		
Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis		
Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps		
Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus minotaur		
Bullneck Seahorse [66705]		Species or species habitat may occur within area
Histiogamphelus briggsii		
Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus		
Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys mollisoni Mollison's Pipefish [66260]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Whales and Other Cetaceans

[Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Current Scientific Name	Status	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks

[Resource Information]

Park Name	Zone & IUCN Categories
Apollo	Multiple Use Zone (IUCN VI)
Zeehan	Multiple Use Zone (IUCN VI)
Zeehan	Special Purpose Zone (IUCN VI)

Extra Information

State and Territory Reserves

[Resource Information]

Protected Area Name	Reserve Type	State
Aire River	Heritage River	VIC
Aire River W.R.	Natural Features Reserve	VIC
Barham Paradise S.R.	Natural Features Reserve	VIC
Bay of Islands Coastal Park	Conservation Park	VIC
Brucknell Creek F.F.R	Nature Conservation Reserve	VIC
Bungador Stoney Rises N.C.R.	Natural Features Reserve	VIC
Calder River	Reference Area	VIC
Carpendeit	Reference Area	VIC

Protected Area Name	Reserve Type	State
Carpendeit B.R.	Natural Features Reserve	VIC
Cobrico Swamp W.R	Natural Features Reserve	VIC
Cooriemungle	Reference Area	VIC
Cooriemungle Creek F.R	Nature Conservation Reserve	VIC
Coradjil B.R.	Natural Features Reserve	VIC
Coradjil N.C.R.	Natural Features Reserve	VIC
Crinoline Creek	Reference Area	VIC
Curdie Vale N.C.R.	Natural Features Reserve	VIC
Ecklin South Swamp N.C.R.	Natural Features Reserve	VIC
Floating Islands F.F.R	Nature Conservation Reserve	VIC
Framlingham Forest	Indigenous Protected Area	VIC
Gellibrand B.R	Natural Features Reserve	VIC
Gellibrand North B.R.	Natural Features Reserve	VIC
Goose Lagoon W.R	Natural Features Reserve	VIC
Great Otway	National Park	VIC
Hopkins Falls S.R.	Natural Features Reserve	VIC
Hopkins River, Framlingham SS.R.	Natural Features Reserve	VIC
Irrewillipe B.R.	Natural Features Reserve	VIC
Jancourt N.C.R.	Natural Features Reserve	VIC
Johanna Falls S.R.	Natural Features Reserve	VIC

Protected Area Name	Reserve Type	State
Lake Gillear W.R	Natural Features Reserve	VIC
Lake Purrumbete W.R	Nature Conservation Reserve	VIC
Latrobe B.R.	Natural Features Reserve	VIC
Marengo N.C.R.	Nature Conservation Reserve	VIC
Marengo Reefs	Marine Sanctuary	VIC
Merri	Marine Sanctuary	VIC
Nullawarre F.R.	Nature Conservation Reserve	VIC
Olangolah Creek	Reference Area	VIC
Parker River	Reference Area	VIC
Porcupine Creek	Reference Area	VIC
Port Campbell	National Park	VIC
Princetown W.R	Natural Features Reserve	VIC
Stony Creek (Otways)	Reference Area	VIC
The Arches	Marine Sanctuary	VIC
Timboon I1 B.R	Natural Features Reserve	VIC
Tomahawk Creek	Reference Area	VIC
Tower Hill W.R	Natural Features Reserve	VIC
Twelve Apostles	Marine National Park	VIC
Unnamed P0126	Private Nature Reserve	VIC
Unnamed P0176	Private Nature Reserve	VIC
Unnamed P0353	Private Nature Reserve	VIC
Wild Dog B.R.	Natural Features Reserve	VIC
Wild Dog Creek SS.R.	Natural Features Reserve	VIC

Protected Area Name	Reserve Type	State
Wongarra B.R.	Natural Features Reserve	VIC
Yaugher B.R.	Natural Features Reserve	VIC

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included. Please see the associated resource information for specific caveats and use limitations associated with RFA boundary information.

RFA Name	State
West Victoria RFA	Victoria

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Aire River	VIC
Cobden-Terang Volcanic Craters	VIC
Lake Corangamite	VIC
Lower Aire River Wetlands	VIC
Lower Merri River Wetlands	VIC
Princetown Wetlands	VIC
Stonyford-Bungador Wetlands	VIC
Tower Hill	VIC

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Apollo Bay to Skenes Creek Coastal Trail	2022/09274		Assessment
Colac Pipeline Upgrade ? Sections 19, 20, 21, 23 & 25i	2022/09343		Post-Approval
Decommissioning of the Minerva Pipeline in Victorian state waters	2024/09879		Completed
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia East	2024/09795		Completed
Otway Astrolabe 3D Marine Seismic Survey, Otway Basin	2012/6421		Completed
Spinifex Offshore Surveys	2022/09359		Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Spinifex Offshore Wind Farm - Offshore Investigations	2024/09918		Referral Decision
Swansons Lane Wind Farm	2024/09949		Assessment
Controlled action			
Alston-1 petroleum exploration well, permit VIC/P44	2003/1315	Controlled Action	Post-Approval
Casino Gas Field Development	2003/1295	Controlled Action	Post-Approval
Otway Development	2002/621	Controlled Action	Post-Approval
Residential Subdivision & Infrastructure Parish of Belfast	2005/1954	Controlled Action	Completed
Schomberg 3D Marine Seismic Survey	2007/3754	Controlled Action	Completed
Strike Oil Gas Exploration Well, Otway Basin (VIC/P44)	2000/97	Controlled Action	Completed
Twelve Apostles Saddle Lookout	2019/8571	Controlled Action	Post-Approval
VICP61 2D Marine Seismic Survey	2008/4075	Controlled Action	Completed
Not controlled action			
Alteration of Grass Maintenance Regime within Powling St Wetlands	2012/6527	Not Controlled Action	Completed
Amrit-1 exploration well	2004/1572	Not Controlled Action	Completed
Apollo Bay Water Storage Basin, VIC	2012/6484	Not Controlled Action	Completed
CO2 geosequestration - Otway Basin Pilot Project	2006/2699	Not Controlled Action	Completed
construction of pump station for pump diversion from the Barham River	2003/1242	Not Controlled Action	Completed
Enterprise 1 Exploration Drilling Program, near Port Campbell, Vic	2019/8438	Not Controlled Action	Completed
Exploration drilling for liquid/gaseous hydrocarbons	2004/1681	Not Controlled Action	Completed
Gas Field Development	2006/2635	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Gas Fields Development	2011/5879	Not Controlled Action	Completed
Gas Pipeline Installation	2005/2495	Not Controlled Action	Completed
Halladale and Speculant Gas Pipeline Project, North of Port Campbell, Vic	2015/7551	Not Controlled Action	Completed
Henry-1 Exploration Well, Petroleum Permit Area VIC/P44	2005/2147	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Kelly Swamp Boardwalk Construction	2010/5371	Not Controlled Action	Completed
Maintenance of Access Track and Weed Removal	2009/4973	Not Controlled Action	Completed
Minerva Cut Back Project, Vic	2017/8036	Not Controlled Action	Completed
Naroghid Wind Farm	2004/1542	Not Controlled Action	Completed
Newfield wind farm	2007/3226	Not Controlled Action	Completed
Nirranda South Wind Farm Pty Ltd	2002/763	Not Controlled Action	Completed
Offshore exploration drilling within permit area VIC/P 37(v)	2004/1466	Not Controlled Action	Completed
Port Campbell Headland Walking Trail Realignment	2012/6676	Not Controlled Action	Completed
Railway Bridge (H0151) Partial Demolition, Merri River	2010/5534	Not Controlled Action	Completed
Residential/Resort/Golf Course development	2002/907	Not Controlled Action	Completed
Salt Creek Wind Farm transmission line, Vic	2016/7763	Not Controlled Action	Completed
Stage 1 residential subdivision, Anna Catherine Drive	2005/1992	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
The Sisters Wind Farm	2008/4268	Not Controlled Action	Completed
Track construction - Great Ocean Walk	2002/793	Not Controlled Action	Completed
VIC-P44 Stage 2 Gas Field Development	2007/3767	Not Controlled Action	Completed
Victorian Generator Project	2005/1984	Not Controlled Action	Completed
Wind Farm Construction and Operation	2001/471	Not Controlled Action	Completed
Wind farm development	2005/1960	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Moonlight Head' 3D seismic survey, VIC/P38(V), VIC/P43 and VIC/RL8	2005/2236	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2005/2295	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2003/1214	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey near King Island	2004/1461	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic program VIC/P38(v), VIC/P43 and VIC/RL8	2003/1137	Not Controlled Action (Particular Manner)	Post-Approval
Astrolabe 3D Marine Seismic Survey	2011/6048	Not Controlled Action (Particular Manner)	Post-Approval
BHPBilliton Otway 3D Seismic Survey	2007/3443	Not Controlled Action (Particular Manner)	Post-Approval
Deepwater Sorell Basin 2001 Non-Exclusive 2D Seismic Survey	2001/156	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Drill and Profile Exploration Well Somerset 1, License Area T34P	2009/5037	Not Controlled Action (Particular Manner)	Post-Approval
Enterprise Three-dimensional Transition Zone Seismic Survey, Victoria	2016/7800	Not Controlled Action (Particular Manner)	Post-Approval
Fuelbreak construction	2009/4915	Not Controlled Action (Particular Manner)	Post-Approval
Gas Pipeline Crossing at Mount Emu Creek	2009/4913	Not Controlled Action (Particular Manner)	Post-Approval
Geographe-A gas exploration well	2000/82	Not Controlled Action (Particular Manner)	Post-Approval
Hydrocarbon exploration wells	2003/1062	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
La Bella 3D Marine Seismic Survey, Otway Basin, VIC	2012/6683	Not Controlled Action (Particular Manner)	Post-Approval
OTE10 2D Marine Seismic Survey	2009/5223	Not Controlled Action (Particular Manner)	Post-Approval
Otway Basin Exploration Drilling Campaign, Vic	2011/6125	Not Controlled Action (Particular Manner)	Post-Approval
Residential Development and Associated Infrastructure at Port Fairy	2012/6687	Not Controlled Action (Particular Manner)	Post-Approval
Santos Otway 3d Seismic VIC/P44	2007/3367	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Schomberg 3D Marine Seismic survey	2007/3868	Not Controlled Action (Particular Manner)	Post-Approval
SEA Gas Project transmission pipeline	2001/513	Not Controlled Action (Particular Manner)	Post-Approval
Shaw River Power Station construct gas pipeline and associated infrastructure	2009/5089	Not Controlled Action (Particular Manner)	Post-Approval
Shaw River Power Station Project - Water Supply Pipeline	2009/5091	Not Controlled Action (Particular Manner)	Post-Approval
Southern Gas Pipeline Project	2002/619	Not Controlled Action (Particular Manner)	Post-Approval
Southern Margins T/35P and T/36P 3D Seismic Surveys	2007/3817	Not Controlled Action (Particular Manner)	Post-Approval
Speculant 3D Transition Zone Seismic Survey	2010/5558	Not Controlled Action (Particular Manner)	Post-Approval
Strike Oil NL Seismic Surveys	2000/107	Not Controlled Action (Particular Manner)	Post-Approval
Surface Geochemical Exploration Program, TAS	2010/5780	Not Controlled Action (Particular Manner)	Post-Approval
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, Vic	2012/6565	Not Controlled Action (Particular Manner)	Post-Approval
Thylacine-A Exploration Well	2000/81	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Undertake a three dimensional marine seismic survey	2010/5700	Not Controlled Action (Particular Manner)	Post-Approval
Vic/P37(v) and Vic/P44 3D marine seismic survey	2003/1102	Not Controlled Action (Particular Manner)	Post-Approval
VIC P44 Gas Exploration Wells	2002/662	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 2D seismic survey	2002/811	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 3D seismic survey	2002/799	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, VIC	2012/6545	Referral Decision	Completed
VICP61 2D Marine Seismic Survey	2008/3975	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Bonney Coast Upwelling	South-east
West Tasmania Canyons	South-east

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Likely to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Morus serrator Australasian Gannet [1020]	Foraging	Known to occur
Pelagodroma marina White-faced Storm-petrel [1016]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Sharks		
Carcharodon carcharias White Shark [64470]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur

Scientific Name	Behaviour	Presence
Balaenoptera musculus brevicauda		
Pygmy Blue Whale [81317]	Known Foraging Area	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

Appendix F Sound Modelling Report – Koessler and McPherson 2021

Unit 1, 14 Hook Street
Capalaba, Queensland, 4157

Tel: +61 7 3823 2620
www.jasco.com

TECHNICAL ADDENDUM

DATE: 27 August 2021
FROM: Matthew Koessler, Craig McPherson (JASCO Applied Sciences (Australia) Pty Ltd)
TO: Phil Wemyss (Beach Energy)

SUBJECT: Beach Otway Project: Additional and Revised Modelling Study

1. Summary

JASCO Applied Sciences (JASCO) performed modelling study of underwater sound levels associated with the Beach Energy Otway Development, to supplement drilling and construction results previously presented in Koessler et al. (2020), Matthews et al. (2020) and Matthews et al. (2021).

The results have been revised due to better understanding of the propagation loss in the region gained through the validation monitoring of drilling operations at Artisan-1 McPherson et al. (2021). A significant finding of this study was lack of a thin layer of sand overlying the carbonate seabed structure near Artisan-1, which has a significant influence on propagation loss.

This monitoring project also characterised Monopole Source Levels (MSL) for project vessels (during transit and under dynamic positioning (DP)) and the *Ocean Onyx* Mobile Offshore Drilling Unit (MODU). These source levels are considered in the revised modelling.

Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), and as accumulated sound exposure levels (SEL, L_E) as appropriate for non-impulsive (continuous) noise sources. For the non-time dependent scenarios, the modelled maximum and 95th percentile distances to the marine mammal behavioural threshold based on the current interim NOAA (2019) criterion for marine mammals of 120 dB re 1 µPa (SPL; L_p) for non-impulsive sound sources are summarised in Table 1.

For the time-dependent scenarios, the modelled maximum distances to permanent threshold shift (PTS) and temporary threshold shift (TTS) criteria for low-frequency cetaceans (NMFS 2018), which are based on SEL accumulated over a period of time are summarised in Table 2.

Table 1. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. MCR: Maximum Continuous Rating, MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, ROV: Remotely Operated Vehicle.

Applicable Scenario number	Well Area	Description	R_{max} (km)	$R_{95\%}$ (km)
A1	Thylacine North-1	MODU Drilling	1.24	1.12
A2		OSV under DP	7.1	6.5
A3		OSV Standby Transit	0.38	0.35
A4	Thylacine A	Platform Operations	0.20	0.19
A5	Thylacine North-1	MODU Drilling + OSV resupply	7.89	6.56
A7		MODU Drilling + OSV Standby Transit	1.32	1.19
1, 2, 3, 4	Thylacine A	Platform Operations + OSV resupply	7.28	6.56
5, 6		Platform Operations + OSV Standby	0.45	0.43
7, 9	Thylacine North-1	Pipelay Vessel stationary (June), operating at 20% MCR	2.71	2.57
8, 10		Pipelay Vessel stationary (November), operating at 20% MCR	2.70	2.55
11, 13	Artisan-1	Pipelay Vessel stationary (June), operating at 20% MCR	2.27	2.09
12, 14		Pipelay Vessel stationary (November), operating at 20% MCR	2.26	2.02
15	Thylacine North-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (June)	2.98	2.76
16		Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (November)	2.97	2.73
17	Artisan-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (June)	2.98	2.75
18		Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (November)	2.97	2.72

Applicable Scenario number	Well Area	Description	R_{max} (km)	$R_{95\%}$ (km)
19, 20	Thylacine North-1 + Thylacine A	MODU Drilling + Platform + OSV resupply	7.90	6.65
21		MODU Drilling + Platform + Skid installation vessel operating at 20% MCR	4.85	4.29
23	Thylacine North-1	Pipelay Vessel stationary (June), operating at 40% MCR	4.13	3.64
24		Pipelay Vessel stationary (November), operating at 40% MCR	4.11	3.63
27	Artisan-1	Pipelay Vessel stationary (June), operating at 40% MCR	2.87	2.46
28		Pipelay Vessel stationary (November), operating at 40% MCR	2.86	2.46
31	Thylacine North-1 + Geographe-4	Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4) (June)	3.77	3.29
32		Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4) (November)	3.76	3.23
33	Artisan-1 + Geographe-4	Vessel stationary, operating at 40% MCR (Artsian-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4) (June)	3.76	3.24
34		Vessel stationary, operating at 40% MCR (Artsian-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4) (November)	3.63	3.20
35	Thylacine North-1	MODU Drilling + Platform + Skid installation vessel operating at 40% MCR	6.08	4.99

Table 2. Summary: Maximum (R_{max}) horizontal distances (in km) and ensonified area (km^2) for the frequency-weighted LF-cetacean SEL_{24h} TTS thresholds based on NMFS (2018) from the most appropriate location for considered sources per scenario. MCR: Maximum Continuous Rating, MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, ROV: Remotely Operated Vehicle.

Scenario number	Well Area	Description	R_{max} (km)	Area (km^2)
A1	Thylacine North-1	MODU Drilling	0.39	0.33
A2		OSV under DP	0.95	2.33
A3		OSV Standby Transit	–	–
A4	Thylacine A	Platform Operations	0.04	0.004
A5	Thylacine North-1	MODU Drilling + 4h OSV resupply	1.06	2.49
A6		MODU Drilling + 8h OSV resupply	1.31	4.39
A7		MODU Drilling + OSV Standby Transit	0.39	0.33
1	Thylacine A	Platform + 2h OSV resupply	0.75	1.31
2		Platform + 4h OSV resupply	0.95	2.30
3		Platform + 6h OSV resupply	1.11	3.15
4		Platform + 8h OSV resupply	1.25	4.01
5		Platform 8h + OSV Standby	0.04	0.004
6		Platform + 24h OSV Standby	0.04	0.004
7	Thylacine North-1	Pipelay Vessel stationary (June), operating at 20% MCR	0.60	1.04
8		Pipelay Vessel stationary (November), operating at 20% MCR	0.59	1.04
9		Pipelay Vessel laying pipe (June), operating at 20% MCR	1.18	13.62
10		Pipelay Vessel laying pipe (November), operating at 20% MCR	1.17	13.53
11	Artisan-1	Pipelay Vessel stationary (June), operating at 20% MCR	0.67	1.14
12		Pipelay Vessel stationary (November), operating at 20% MCR	0.67	1.12
13		Pipelay Vessel laying pipe (June), operating at 20% MCR	0.90	10.76
14		Pipelay Vessel laying pipe (November), operating at 20% MCR	0.90	10.69
15	Thylacine North-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (June)	0.66	1.35
16		Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (November)	0.66	1.34
17	Artisan-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (June)	0.67	1.35
18		Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4) (November)	0.67	1.33
19	Thylacine North-1 + Thylacine A	MODU Drilling + Platform + 4h OSV resupply	0.95	2.31
20		MODU Drilling + Platform + 8h OSV resupply	1.23	4.03
21		MODU Drilling + Platform + Skid installation vessel operating at 20% MCR	0.65	1.10

Scenario number	Well Area	Description	R_{max} (km)	Area (km^2)
23	Thylacine North-1	Pipelay Vessel stationary (June), operating at 40% MCR	0.95	2.28
24		Pipelay Vessel stationary (November), operating at 40% MCR	0.94	2.23
25		Pipelay Vessel laying pipe (June), operating at 40% MCR	1.95	24.2
26		Pipelay Vessel laying pipe (November), operating at 40% MCR	1.95	24.1
27	Artisan-1	Pipelay Vessel stationary (June), operating at 40% MCR	0.88	2.02
28		Pipelay Vessel stationary (November), operating at 40% MCR	0.88	1.99
29		Pipelay Vessel laying pipe (June), operating at 40% MCR	1.40	17.1
30		Pipelay Vessel laying pipe (November), operating at 40% MCR	1.39	17.0
31	Thylacine North-1 + Geographe-4	Pipelay Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	0.95	2.39
32		Pipelay Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	0.94	2.38
33	Artisan-1 + Geographe-4	Pipelay Vessel stationary, operating at 40% MCR (Artsian-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	0.91	2.39
34		Vessel stationary, operating at 40% MCR (Pipelay Vessel -1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	0.91	2.38
35	Thylacine North-1	MODU Drilling + Platform + Skid installation vessel operating at 40% MCR	0.85	2.10

2. Introduction

JASCO Applied Sciences (JASCO) performed modelling study of underwater sound levels associated with the Beach Energy Otway Development, to supplement drilling and construction results previously presented in Koessler et al. (2020), Matthews et al. (2020) and Matthews et al. (2021).

The results have been revised due to better understanding of the propagation loss in the region gained through the validation monitoring of drilling operations at Artisan-1 McPherson et al. (2021) as described in Section 2.1. An overview of the modelling scenarios considered is provided in Section 2.2, with results presented in Section 4, and briefly discussed in Section 5.

For noise effect criteria and explanations on methodologies applied, refer to Koessler et al. (2020), Matthews et al. (2020), Matthews et al. (2021) and McPherson et al. (2021).

2.1. Validation Monitoring Study Summary

The monitoring study (McPherson et al. 2021) was completed in relation to the exploration drilling activities at the Artisan-1 well with the aim of completing an acoustic characterisation of the drilling and associated vessel activity within the Otway Basin. Through this characterisation, validation of the modelling predictions used in Beach Energy Otway Environment Plans (EPs) for the development drilling activities was required.

The exploration well Artisan-1, drilled by the *Ocean Onyx*, was selected for the monitoring program because the predicted distances to thresholds for effects on marine mammals, including pygmy blue whales, were farthest at this location in the modelling study used for the EP (Koessler et al. 2020), as well as because it was the first well in the Otway drilling campaign.

Four JASCO Autonomous Multichannel Acoustic Recorders (AMARs) in C-lander moorings were deployed in February and retrieved in early April. Stations 1 through 4 were deployed at distances of 0.336, 1.13, 5.11, and 25 km from the *Ocean Onyx*. The AMARs recorded continuously at 24-bit resolution and 64 kHz sample rate for the entire deployment. The three stations closest to the *Ocean Onyx* were configured with a single hydrophone, whilst the station 25 km away was configured with three hydrophones to provide directional processing of received sounds.

To assist in the characterisation of *Ocean Onyx* and attendant support vessels, the vessels conducted specific activities under dynamic positioning and followed a nominated transit track between the *Ocean Onyx* and Geelong Supply Base. No specific operational requests were made of the *Ocean Onyx* and vessels during normal drilling activities due to the complexity of operationally meeting any requests. Over the course of the monitoring program, the MODU and support vessels engaged in different operational states with different uncontrollable contributors, such as variable drilling operations, resupply and support operations, weather conditions, and merchant shipping.

A summary of the findings of the monitoring study are described in the following sections.

Source Levels

The Monopole Source Levels determined through the measurement study differed from those either estimated for use in the modelling study or those determined using proxy sources. The key differences are as follows:

- The support vessels are quieter than estimated when they are under slow transit speeds, such as 7 knots.
- The support vessels are louder than estimated when they are travelling at faster transit speeds, with 9 knots used to represent these speeds and the associated MSL.
- The support vessels are louder than estimated when holding station or moving under dynamic positioning.
- The drilling operations of the *Ocean Onyx* are both louder at some frequencies and quieter at others than those for the proxy rig the *Polar Pioneer* (Austin et al. 2018), although the results presented for the *Polar Pioneer* did not examine the changes in level with increased drilling depth (over time) as completed within this study.

Comparison of Results

The results from the measurement study could not be directly compared to the modelling presented in Koessler et al. (2020) due to the differences in actual events compared to the nominal representative scenarios developed and evaluated as part of the EP assessment process. Additionally, the measurements were obtained at a receiver located 1.2 m off the seafloor, which is not the maximum-over-depth results reported in the modelling study. The ranges obtained from the measurement study were reported in relation to the Artisan-1 well location, and thus the centre of the *Ocean Onyx*. The ranges in project related modelling studies are reported from a range of locations, including the centroids of multiple sources, thus it was not possible to report the measurement results in a similar fashion using the small number of recording locations used in this study.

Geological Environment Representation

Previous modelling studies for Beach Energy, Koessler et al. (2020), Matthews et al. (2020) and Matthews et al. (2021), used MONM with the assumption of a 1 m thick layer of sand overlaying the carbonate seabed structure at the Artisan-1 well location. This assumption was made due to the lack of available information, and is similar to other inshore work in the Otway Basin, such as (Duncan et al. 2012), who represented the shelf as two zones, an in-shore zone out to a water depth of about 70 m in which the sand layer has a thickness of between 4–10 m, and an off-shore zone of effectively bare calcarenite probably due to scouring by current and swell. The transition between these two zones is ill-defined due to a lack of datapoints, and lies close to the Artisan-1 location, and a balanced approach of assuming 1 m thick layer of sand overlaying the carbonate seabed structure was judged to be appropriate given available information.

The measurement study has increased the understanding of the geological environment in the region and indicates that the sand overlay is thinner (or non-existent) at shallower water depths. The different environment required the use of an alternate configuration of numerical models to represent the propagation loss.

Propagation Loss

The accuracy of the broadband calculated propagation loss for the Otway Basin continental shelf environment depends significantly upon the frequency content of the radiating sound source together with thickness of the sand layer on carbonate seabed (calcarenite) likely to occur within the region. In general, the thinner the sand layer, the greater the overall propagation loss.

When comparing SPL data fits for Stations 1–3 in McPherson et al. (2021), the loss rate is higher than what would have been expected in this environment, considering the higher monopole source levels for the support vessel on DP derived from trial measurements. The differences are likely attributable to the potential absence of a sand veneer.

Comparisons were conducted using JASCO’s Marine Operations Noise Model (MONM), a wide-angle parabolic equation model which applies the BELLHOP Gaussian beam acoustic ray-trace model at higher frequencies, and JASCO’s wavenumber integration model (VSTACK) which can fully account for the elasto-acoustic properties of the sub-bottom. The agreement between the models was excellent when only a comparatively thin (1 m thick) layer of sand overlies the carbonate seabed structure. In an environment such as this, MONM could have been used without correction. However, the comparisons indicate a much higher rates of loss, as would be expected if no (or only a very thin) sand layer were present.

A better understanding of the propagation loss environment, and the revision of the representation and treatment of it through the measurement study, enabled the modelling scenarios for the activities at Artisan-1 presented in Koessler et al. (2020) to be recalculated (Section 6.3 in McPherson et al. (2021)).

2.2. Scenario Details

The scenarios considered within this assessment are detailed below and in Table 3, with the associated modelling sites provided in Table 4. An overview of the scenarios is as follows:

1. Otway Offshore Project Development Drilling Campaign, Thylacine North-1 Operations:
    a. Mobile Offshore Drilling Unit (MODU) conducting normal drilling operations
    b. MODU with Offshore Supply Vessel (OSV) in attendance, standing by and conducting resupply operations under Dynamic Positioning (DP)
2. Otway Offshore Project Operations scenarios:
    1. Operations of the Thylacine platform (at Thylacine-A)
    2. OSV vessel resupply at Thylacine platform for periods of 2, 4, 6 and 8 hrs.
    3. OSV vessel on standby at Thylacine platform for periods of 8 and 24 hrs
4. Otway Offshore Project Construction scenarios: A single nominated pipelay/construction vessel, the Skandi Singapore, was considered for these scenarios. Each scenario was considered with a sound speed profiles for the ‘worst case over the year’ and for the period pygmy blue whales are present in the region, between November and January:
    a. Pipelay vessel (PLV) both stationary and laying pipe at Thylacine North-1 and Artisan-1 operating at 20% of its Maximum Continuous Rating (MCR).
    b. Pipelay vessel operating a Remotely Operated Vehicle (ROV) and cutting tool at Geographe-4. The vessel at Geographe-4 was also modelled operating at 20% and 40% of its Maximum Continuous Rating (MCR).
    c. Quantitively assess the combined sound levels of drilling activities and the construction vessel(s) at the emerging SRW aggregation area at Port Campbell. This scenario considered the drilling activities at

Thylacine North-1 presented in Koessler et al. (2020) and the nominated construction vessel (Skandi Singapore) operating at Geographe-4.

5. Simultaneous assessment for drilling, operations and construction operations were considered for key scenarios:
    a. Drilling at Thylacine while doing Thylacine platform resupply
    b. Drilling at Thylacine while doing installation of Thylacine skid near Thylacine platform. The construction vessel installing the skid was modelled operating at 20% and 40% of its Maximum Continuous Rating (MCR).

Table 3. Description of modelled scenarios. MCR: Maximum Continuous Rating, MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, ROV: Remotely Operated Vehicle.

Scenario number	Well Name	Description	SSP Month	Modelled sites
A1	Thylacine North-1	MODU Drilling	June	1
A2		OSV under DP	June	2
A3		OSV Standby Transit	June	3
A4	Thylacine A	Platform Operations	June	4
A5	Thylacine North-1	MODU Drilling + 4h OSV resupply	June	1,2,3
A6		MODU Drilling + 8h OSV resupply	June	1,2,3
A7		MODU Drilling + OSV Standby Transit	June	1,3
1	Thylacine A	Platform + 2h OSV resupply	June	4,5
2		Platform + 4h OSV resupply	June	4,5
3		Platform + 6h OSV resupply	June	4,5
4		Platform + 8h OSV resupply	June	4,5
5		Platform 8h + OSV Standby	June	3,5
6		Platform + 24h OSV Standby	June	3,5
7	Thylacine North-1	Pipelay Vessel stationary, operating at 20% MCR	June	6
8		Pipelay Vessel stationary, operating at 20% MCR	November	6
9		Pipelay Vessel laying pipe, operating at 20% MCR	June	6
10		Pipelay Vessel laying pipe, operating at 20% MCR	November	6
11	Artisan-1	Pipelay Vessel stationary, operating at 20% MCR	June	7
12		Pipelay Vessel stationary, operating at 20% MCR	November	7
13		Pipelay Vessel laying pipe, operating at 20% MCR	June	7
14		Pipelay Vessel laying pipe, operating at 20% MCR	November	7
15	Thylacine North-1 + Geographe-4	Pipelay Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	June	6,8,9
16		Pipelay Vessel stationary, operating at 20% MCR (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	November	6,8,9

Scenario number	Well Name	Description	SSP Month	Modelled sites
17	Artisan-1 + Geographe-4	Pipelay Vessel stationary, operating at 20% MCR (Artsian-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	June	7,8,9
18	Artisan-1 + Geographe-4	Vessel stationary, operating at 20% MCR (Pipelay Vessel -1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	November	7,8,9
19	Thylacine North-1 + Thylacine A	MODU Drilling + Platform + 4h OSV resupply	June	1,4,5
20		MODU Drilling + Platform + 8h OSV resupply	June	1,4,5
21		MODU Drilling + Platform + Skid installation vessel at 20% MCR	June	1,4,6
22	Thylacine North-1 + Geographe-4	MODU Drilling + 8h OSV resupply (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	June	1,2,3,8,9
23	Thylacine North-1	Pipelay Vessel stationary, operating at 40% MCR	June	6
24		Pipelay Vessel stationary, operating at 40% MCR	November	6
25		Pipelay Vessel laying pipe, operating at 40% MCR	June	6
26		Pipelay Vessel laying pipe, operating at 40% MCR	November	6
27	Artisan-1	Pipelay Vessel stationary, operating at 40% MCR	June	7
28		Pipelay Vessel stationary, operating at 40% MCR	November	7
29		Pipelay Vessel laying pipe, operating at 40% MCR	June	7
30		Pipelay Vessel laying pipe, operating at 40% MCR	November	7
31	Thylacine North-1 + Geographe-4	Pipelay Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	June	6,8,9
32		Pipelay Vessel stationary, operating at 40% MCR (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	November	6,8,9
33	Artisan-1 + Geographe-4	Pipelay Vessel stationary, operating at 40% MCR (Artsian-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	June	7,8,9
34		Vessel stationary, operating at 40% MCR (Pipelay Vessel -1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	November	7,8,9

35	Thylacine North-1	MODU Drilling + Platform + Skid installation at 40% MCR	June	1,4,6
36	Thylacine North-1 + Geographe-4	MODU Drilling + 8h OSV resupply (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	June	1,2,3,8,9

Table 4. Location details for the modelled sites. MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, PLV: Pipelay Vessel, ROV: Remotely Operated Vehicle, WHP: Well Head Platform

Well	**Site**	**Source**	**Latitude (S)**	**Longitude (E)**	**MGA Zone 54 (GDA94)**		**Water depth (m)**
					X (m)	*Y* (m)	
Thylacine North-1	1	MODU	39° 12.51001'	142° 52.49601'	661882	5658411	99.1
	2	OSV	39° 12.48903'	142° 53.88508'	663882	5658408	99.1
	3	OSV standby	39° 12.50986'	142° 52.54039'	661946	5658410	99.2
Thylacine A	4	WHP	39° 14.40200'	142° 54.60100'	664838	5654848	102.4
	5	OSV	39° 14.40059'	142° 54.64574'	664902	5654849	102.3
Thylacine North-1	6	PLV	39° 12.51001'	142° 52.49601'	661882	5658411	99.1
Artisan-1	7	PLV	38° 53.45684'	142° 52.97408'	663300	5693640	71.5
Geographe-4	8	PLV	39° 6.49400'	142° 57.06700'	668700	5669400	85.0
	9	*ROV Cutting Tool*	39° 6.49400'	142° 57.06700'	668700	5669400	85.0
Thylacine North-1	10	OSV	39° 14.40200'	142° 54.60100'	664838	5654848	102.4

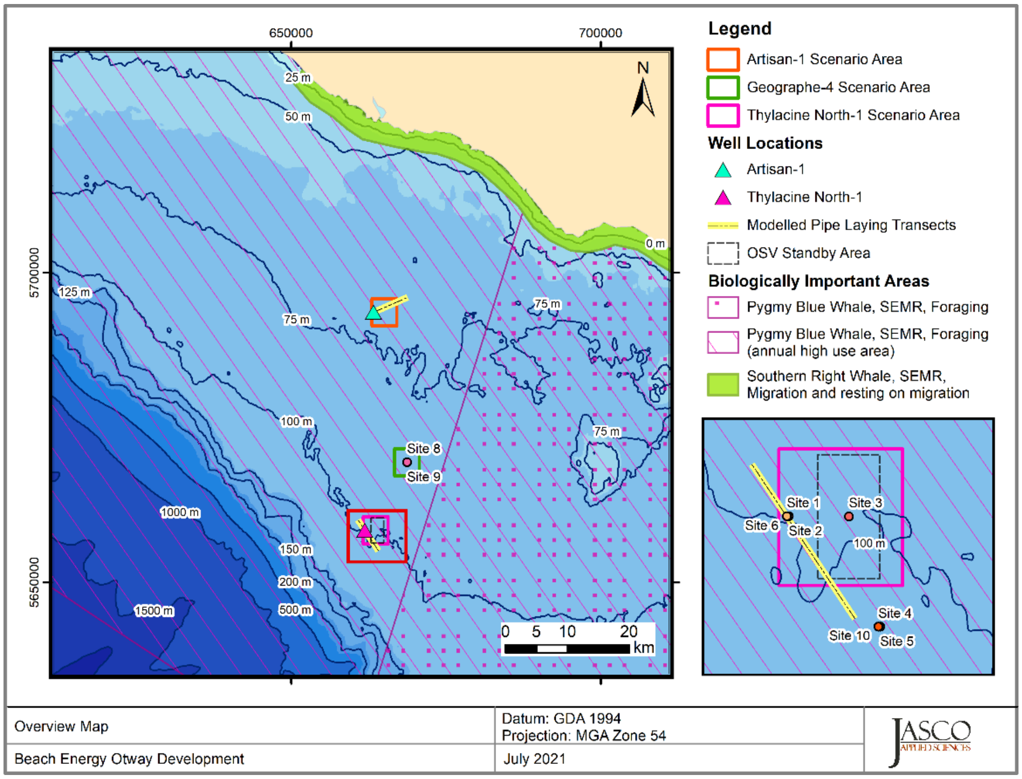


Figure 1. Overview of the modelled area (focus on Thylacine North-1 Scenario Area) and local features within the South East Marine Region (SEMR).

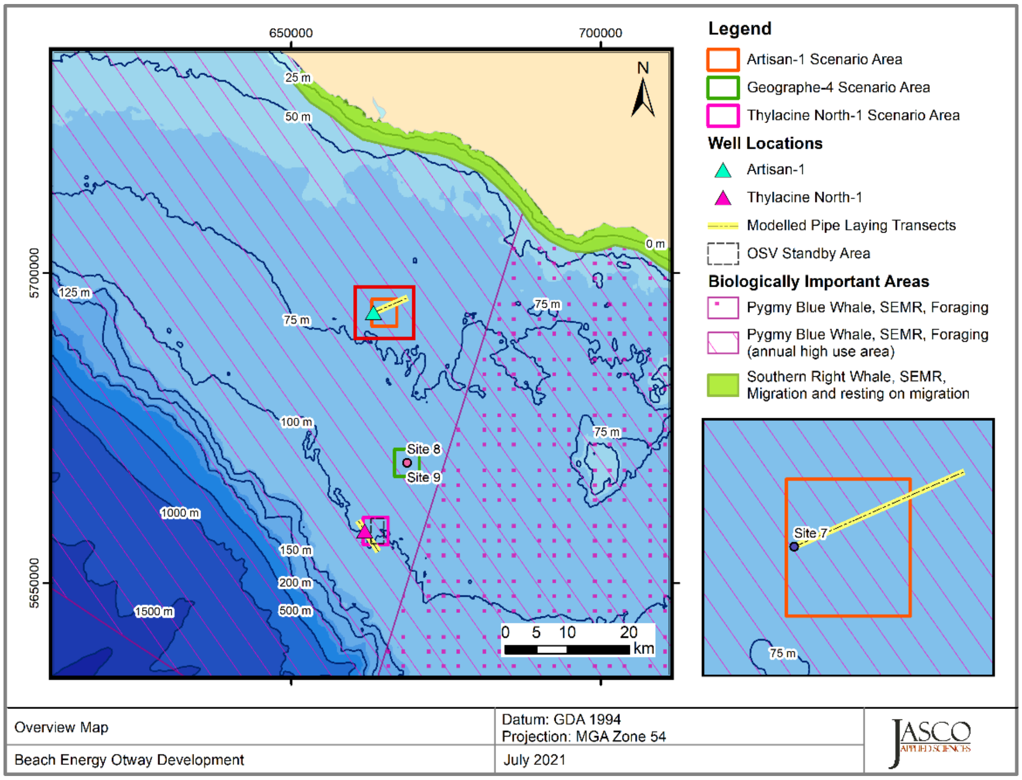


Figure 2. Overview of the modelled area (focus on Artisan-1 Scenario Area) and local features within the South East Marine Region (SEMR).

3. Methods and Parameters

A details description of the employed modelling method and input parameters can be found in refer to Koessler et al. (2020), Matthews et al. (2020), Matthews et al. (2021), Connell et al. (2021) and McPherson et al. (2021). A brief a summary of key elements used in this addendum are provided as follows.

The measured monopole source levels (MSLs) and spectra for the MODU and OSV were used here from McPherson et al. (2021):

- For the MODU drilling, mean levels from Section 5.5.1 in McPherson et al. (2021) were used.
- For scenarios where the OSV was under dynamic positioning (DP) the average spectrum from Section 5.5.2 in McPherson et al. (2021) was used.
- For scenarios where the OSV was transiting or standing by the average slow transit (7 knots) spectrum in McPherson et al. (2021) was used.

For the construction phase scenarios, estimates of the energy source levels (ESLs) for the pipelay/construction vessel were based on the specifications of the *Skandi Singapore* and an ESL derived from recordings of the TechnipFMC flexible lay and construction vessel *Deep Orient*. The specifications of proxy vessel and details on scaling can be found in Matthews et al. (2020), Matthews et al. (2021) and Connell et al. (2021).

Fixed structures such as the WHP have lower radiated sound levels than floating platforms (Spence et al. 2007). Equipment operating onboard floating platforms can contribute to marine environment sound however, airborne and structure-borne (vibration) pathways are considered more significant on these facilities, where equipment can be located below the water line. Underwater noise produced from platforms standing on metal jack-up legs is relatively low given the small surface areas available for sound transmission and also given the location of machinery above the waterline. It is therefore expected that the dominant pathway for sound generation is structure-borne (i.e., vibration from machinery passing through the legs) (Spence et al. 2007).

A study involving the Endeavour Jack-up Rig, operating in Cook Inlet, was conducted by Illingworth and Rodkin (2014) during drilling activities. The results from the sound source verification indicated that sound generated from drilling or generators were below ambient sound levels. The generators used on the Endeavour are mounted on pedestals specifically to reduce sound transfer through the infrastructure, and they are enclosed in an insulated engine room, which may have reduced further underwater sound transmission to levels below those generated by the Spartan 151. The sound source verification revealed that the submersed deep-well pumps that charge the fire-suppression system and cool the generators (in a closed water system) were the most likely dominant contributor the sound field. The measurements are reported as near-source levels recorded close to the bow leg pump system (at 10 m range) (Figure 3-5 in Illingworth and Rodkin Inc. (2014). These were backpropagated using spherical spreading to determine an energy source level (ESL) spectrum. Considering the similarities between a Jack-up Rig and a static WHP the decidecade band spectrum is shown in Figure 3 was used in modelling noise emissions from the Thylacine-A platform.

Furthermore, as discussed by (McPherson et al. 2021) and discussed above in Section 2.1, significant rates of propagation loss were found when analysing the data from the measurement study. As part of the model-measurement validation an adjustment factor was applied broadband received level predictions to account for the loss associated with a cemented limestone seabed (calcarenite) (Section 6.2 in McPherson et al. (2021)). A similar adjustment, which only differed by accounting for sources in different water depths, was applied to broadband level predictions in this addendum as a very similar type of seabed environment is expected at the Thylacine scenario area

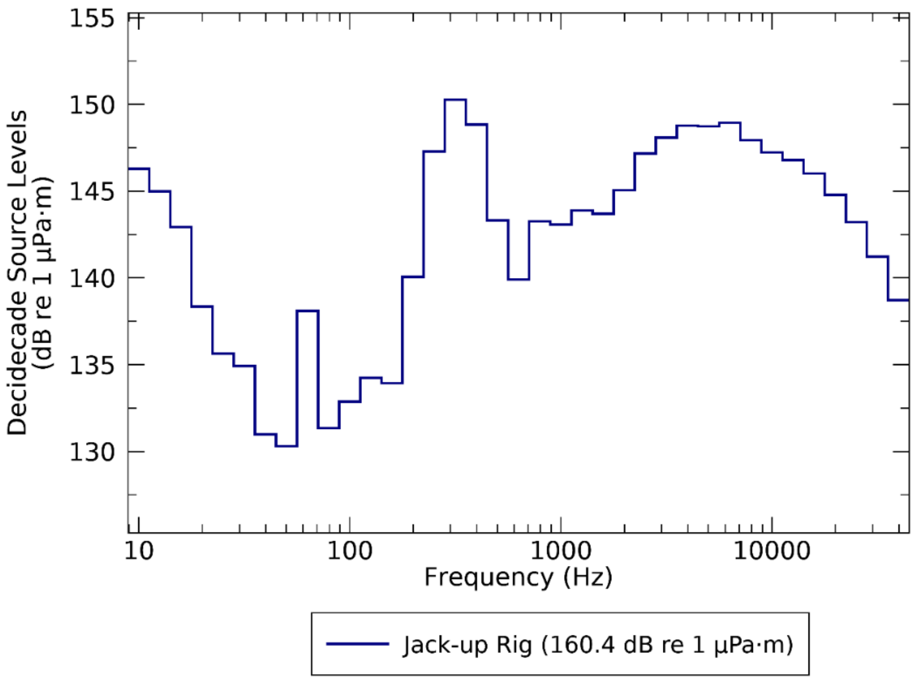


Figure 3. Energy source level (ESL) spectra (in decidecade frequency-band) for the Jack-up Rig considered as a proxy source for the Thylacine WHP.

4. Results

For the considered scenarios (described in Section 2.2), the maximum-over-depth sound fields for the modelled scenarios are presented below in two formats: as tables of distances to sound levels and, where the distances are long enough, as contour maps showing the directivity and distance to various sound levels. Distances to isopleths/thresholds were reported from either the centroid of several sources or from the most dominant single source. When an isopleth completely envelopes multiple sources the centroid was used. When several closed isopleths exist the most dominant source was used.

Tables 5–7 present the maximum and 95% distances (defined in Appendix B.1) to SPL isopleths. Since the SPL metric does not depend on the duration of the operation, these estimates are valid for both, stationary and non-stationary scenarios. Tables 11–16 present the distances to frequency-weighted SEL_{24h} threshold, as well as the total ensonified area for all scenarios.

The maximum-over-depth sound fields for nine scenarios (described in Section were extracted at the emerging SRW aggregation area at Port Campbell, and can be compared to the 120 dB re 1 µPa threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

4.1. Tabulated Results

Table 5. *Scenarios A1–A7:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenarioA dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, DP: Dynamic Positioning.

SPL (L_p; dB re 1 μPa)	**MODU Drilling (Scenario A1)**		**OSV under DP (Scenario A2)**		**OSV Standby Transit (Scenario A3)**		**Platform (Scenario A4)**		**MODU Drilling and OSV Resupply (Scenario A5)**		**MODU Drilling and OSV Standby (Scenario A7)**	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	0.05	0.05	–	–
170[A]	–	–	–	–	–	–	–	–	0.05	0.05	–	–
160	–	–	0.08	0.08	–	–	–	–	0.11	0.10	–	–
158[B]	–	–	0.13	0.12	–	–	–	–	0.15	0.15	–	–
150	–	–	0.32	0.31	–	–	–	–	0.36	0.31	–	–
140	0.09	0.09	0.87	0.81	–	–	–	–	0.88	0.82	0.09	0.09
130	0.38	0.35	2.3	2.15	0.17	0.16	–	–	2.51	2.18	0.38	0.35
120[C]	1.24	1.12	7.10	6.50	0.38	0.35	0.20	0.19	7.89	6.56	1.32	1.19

[A] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).

[B] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).

[C] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

Table 6. *Scenarios 1–11:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. A dash indicates the level was not reached within the limits of the modelling resolution (20 m). OSV: Offshore Supply Vessel, PLV: Pipelay Vessel.

SPL (L_p; dB re 1 µPa)	**Platform and OSV resupply (Scenario 1)**		**Platform and OSV standby (Scenario 5)**		**PLV stationary operating at 20% MCR, Thylacine**				**PLV stationary operating at 20% MCR, Artisan**			
					June (Scenario 7)		**November (Scenario 8)**		**June (Scenario 11)**		**November (Scenario 12)**	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	–	–	–	–
170[A]	–	–	–	–	–	–	–	–	–	–	–	–
160	0.08	0.08	–	–	–	–	–	–	–	–	–	–
158[B]	0.14	0.09	–	–	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
150	0.28	0.27	–	–	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
140	0.85	0.80	–	–	0.33	0.32	0.33	0.32	0.29	0.29	0.29	0.29
130	2.48	2.18	0.17	0.16	0.95	0.85	0.94	0.84	0.87	0.80	0.87	0.80
120[C]	7.31	6.56	0.45	0.43	2.71	2.57	2.70	2.55	2.27	2.09	2.26	2.02

[A] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).

[B] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).

[C] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

Table 7. *Scenarios 15–21:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. A dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, PLV: Pipelay Vessel, ROV: Remotely Operated Vehicle.

SPL (L_p; dB re 1 µPa)	**PLV stationary operating at 20% MCR, at Thylacine and ROV Operations at Geographe-4**				**PLV stationary operating at 20% MCR, at Artisan and ROV Operations at Geographe-4**				**MODU Drilling, Platform and OSV resupply**		**MODU Drilling, Platform and Skid installation vessel at 20% MCR**	
	June (Scenario 15)		**November (Scenario 16)**		**June (Scenario 17)**		**November (Scenario 18)**		**(Scenario 19)**		**(Scenario 21)**	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	–	–	–	–
170[A]	–	–	–	–	–	–	–	–	–	–	–	–
160	–	–	–	–	–	–	–	–	0.08	0.08	–	–
158[B]	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.14	0.09	0.04	0.04
150	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.28	0.27	0.09	0.09
140	0.32	0.31	0.32	0.31	0.32	0.31	0.32	0.31	0.85	0.80	0.31	0.30
130	0.91	0.86	0.91	0.84	0.91	0.86	0.91	0.84	2.48	2.18	0.85	0.83
120[C]	2.98	2.76	2.97	2.73	2.98	2.75	2.97	2.72	7.90	6.65	4.85	4.29

[A] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).

[B] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).

[C] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

Table 8. *Scenarios 23–24, 27–28:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. A dash indicates the level was not reached within the limits of the modelling resolution (20 m). OSV: Offshore Supply Vessel, PLV: Pipelay Vessel.

SPL (L_p; dB re 1 µPa)	**PLV stationary operating at 40% MCR, Thylacine**				**PLV stationary operating at 40% MCR, Artisan**			
	June (Scenario 23)		**November (Scenario 24)**		**June (Scenario 27)**		**November (Scenario 28)**	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–
170[A]	–	–	–	–	–	–	–	–
160	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
158[B]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
150	0.17	0.17	0.17	0.17	0.16	0.15	0.16	0.15
140	0.44	0.43	0.44	0.43	0.39	0.38	0.39	0.38
130	1.26	1.18	1.27	1.17	1.12	1.10	1.12	1.09
120[C]	4.13	3.64	4.11	3.63	2.87	2.46	2.86	2.46

[A] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).

[B] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).

[C] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

Table 9. *Scenarios 31–35:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. A dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel, PLV: Pipelay Vessel, ROV: Remotely Operated Vehicle.

SPL (L_p; dB re 1 µPa)	**PLV stationary operating at 40% MCR, at Thylacine and ROV Operations at Geographe-4**				**PLV stationary operating at 40% MCR, at Artisan and ROV Operations at Geographe-4**				**MODU Drilling, Platform and Skid Installation Vessel operating at 40% MCR**	
	June (Scenario 31)		**November (Scenario 32)**		**June (Scenario 33)**		**November (Scenario 34)**		**(Scenario 35)**	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	–	–
170[A]	–	–	–	–	–	–	–	–	–	–
160	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
158[B]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
150	0.16	0.15	0.16	0.16	0.16	0.15	0.16	0.16	0.15	0.14
140	0.46	0.41	0.46	0.4	0.46	0.41	0.46	0.40	0.42	0.38
130	1.56	1.26	1.56	1.25	1.56	1.26	1.56	1.25	1.39	1.14
120[C]	3.77	3.29	3.76	3.23	3.76	3.24	3.63	3.20	6.08	4.99

[A] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
[B] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
[C] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

Table 10. Received SPL at the Port Campbell SRW receiver for relevant scenarios.

Scenario	**Description**	**Location(s)**	**SPL (Lp; dB re 1 µPa) at Port Campbell SRW Receiver**
22	MODU Drilling + 8h OSV resupply (Thylacine North-1) + Vessel stationary, operating at 20% MCR + ROV cutting tool (Geographe-4)	Thylacine North-1 + Geographe-4	93.8
36	MODU Drilling + 8h OSV resupply (Thylacine North-1) + Vessel stationary, operating at 40% MCR + ROV cutting tool (Geographe-4)	Thylacine North-1 + Geographe-4	94.1

Table 11. *Scenarios A1-A7:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL$_{24h}$ PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel.

Hearing group	**SEL$_{24h}$ threshold** ($L_{E,24h}$; dB re 1 µPa^2·s)†	**MODU Drilling (Scenario A1)**		**OSV under DP (Scenario A2)**		**OSV Standby Transit (Scenario A3)**		**Platform (Scenario A4)**		**MODU Drilling and 4h OSV resupply (Scenario A5)**		**MODU Drilling and 8h OSV resupply (Scenario A6)**		**MODU Drilling and OSV Standby Transit (Scenario A7)**	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS															
LF cetaceans	199	0.03	0.004	0.09	0.03	–	–	0.02	0.001	0.12	0.03	0.18	0.08	0.06	0.004
MF cetaceans	198	0.02	0.001	0.02	0.001	–	–	0.02	0.001	0.05	0.002	0.05	0.002	0.04	0.001
HF cetaceans	173	0.23	0.16	0.06	0.01	–	–	0.03	0.004	0.26	0.16	0.26	0.17	0.26	0.16
Phocid seals	201	0.02	0.001	0.03	0.003	–	–	0.02	0.001	0.05	0.004	0.07	0.01	0.04	0.001
Otariid seals	219	–	–	–	–	–	–	–	–	0.03	0.001	0.05	0.001	–	–
Turtles	220	–	–	0.02	0.001	–	–	–	–	0.05	0.002	0.05	0.002	–	–
TTS															
LF cetaceans	179	0.39	0.33	0.95	2.33	–	–	0.04	0.004	1.06	2.49	1.31	4.39	0.39	0.33
MF cetaceans	178	0.13	0.06	0.06	0.01	–	–	0.03	0.003	0.16	0.06	0.16	0.07	0.13	0.06
HF cetaceans	153	1.12	3.22	0.47	0.69	–	–	0.30	0.28	1.16	3.71	1.16	3.99	1.12	3.22
Phocid seals	181	0.12	0.04	0.28	0.24	–	–	0.03	0.00	0.32	0.27	0.46	0.55	0.12	0.04
Otariid seals	199	0.02	0.001	0.04	0.01	–	–	0.02	0.001	0.07	0.01	0.09	0.01	0.02	0.001
Turtles	200	0.02	0.002	0.07	0.02	–	–	0.02	0.001	0.10	0.02	0.16	0.06	0.02	0.002

Table 12. *Scenarios 1–6:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL$_{24h}$ PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), OSV: Offshore Supply Vessel.

Hearing group	**SEL$_{24h}$ threshold** ($L_{E,24h}$; dB re 1 µPa²·s)†	**Platform and OSV resupply 2 h (Scenario 1)**		**Platform and OSV resupply 4 h (Scenario 2)**		**Platform and OSV resupply 6 h (Scenario 3)**		**Platform and OSV resupply 8 h (Scenario 4)**		**Platform and OSV 8h standby (Scenario 5)**		**Platform and OSV 24h standby (Scenario 6)**	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS													
LF cetaceans	199	0.10	0.02	0.12	0.03	0.14	0.04	0.18	0.07	0.02	0.001	0.02	0.001
MF cetaceans	198	0.05	0.001	0.05	0.001	0.05	0.002	0.05	0.002	0.02	0.001	0.02	0.001
HF cetaceans	173	0.08	0.01	0.09	0.02	0.10	0.02	0.11	0.02	0.03	0.004	0.03	0.004
Phocid seals	201	0.05	0.002	0.06	0.004	0.06	0.01	0.08	0.01	0.02	0.001	0.02	0.001
Otariid seals	219	–	–	–	–	–	–	–	–	–	–	–	–
Turtles	220	–	–	–	–	0.04	0.001	0.04	0.001	–	–	–	–
TTS													
LF cetaceans	179	0.75	1.31	0.95	2.30	1.11	3.15	1.25	4.01	0.04	0.004	0.04	0.004
MF cetaceans	178	0.06	0.01	0.08	0.01	0.09	0.02	0.10	0.02	0.03	0.003	0.03	0.003
HF cetaceans	153	0.45	0.60	0.52	0.79	0.60	1.05	0.63	1.17	0.30	0.28	0.30	0.28
Phocid seals	181	0.23	0.12	0.30	0.24	0.37	0.36	0.43	0.46	0.03	0.00	0.03	0.00
Otariid seals	199	0.06	0.004	0.07	0.01	0.08	0.01	0.08	0.01	0.02	0.001	0.02	0.001
Turtles	200	0.08	0.01	0.10	0.02	0.11	0.02	0.17	0.04	0.02	0.001	0.02	0.001

Table 13. *Scenarios 7–10:* Maximum (*R_{max}*) horizontal distances (in km) to frequency-weighted SEL$_{24h}$ PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel.

Hearing group	**SEL$_{24h}$ threshold** ($L_{E,24h}$; dB re 1 µPa²·s)†	**PLV stationary operating at 20% MCR, at Thylacine**				**PLV laying pipe operating at 20% MCR, at Thylacine**			
		June (Scenario 7)		**November (Scenario 8)**		**June (Scenario 9)**		**November (Scenario 10)**	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS									
LF cetaceans	199	0.06	0.01	0.06	0.01	0.02	0.21	0.02	0.21
MF cetaceans	198	0.02	0.001	0.02	0.001	0.01	0.02	0.01	0.02
HF cetaceans	173	0.09	0.03	0.09	0.03	0.03	0.37	0.03	0.36
Phocid seals	201	0.02	0.001	0.02	0.001	0.01	0.14	0.01	0.14
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	0.02	0.001	0.02	0.001	–	–	–	–
TTS									
LF cetaceans	179	0.60	1.04	0.59	1.04	1.18	13.62	1.17	13.53
MF cetaceans	178	0.07	0.02	0.07	0.02	0.02	0.22	0.02	0.22
HF cetaceans	153	0.84	2.02	0.70	1.36	1.19	15.04	1.46	16.02
Phocid seals	181	0.19	0.12	0.19	0.12	0.13	1.54	0.13	1.54
Otariid seals	199	0.02	0.001	0.02	0.001	0.01	0.15	0.01	0.15
Turtles	200	0.08	0.02	0.08	0.02	0.02	0.27	0.02	0.27

Table 14. *Scenarios 11–14:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel.

Hearing group	**SEL_{24h} threshold** ($L_{E,24h}$; dB re 1 µPa²·s)†	**PLV stationary operating at 20% MCR, at Artisan**				**PLV laying pipe operating at 20% MCR, at Artisan**			
		June (Scenario 11)		**November (Scenario 12)**		**June (Scenario 13)**		**November (Scenario 14)**	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS									
LF cetaceans	199	0.06	0.01	0.06	0.01	0.02	0.25	0.02	0.25
MF cetaceans	198	0.01	0.001	0.01	0.001	–	–	–	–
HF cetaceans	173	0.09	0.03	0.09	0.03	0.03	0.37	0.03	0.37
Phocid seals	201	0.02	0.001	0.02	0.001	0.02	0.13	0.02	0.13
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	0.01	0.001	0.01	0.001	–	–	–	–
TTS									
LF cetaceans	179	0.67	1.14	0.67	1.12	0.90	10.76	0.90	10.69
MF cetaceans	178	0.07	0.02	0.07	0.02	0.03	0.30	0.03	0.30
HF cetaceans	153	0.77	1.60	0.62	1.18	0.95	11.92	0.91	10.68
Phocid seals	181	0.19	0.11	0.19	0.11	0.12	1.36	0.12	1.36
Otariid seals	199	0.02	0.001	0.02	0.001	0.02	0.22	0.02	0.22
Turtles	200	0.07	0.02	0.07	0.02	0.03	0.29	0.03	0.29

Table 15. *Scenarios 15–18:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL$_{24h}$ PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel, ROV: Remotely Operated Vehicle.

Hearing group	**SEL$_{24h}$ threshold** ($L_{E,24h}$; dB re 1 µPa^2·s)†	**PLV stationary operating at 20% MCR, at Thylacine and ROV Operations at Geographe-4**				**PLV stationary operating at 20% MCR, at Artisan and ROV Operations at Geographe-4**			
		June (Scenario 15)		**November (Scenario 16)**		**June (Scenario 17)**		**November (Scenario 18)**	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS									
LF cetaceans	199	0.06	0.01	0.06	0.01	0.06	0.01	0.06	0.01
MF cetaceans	198	0.02	0.001	0.02	0.001	0.02	0.001	0.02	0.001
HF cetaceans	173	0.12	0.04	0.11	0.04	0.12	0.04	0.11	0.04
Phocid seals	201	0.02	0.001	0.02	0.001	0.02	0.001	0.02	0.001
Otariid seals	219	0.01	0.001	0.01	0.001	0.01	0.001	0.01	0.001
Turtles	220	0.02	0.001	0.02	0.001	0.01	0.001	0.01	0.001
TTS									
LF cetaceans	179	0.66	1.35	0.66	1.34	0.67	1.35	0.67	1.33
MF cetaceans	178	0.09	0.03	0.09	0.03	0.09	0.03	0.09	0.03
HF cetaceans	153	0.87	2.37	0.83	1.93	0.87	2.37	0.83	1.93
Phocid seals	181	0.19	0.12	0.19	0.12	0.19	0.11	0.19	0.11
Otariid seals	199	0.02	0.001	0.02	0.001	0.02	0.001	0.02	0.001
Turtles	200	0.08	0.02	0.08	0.02	0.08	0.02	0.08	0.02

Table 16. *Scenarios 19–21:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m). MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel.

Hearing group	**SEL_{24h} threshold** ($L_{E,24h}$; dB re 1 µPa²·s)†	**MODU Drilling, Platform and 4 h OSV resupply (Scenario 19)**		**MODU Drilling, Platform and 8 h OSV resupply (Scenario 20)**		**MODU Drilling, Platform and Skid Installation Vessel operating at 20% MCR (Scenario 21)**	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS							
LF cetaceans	199	0.09	0.03	0.15	0.07	0.06	0.01
MF cetaceans	198	0.04	0.001	0.04	0.001	0.04	0.001
HF cetaceans	173	0.26	0.16	0.26	0.16	0.26	0.16
Phocid seals	201	0.04	0.004	0.05	0.008	0.04	0.001
Otariid seals	219	–	–	–	–	–	–
Turtles	220	–	–	0.03	0.001	0.03	0.001
TTS							
LF cetaceans	179	0.95	2.31	1.23	4.03	0.65	1.10
MF cetaceans	178	0.16	0.06	0.16	0.06	0.16	0.06
HF cetaceans	153	1.15	3.25	1.15	3.26	1.15	3.26
Phocid seals	181	0.28	0.24	0.41	0.46	0.18	0.09
Otariid seals	199	0.04	0.005	0.06	0.011	0.04	0.001
Turtles	200	0.08	0.02	0.15	0.04	0.08	0.02

Table 17. *Scenarios 23–26:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel.

Hearing group	**SEL_{24h} threshold** ($L_{E,24h}$; dB re 1 µPa²·s)†	**PLV stationary operating at 40% MCR, at Thylacine**				**PLV laying pipe operating at 40% MCR, at Thylacine**			
		June (Scenario 23)		**November (Scenario 24)**		**June (Scenario 25)**		**November (Scenario 26)**	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS									
LF cetaceans	199	0.09	0.03	0.09	0.03	0.03	0.39	0.03	0.39
MF cetaceans	198	0.02	0.001	0.02	0.001	0.01	0.11	0.01	0.11
HF cetaceans	173	0.16	0.08	0.16	0.08	0.07	0.79	0.07	0.78
Phocid seals	201	0.02	0.001	0.02	0.001	0.02	0.18	0.01	0.18
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	0.02	0.001	0.02	0.001	–	–	–	–
TTS									
LF cetaceans	179	0.95	2.28	0.94	2.23	1.95	24.2	1.95	24.1
MF cetaceans	178	0.10	0.03	0.10	0.03	0.04	0.48	0.04	0.47
HF cetaceans	153	1.17	3.44	0.94	2.47	1.75	21.8	2.08	27.0
Phocid seals	181	0.27	0.22	0.30	0.22	0.24	2.76	0.24	2.75
Otariid seals	199	0.03	0.003	0.03	0.003	0.02	0.18	0.02	0.18
Turtles	200	0.11	0.038	0.11	0.04	0.05	0.57	0.05	0.57

Table 18. *Scenarios 27–30:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel.

Hearing group	**SEL_{24h} threshold** ($L_{E,24h}$; dB re 1 µPa²·s)†	**PLV stationary operating at 40% MCR, at Artisan**				**PLV laying pipe operating at 40% MCR, at Artisan**			
		June (Scenario 27)		**November (Scenario 28)**		**June (Scenario 29)**		**November (Scenario 30)**	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS									
LF cetaceans	199	0.09	0.03	0.09	0.03	0.04	0.39	0.03	0.39
MF cetaceans	198	0.01	0.001	0.01	0.001	0.01	0.02	0.01	0.01
HF cetaceans	173	0.14	0.06	0.14	0.06	0.07	0.75	0.06	0.74
Phocid seals	201	0.02	0.001	0.02	0.001	0.02	0.25	0.02	0.25
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	–	–	–	–	–	–	–	–
TTS									
LF cetaceans	179	0.88	2.02	0.88	1.99	1.40	17.1	1.39	17.0
MF cetaceans	178	0.10	0.03	0.11	0.04	0.04	0.49	0.04	0.48
HF cetaceans	153	0.94	2.75	0.81	1.93	1.27	16.5	1.53	18.3
Phocid seals	181	0.25	0.19	0.24	0.18	0.21	2.44	0.21	2.43
Otariid seals	199	0.03	0.002	0.03	0.002	0.02	0.25	0.02	0.25
Turtles	200	0.14	0.06	0.14	0.06	0.05	0.59	0.05	0.59

Table 19. *Scenarios 31–34:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m), PLV: Pipelay Vessel, ROV: Remotely Operated Vehicle.

Hearing group	**SEL_{24h} threshold** ($L_{E,24h}$; dB re 1 µPa²·s)†	**PLV stationary operating at 40% MCR, at Thylacine and ROV Operations at Geographe-4**				**PLV stationary operating at 40% MCR, at Artisan and ROV Operations at Geographe-4**				**MODU Drilling, Platform and Skid Installation Vessel operating at 40% MCR (Scenario 35)**	
		June (Scenario 31)		**November (Scenario 32)**		**June (Scenario 33)**		**November (Scenario 34)**			
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS											
LF cetaceans	199	0.10	0.03	0.09	0.03	0.10	0.03	0.09	0.03	0.09	0.03
MF cetaceans	198	0.02	0.001	0.02	0.001	0.02	0.001	0.02	0.001	0.04	0.001
HF cetaceans	173	0.16	0.08	0.16	0.08	0.15	0.08	0.15	0.08	0.26	0.16
Phocid seals	201	0.02	0.002	0.02	0.002	0.02	0.002	0.02	0.002	0.04	0.001
Otariid seals	219	–	–	–	–	–	–	–	–	–	–
Turtles	220	0.02	0.001	0.02	0.001	–	–	–	–	0.03	0.001
TTS											
LF cetaceans	179	0.95	2.39	0.94	2.38	0.91	2.39	0.91	2.38	0.85	2.10
MF cetaceans	178	0.13	0.05	0.13	0.05	0.13	0.05	0.13	0.05	0.16	0.06
HF cetaceans	153	1.17	3.55	0.99	3.08	1.06	3.55	0.99	3.08	1.15	3.28
Phocid seals	181	0.27	0.22	0.27	0.22	0.25	0.19	0.25	0.19	0.22	0.15
Otariid seals	199	0.03	0.003	0.03	0.003	0.03	0.003	0.03	0.003	0.04	0.003
Turtles	200	0.15	0.05	0.15	0.05	0.15	0.06	0.15	0.06	0.10	0.04

4.2. Sound Field Maps

4.2.1. SPL Maps

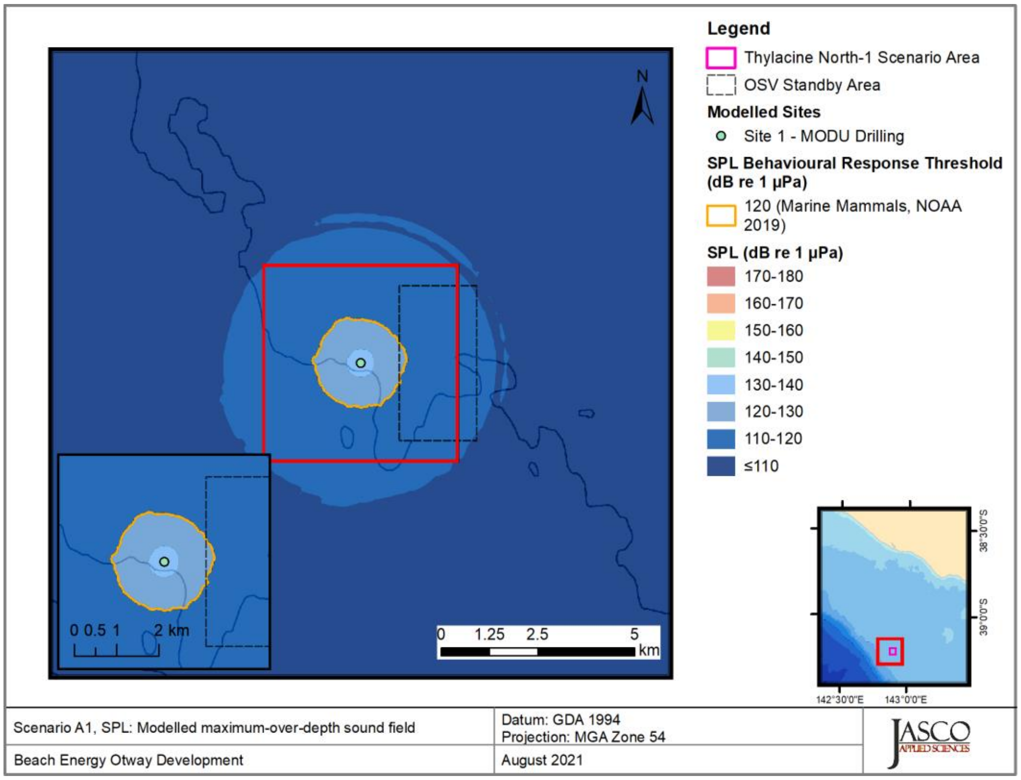


Figure 4. *Thylacine North-1, MODU Drilling (Scenario A1) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

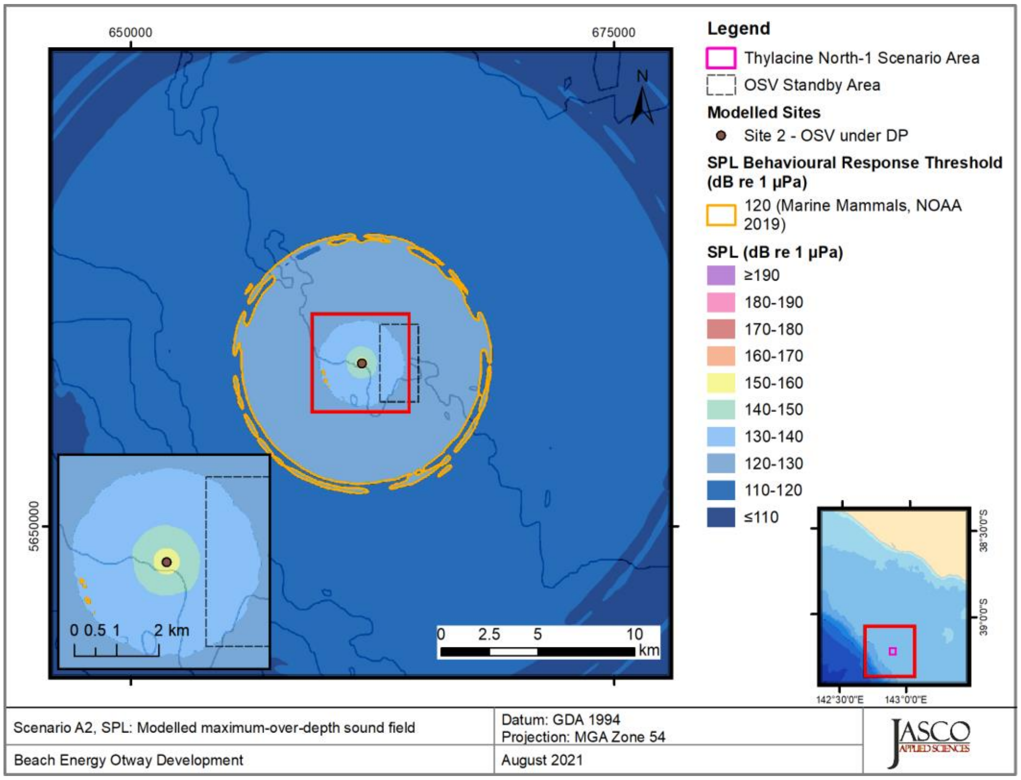


Figure 5. *Thylacine North-1, OSV on DP (Scenario A2) :* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

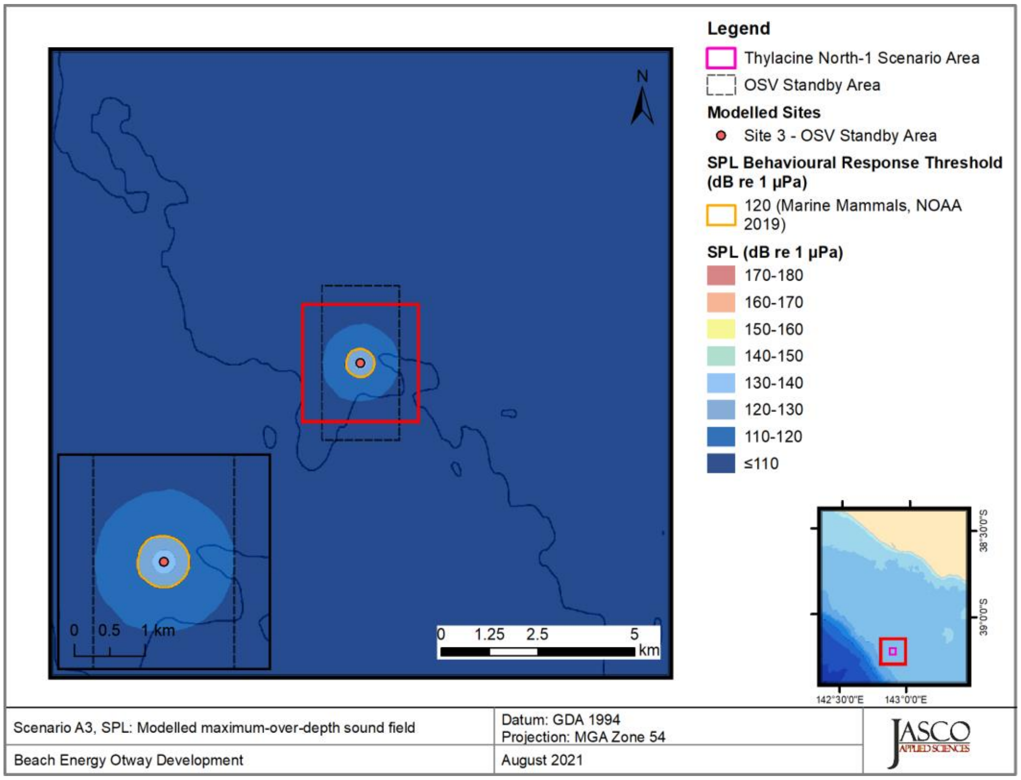


Figure 6. *Thylacine North-1, OSV Standby (Scenario A3) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

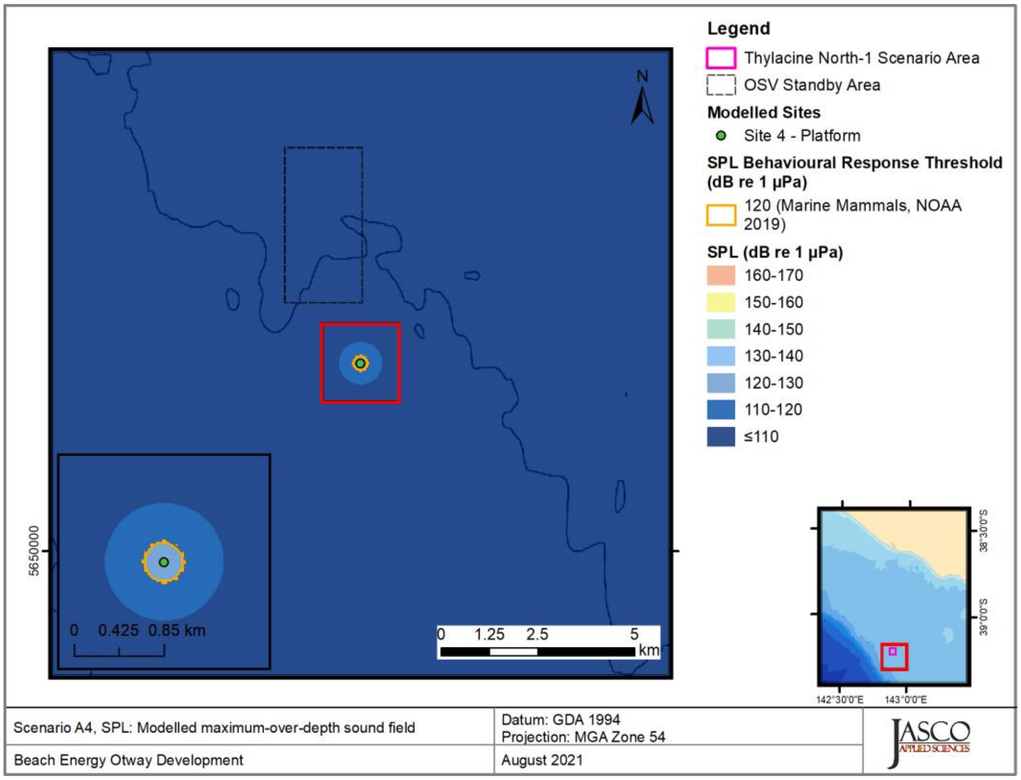


Figure 7. *Thylacine A, Platform Operations (Scenario A4) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

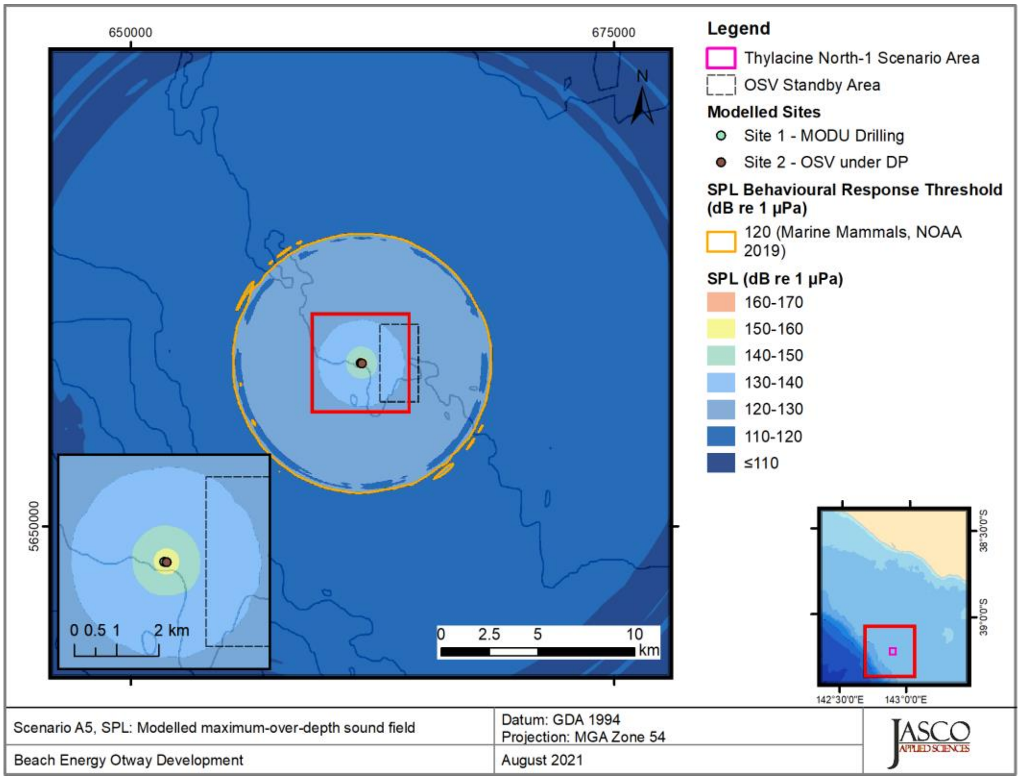


Figure 8. *Thylacine North-1, MODU Drilling and OSV Resupply (Scenario A5) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

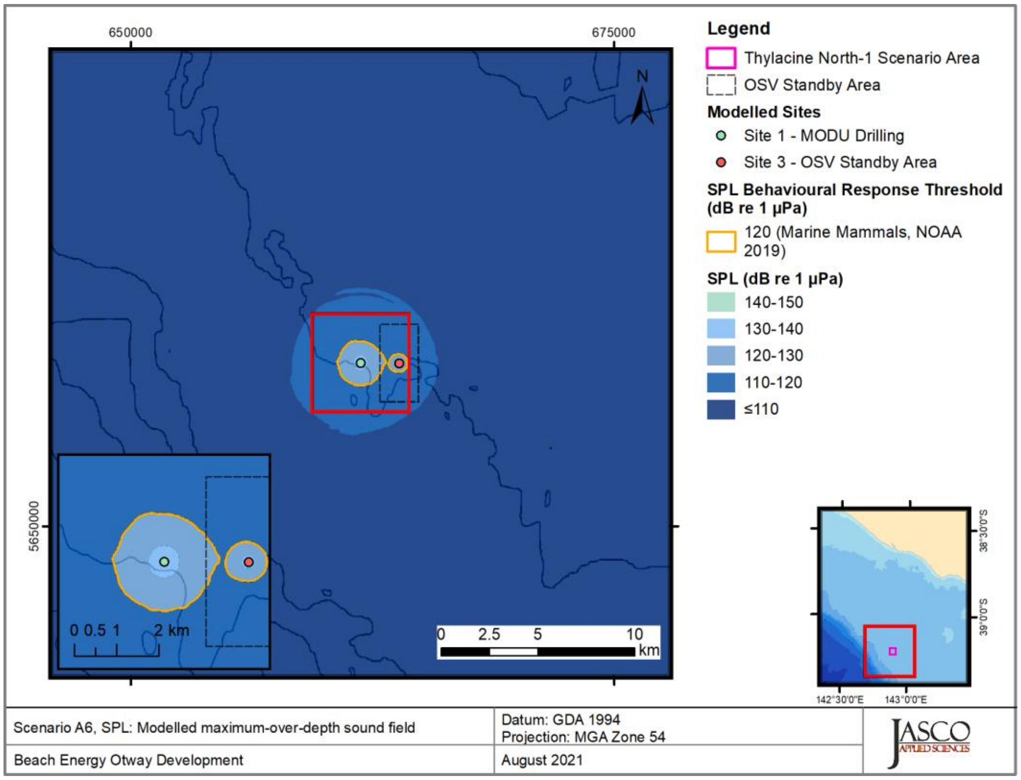


Figure 9. *Thylacine North-1, MODU Drilling and OSV Standby (Scenario A7) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

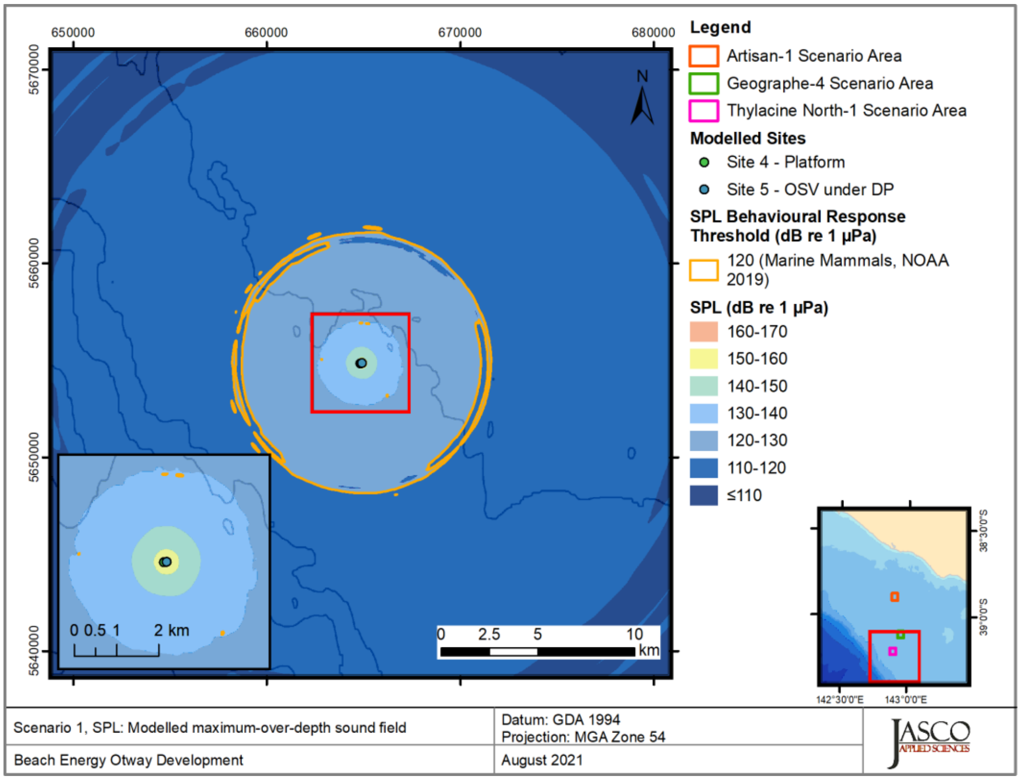


Figure 10. *Thylacine A Platform, Platform Resupply (Scenario 1) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

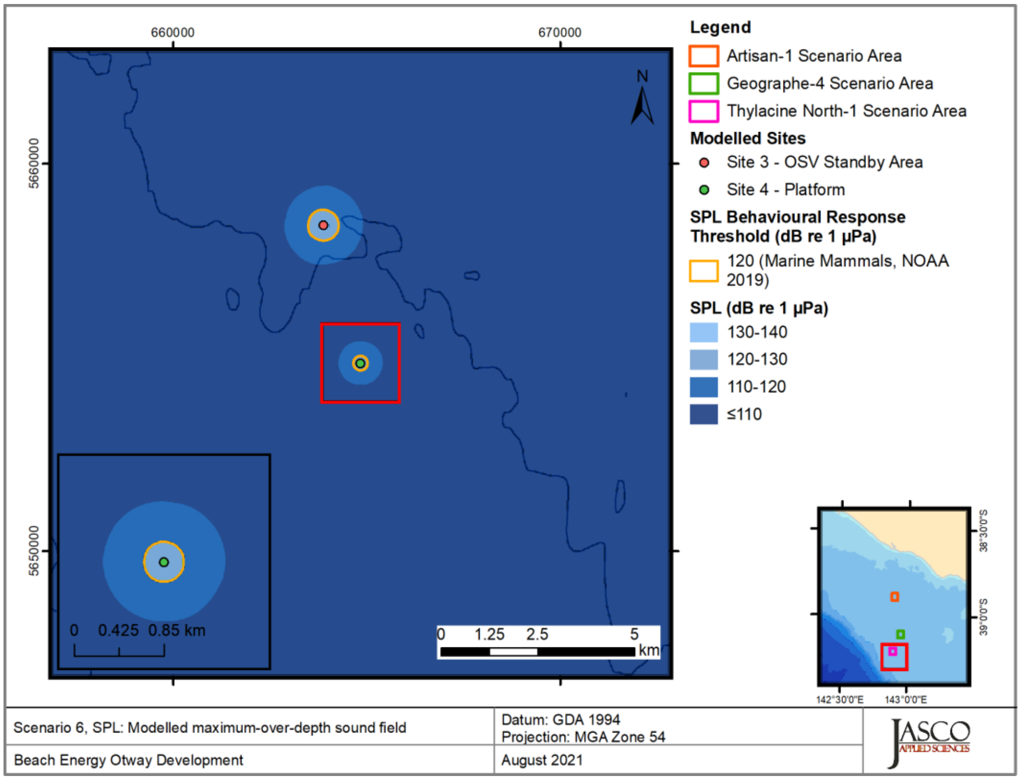


Figure 11. *Thylacine A Platform, OSV standby (Scenario 6) SPL :* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

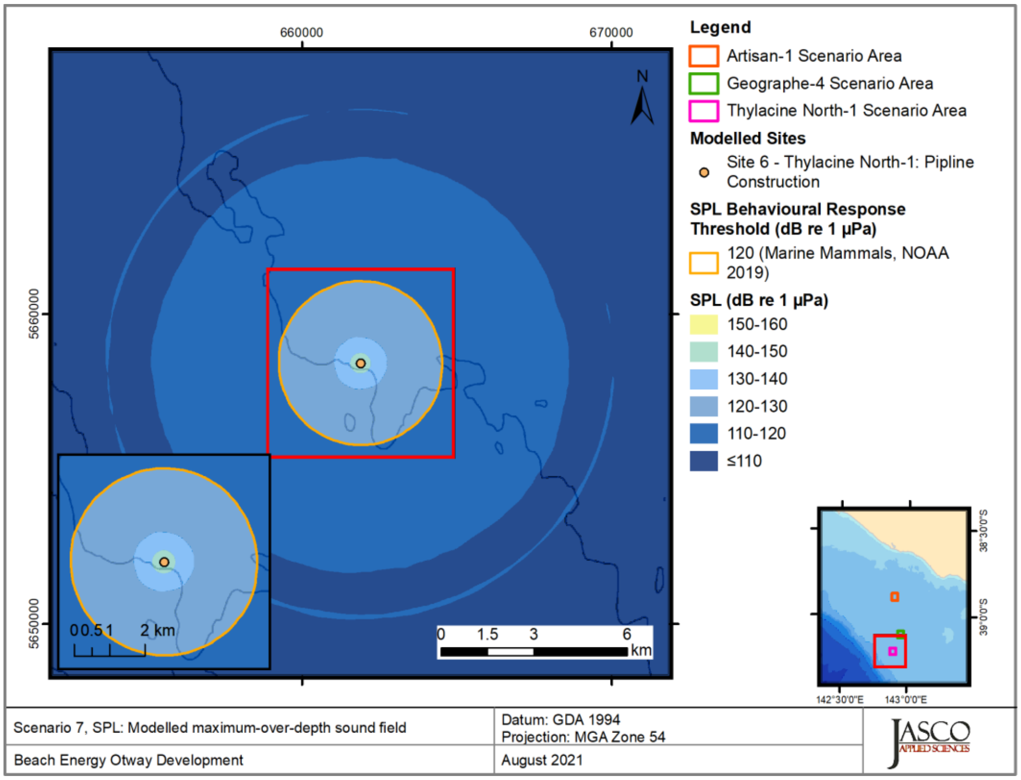


Figure 12. *Thylacine North-1, PLV stationary 20% MCR -June (Scenario 7) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

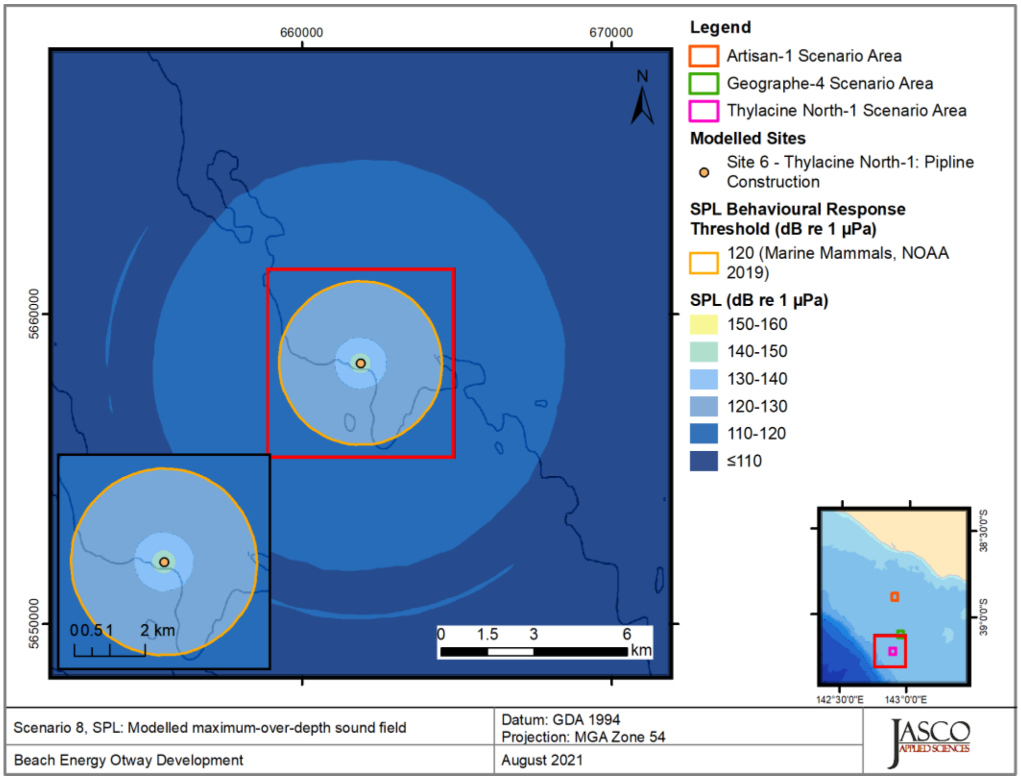


Figure 13. *Thylacine North-1, PLV stationary 20% MCR -November (Scenario 8) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

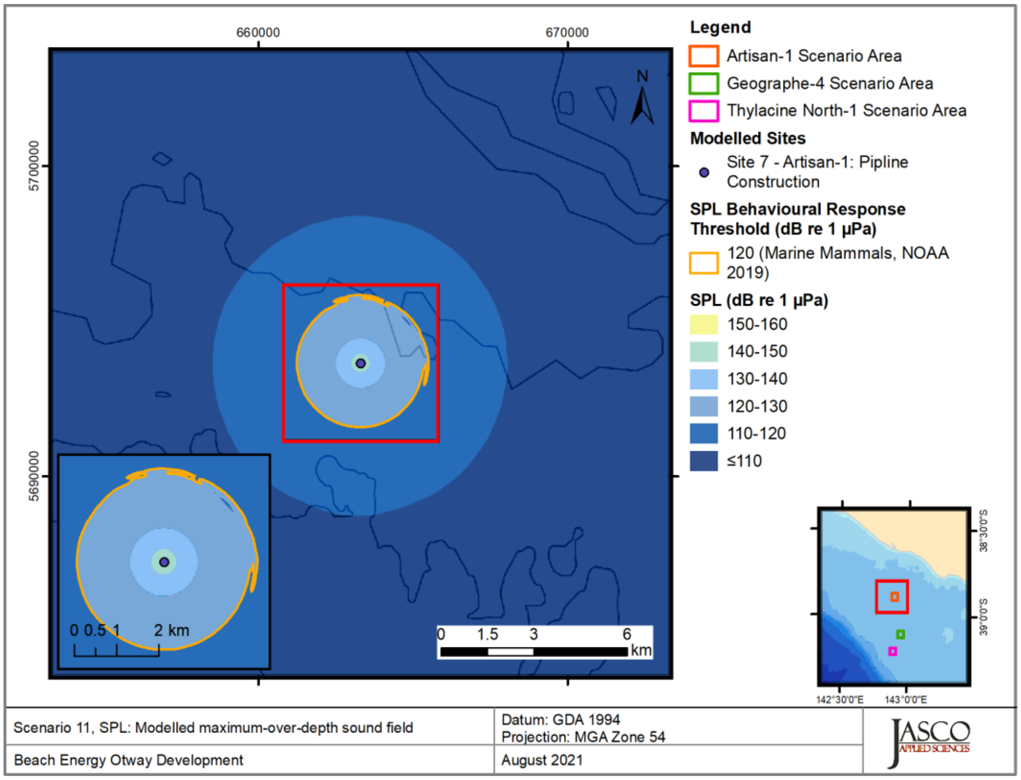


Figure 14. *Artisan-1, PLV stationary 20% MCR -June (Scenario 11) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

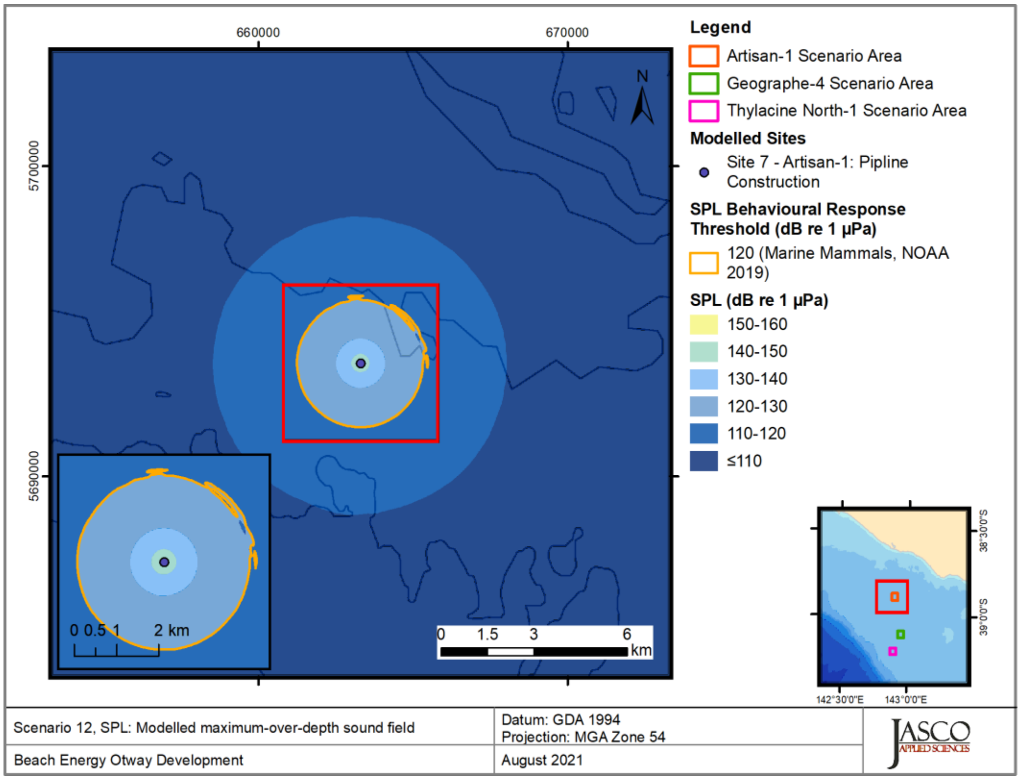


Figure 15. *Artisan-1, PLV stationary 20% MCR - November (Scenario 12) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

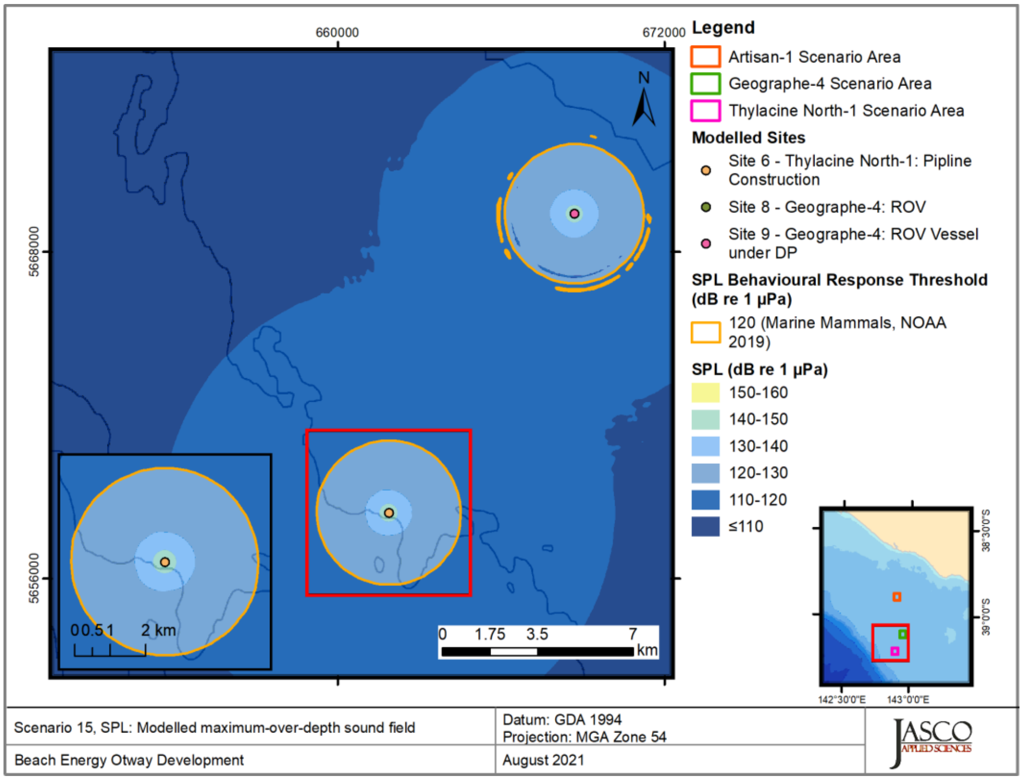


Figure 16. *Thylacine North-1, PLV stationary and ROV operations at Geographe-4 (20% MCR) - June (Scenario 15) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is s hown as an orange contour line.

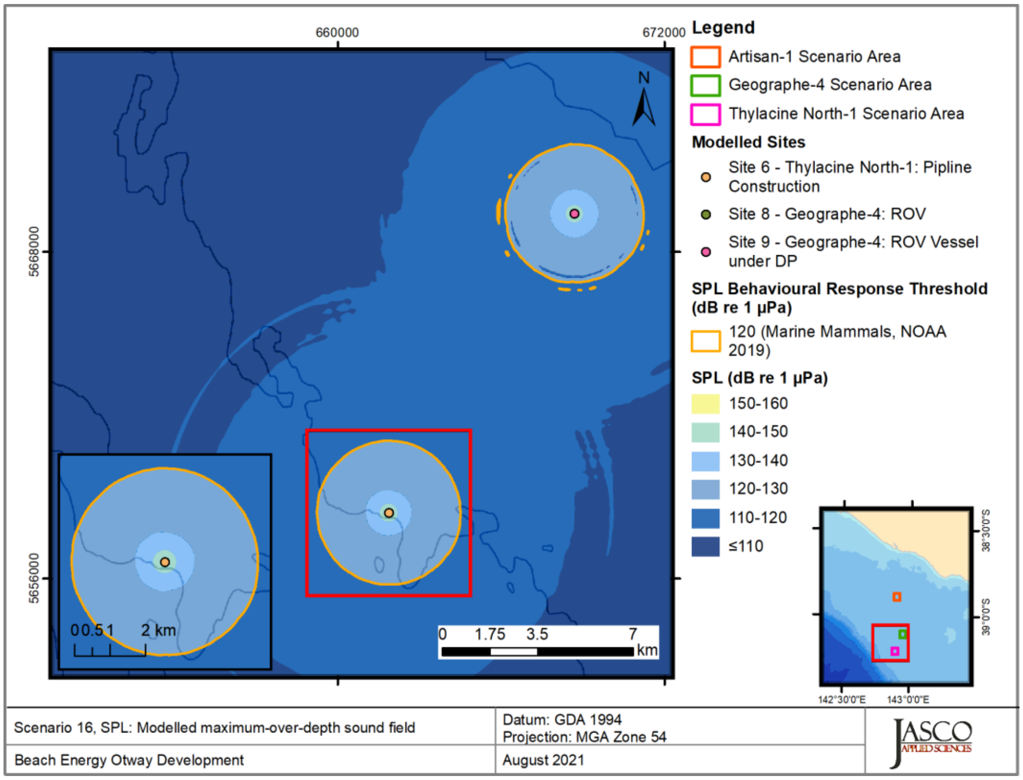


Figure 17. *Thylacine North-1, PLV stationary and ROV operations at Geographe-4 (20% MCR) – November (Scenario 16) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

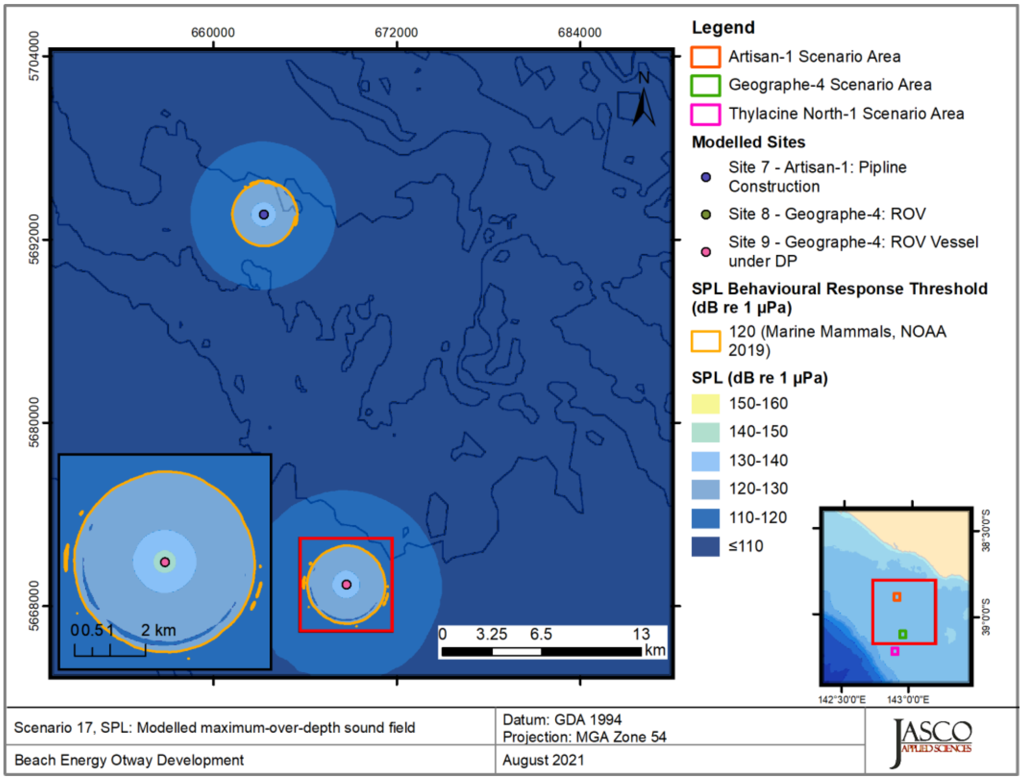


Figure 18. *Artisan-1, PLV stationary and ROV Operations at Geographe-4 (20% MCR) – June (Scenario 17) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

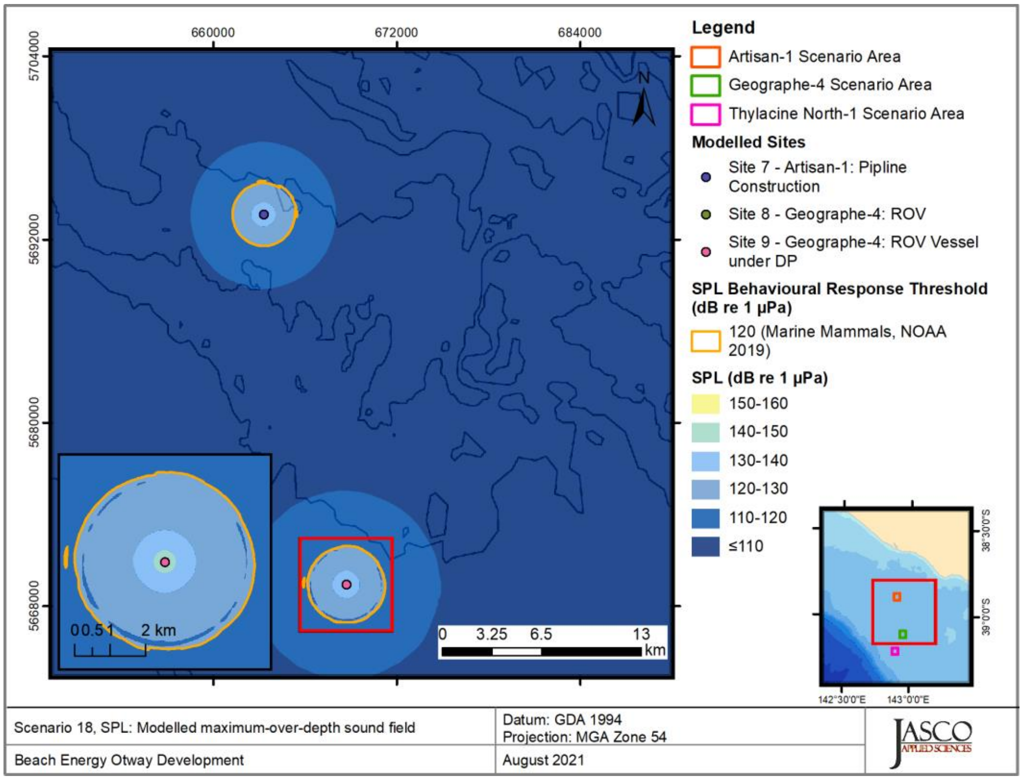


Figure 19. *Artisan-1, PLV stationary and ROV Operations at Geographe-4 (20% MCR) – November (Scenario 18) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

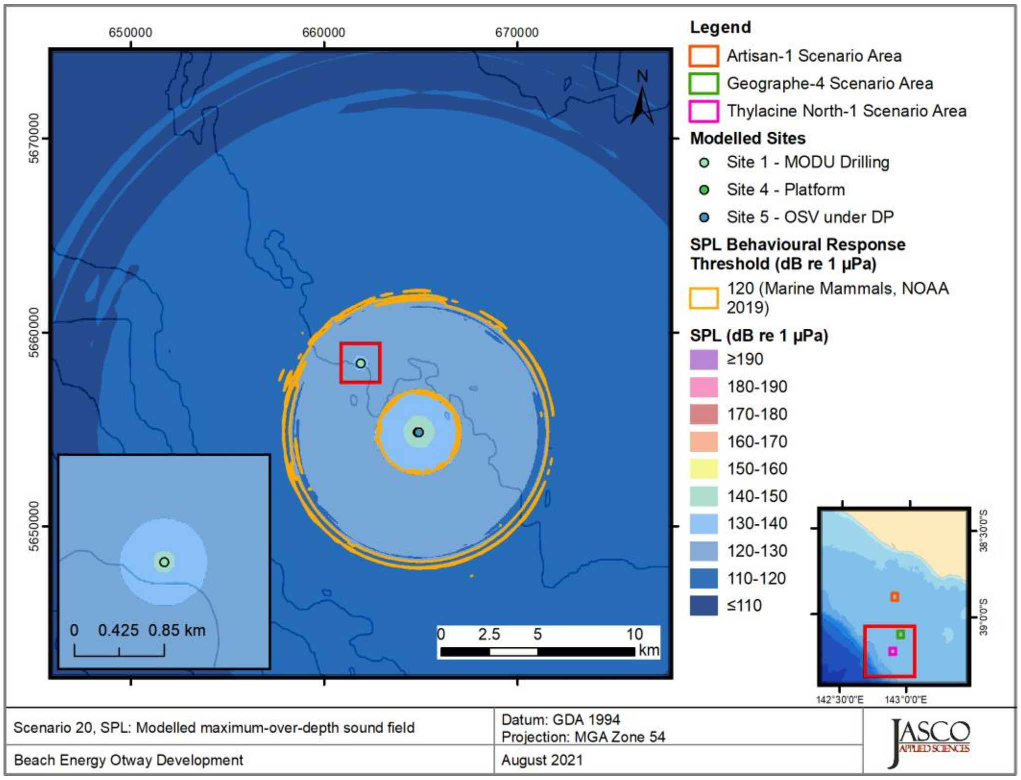


Figure 20. *Thylacine A Platform, Platform Resupply and MODU Drilling (Scenario 20) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

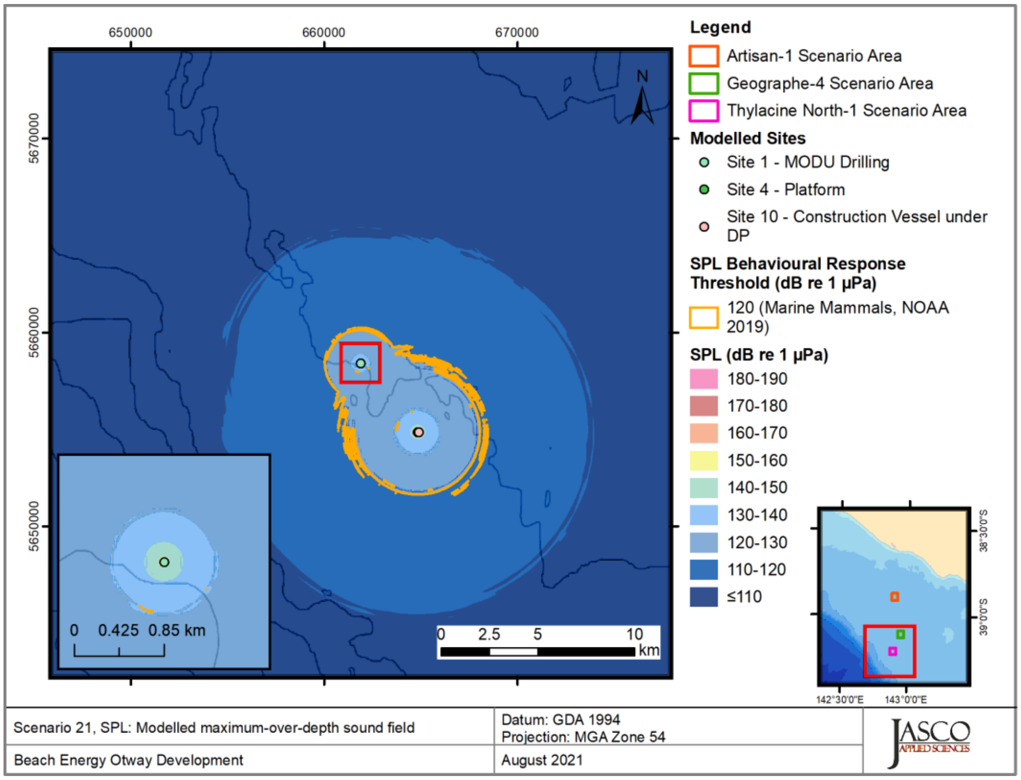


Figure 21. *Thylacine A Platform, Platform operations and skid installation* at 20% MCR *(Scenario 21) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

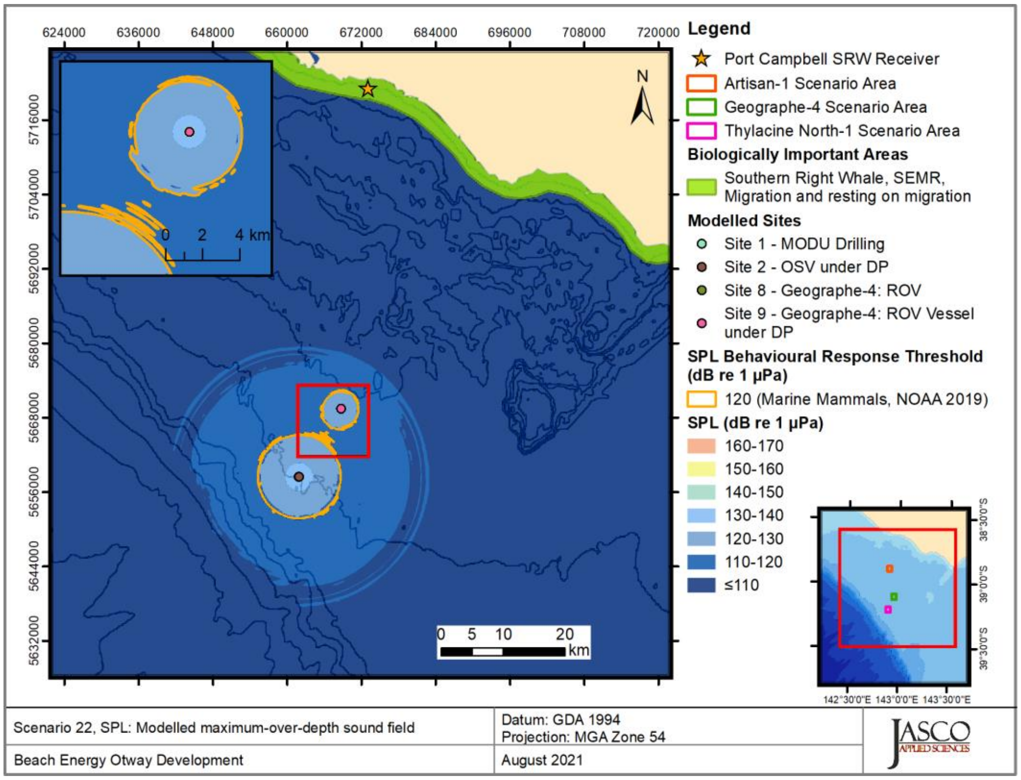


Figure 22. *Concurrent drilling operations at Thylacine North-1 and construction operations (20% MCR) at Geographe-4 (Scenario 22) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

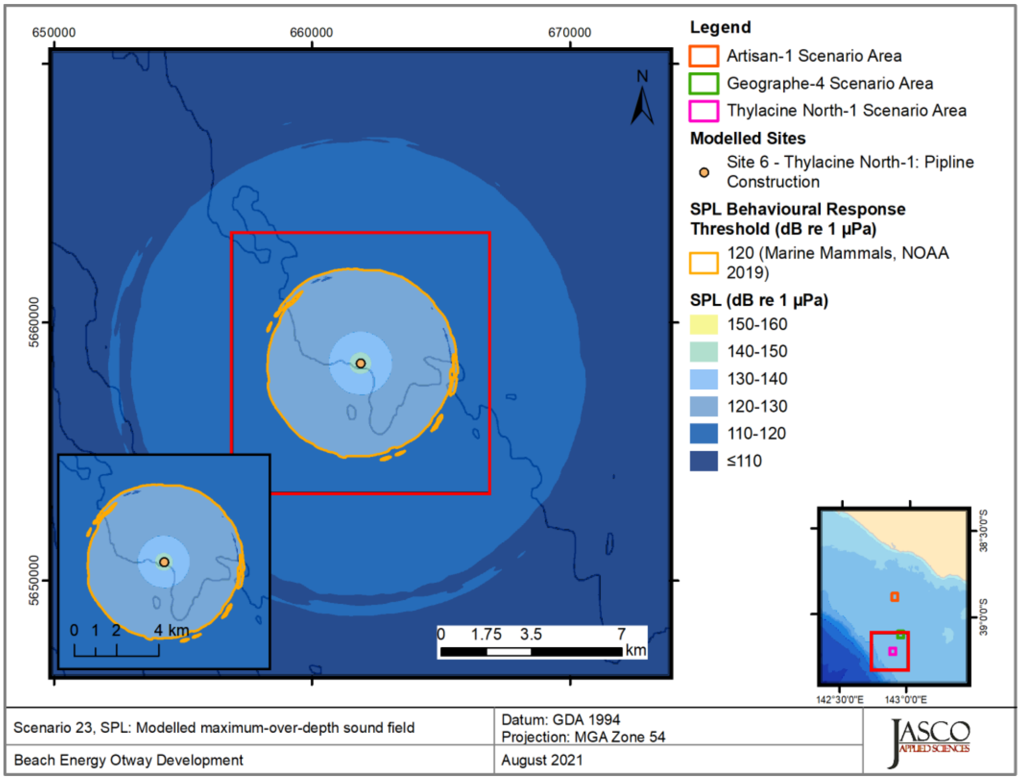


Figure 23. *Thylacine North-1, PLV stationary 40% MCR -June (Scenario 23) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

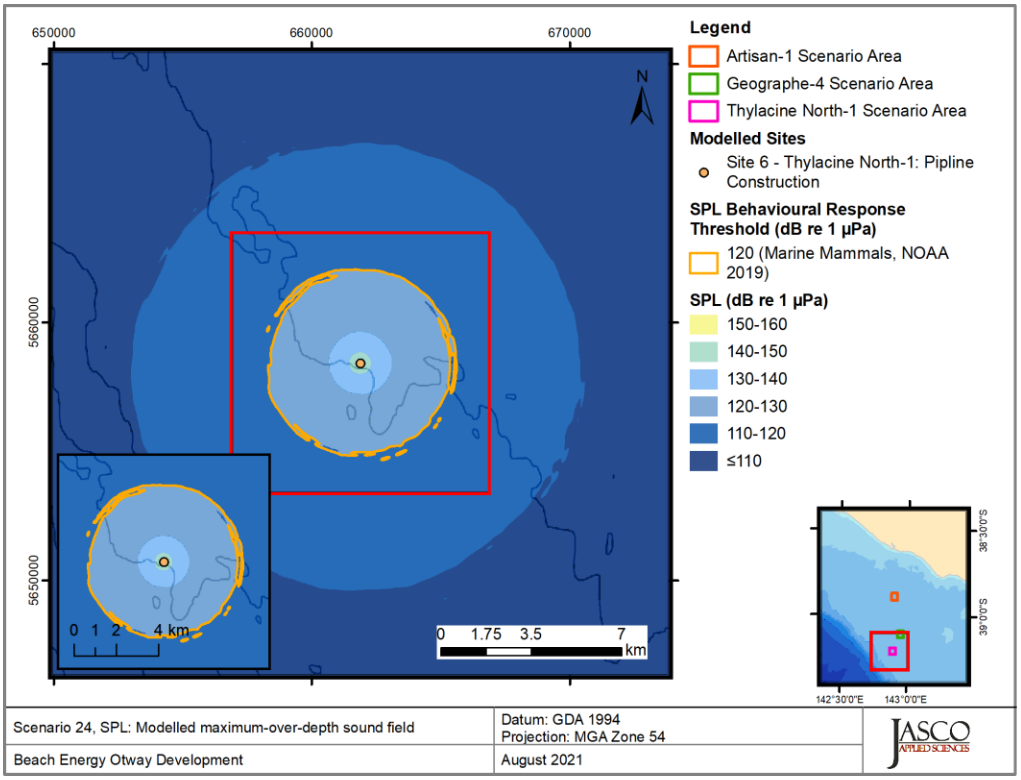


Figure 24. *Thylacine North-1, PLV stationary 40% MCR -November (Scenario 24) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

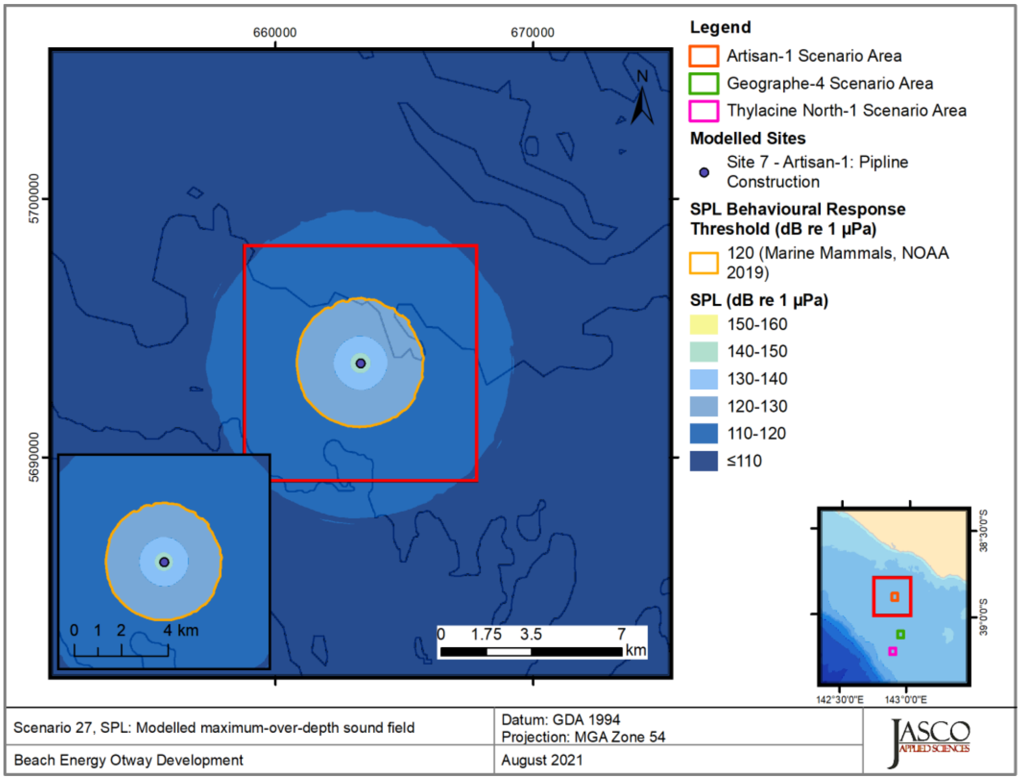


Figure 25. *Artisan-1, PLV stationary 40% MCR -June (Scenario 27) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

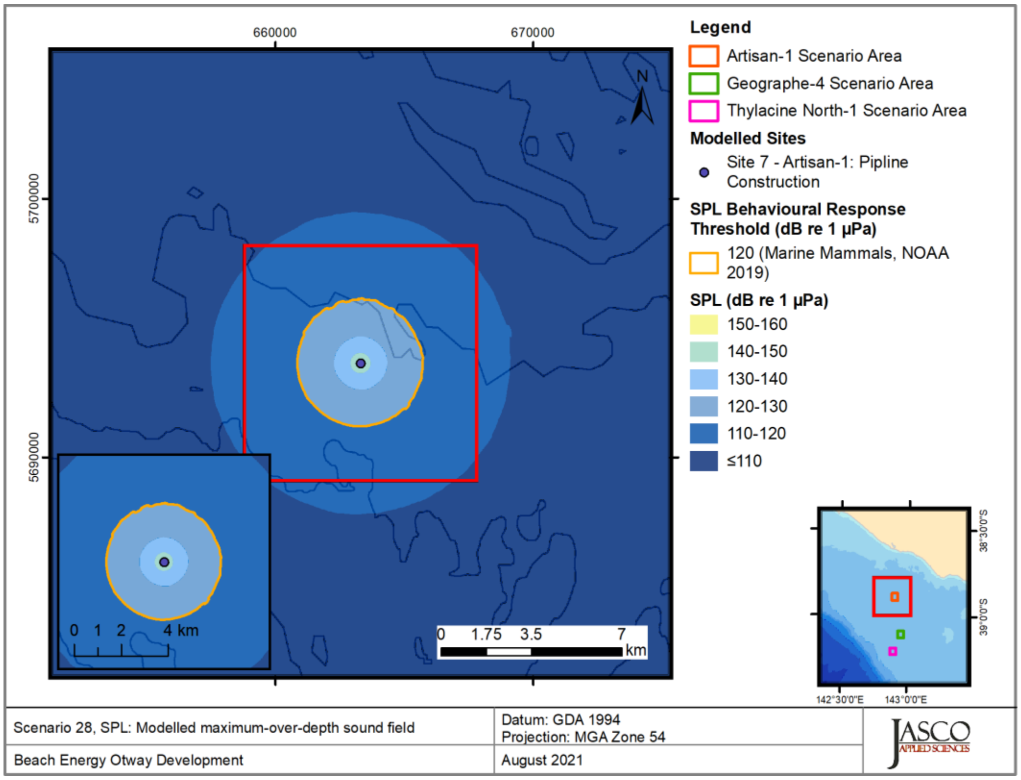


Figure 26. *Artisan-1, PLV stationary 40% MCR -November (Scenario 28) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

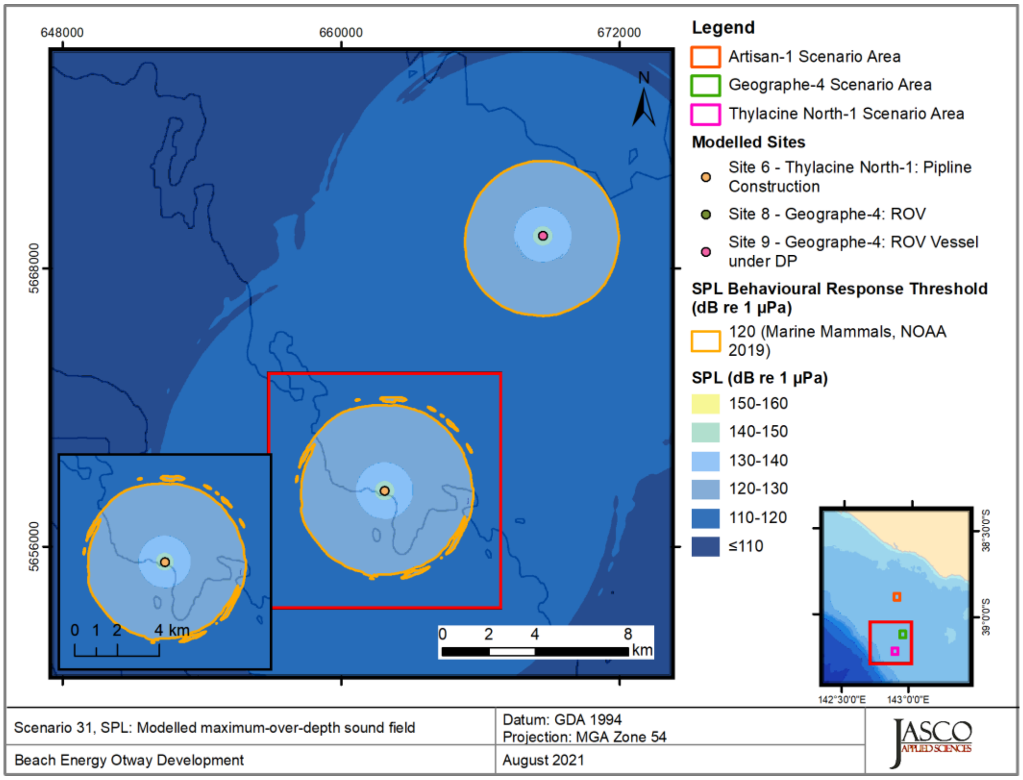


Figure 27. *Thylacine North-1, PLV stationary 40% MCR and ROV operations at Geographe-4 - June (Scenario 31) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

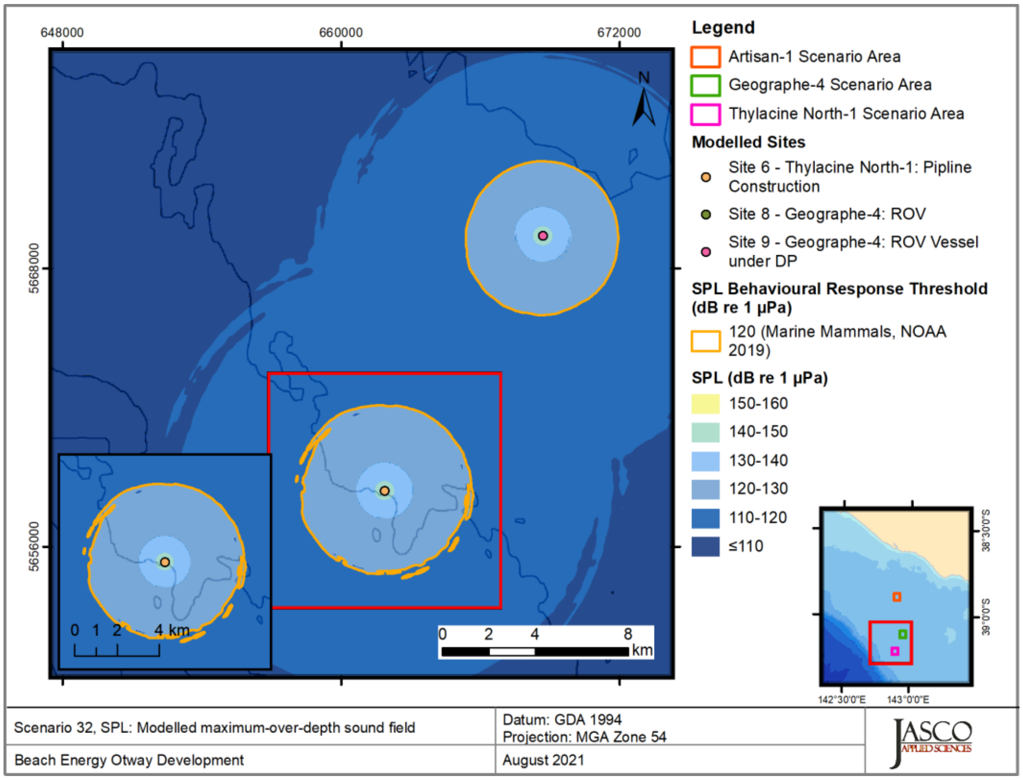


Figure 28. *Thylacine North-1, PLV stationary 40% MCR and ROV operations at Geographe-4 – November (Scenario 32) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

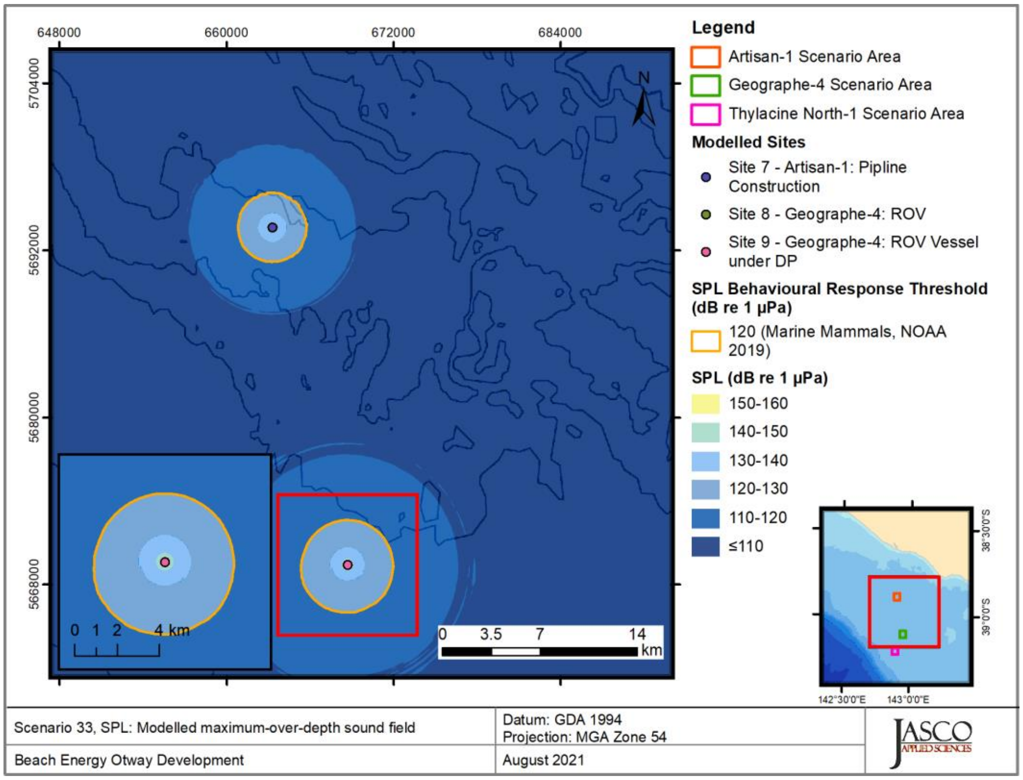


Figure 29. *Artisan-1, PLV stationary 40% MCR and ROV Operations at Geographe-4 – June (Scenario 33) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

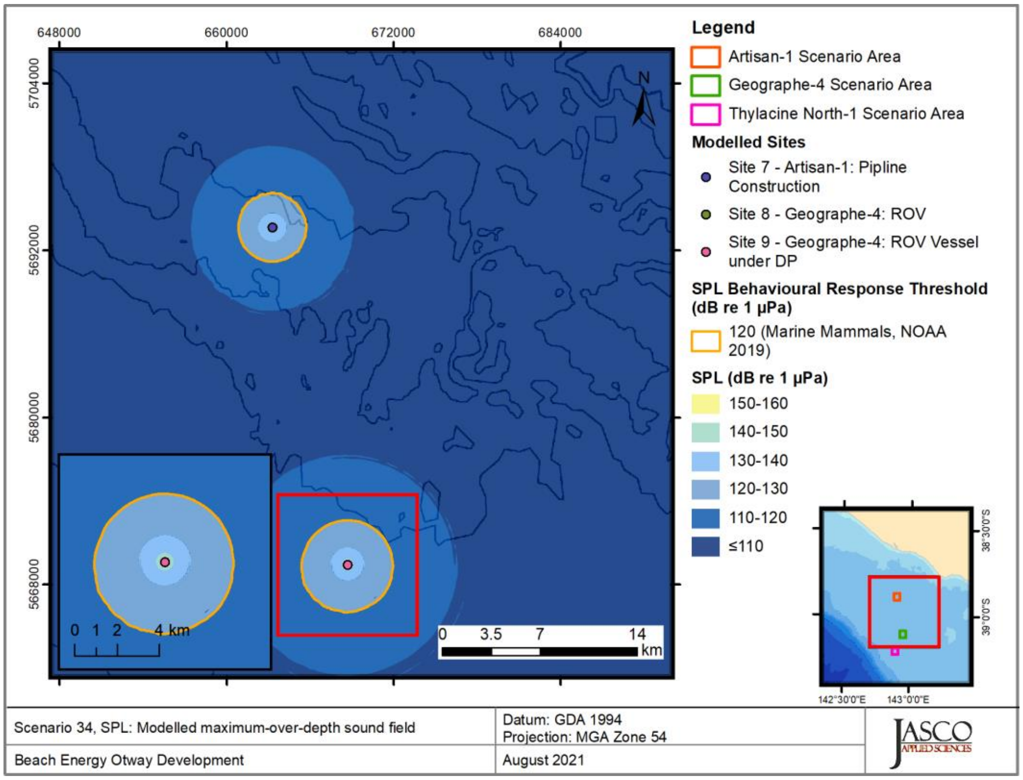


Figure 30. *Artisan-1, PLV stationary 40% MCR and ROV Operations at Geographe-4 – November (Scenario 34) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

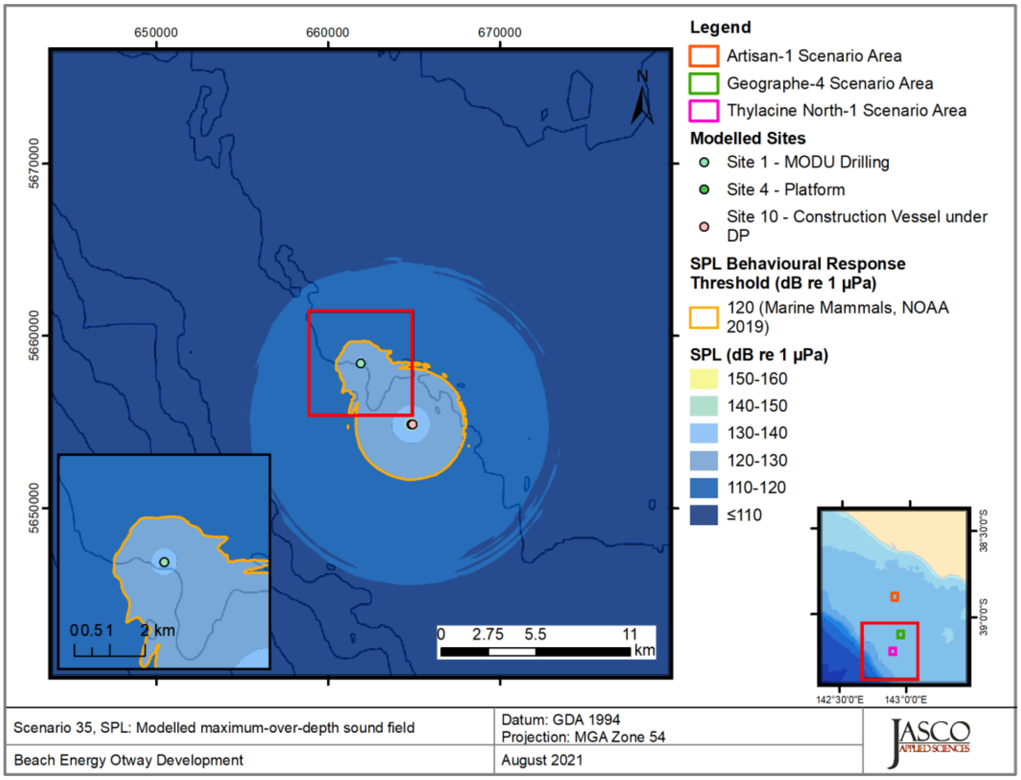


Figure 31. *Thylacine A Platform, Platform operations and skid installation at 40% MCR (Scenario 35) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

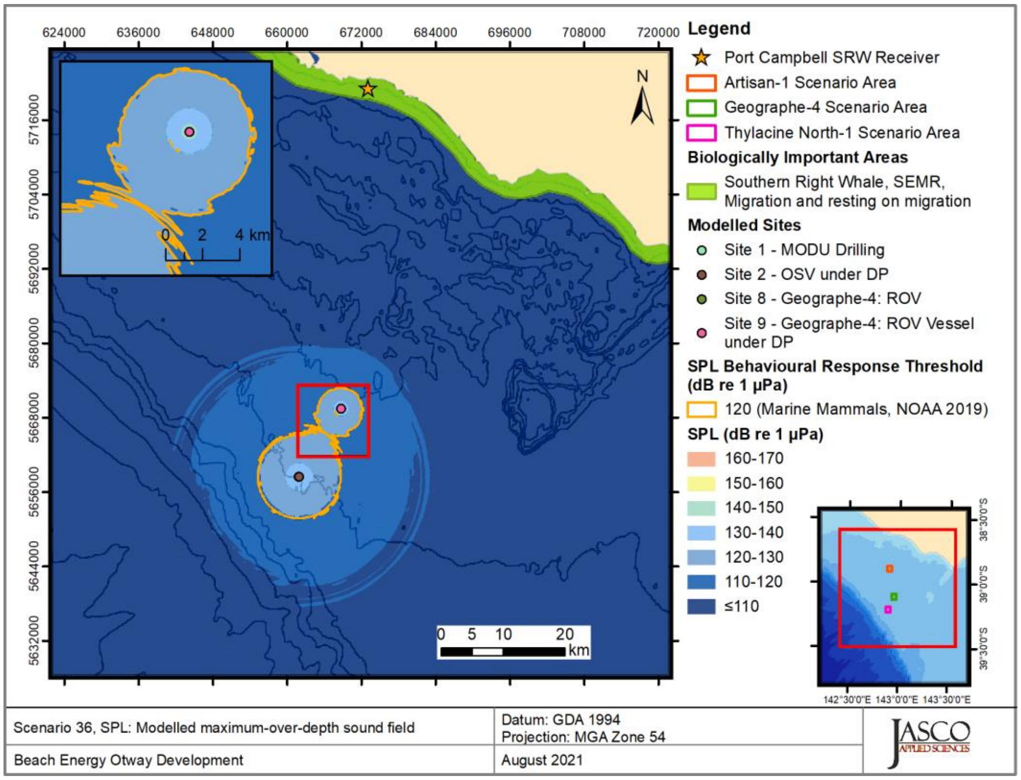


Figure 32. *Concurrent drilling operations at Thylacine North-1 and construction operations (40% MCR) at Geographe-4 (Scenario 36) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

4.2.2. Accumulated SEL_{24h} Maps

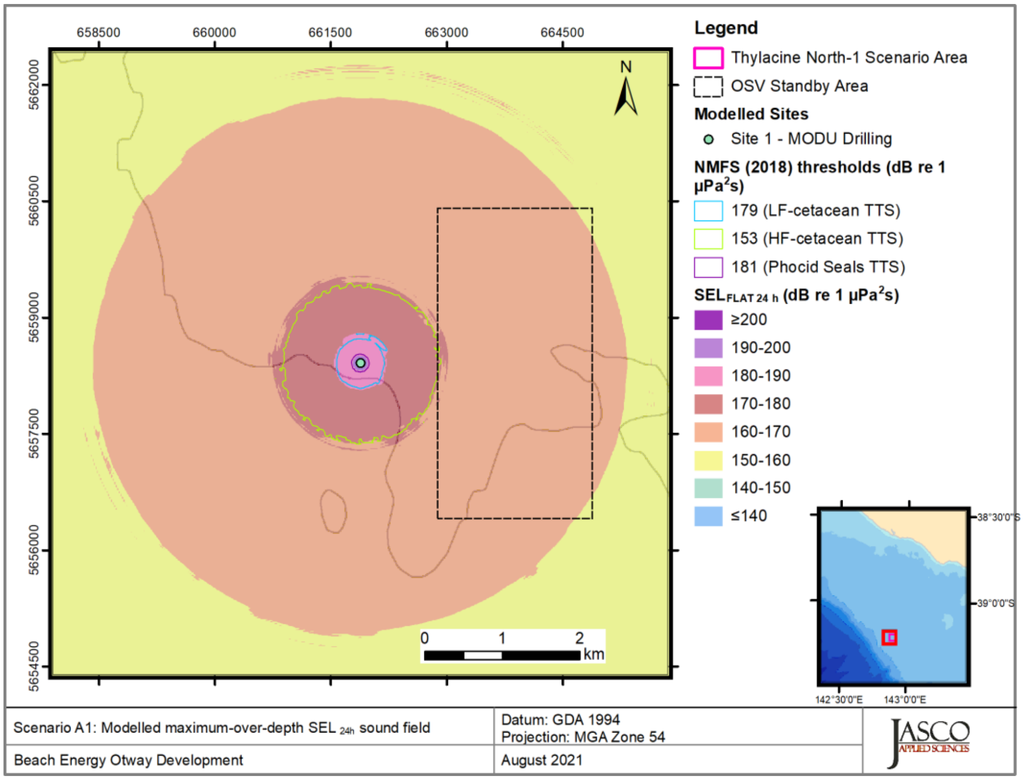


Figure 33. *Thylacine North-1, MODU Drilling (Scenario A1) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

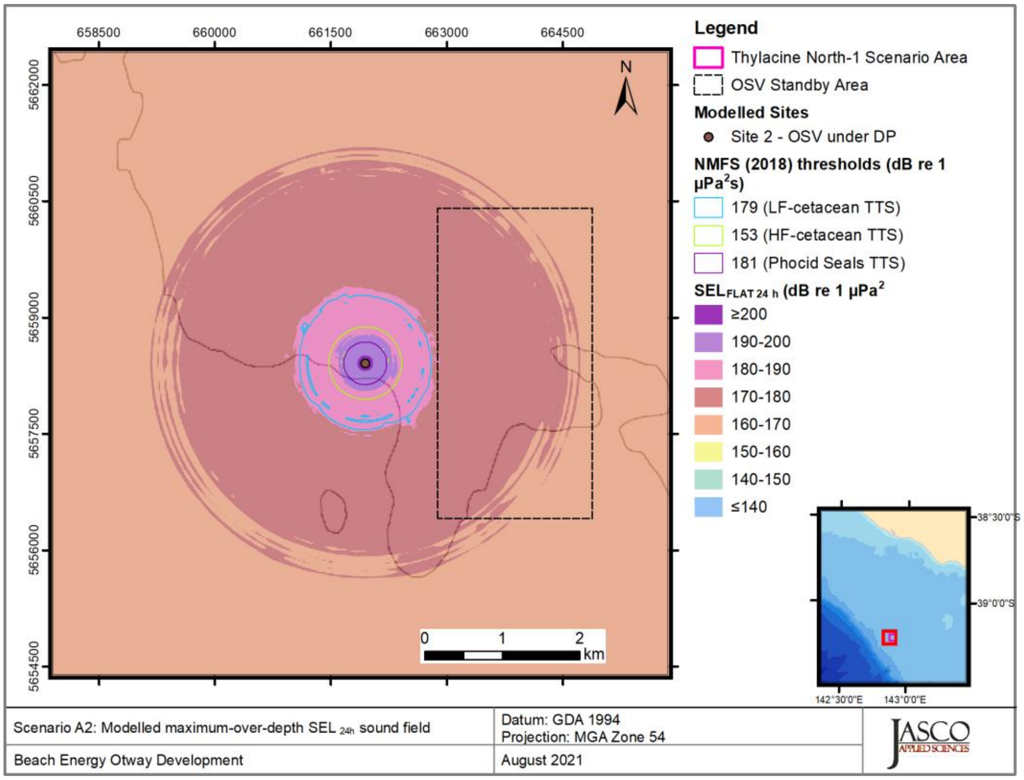


Figure 34. *Thylacine North-1, OSV on DP (4h) (Scenario A2) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

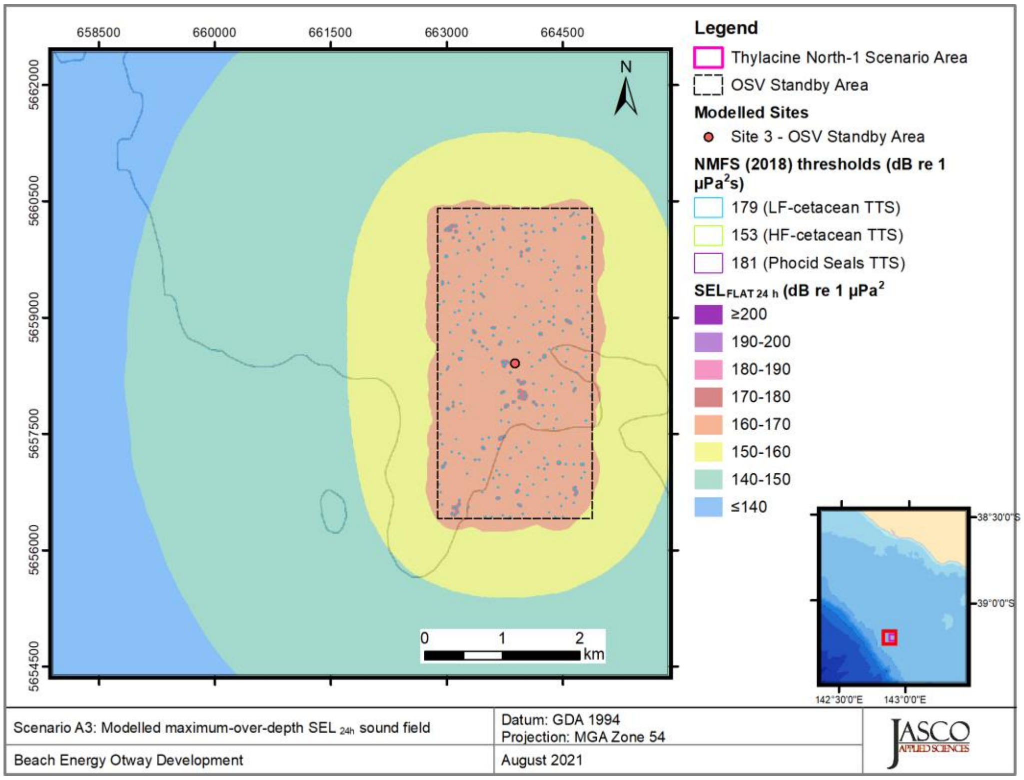


Figure 35. *Thylacine North-1, OSV Standby (Scenario A3) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

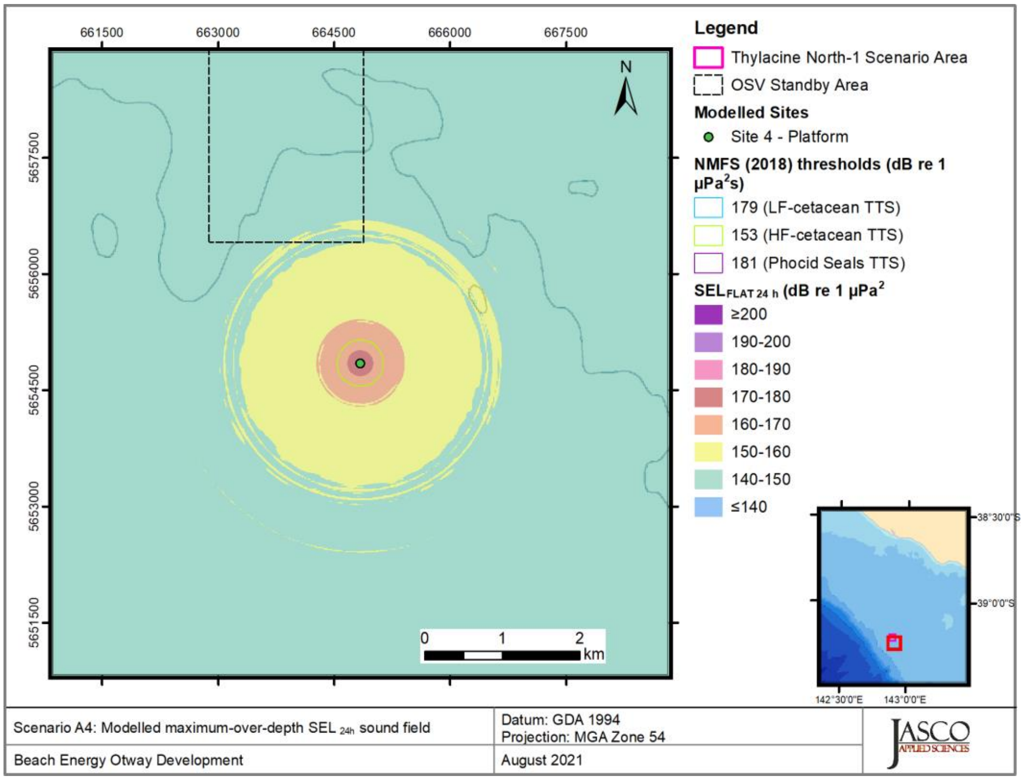


Figure 36. *Thylacine A, Platform Operations (Scenario A4) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

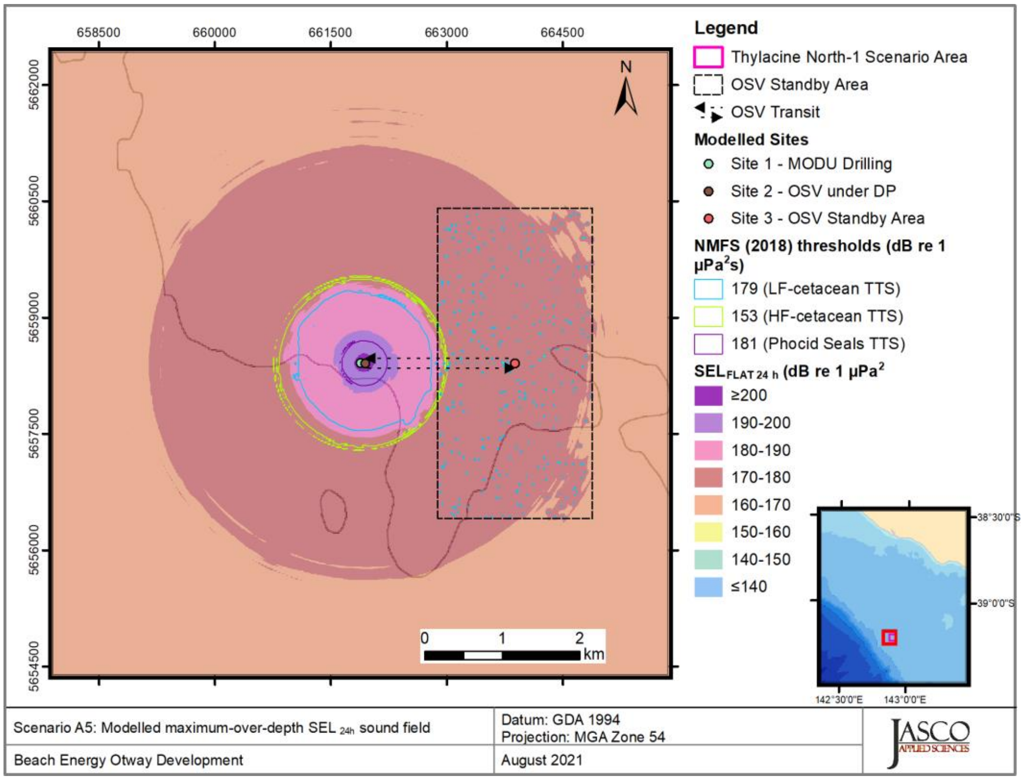


Figure 37. *Thylacine North-1, MODU 4h Resupply Operations (Scenario A5) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

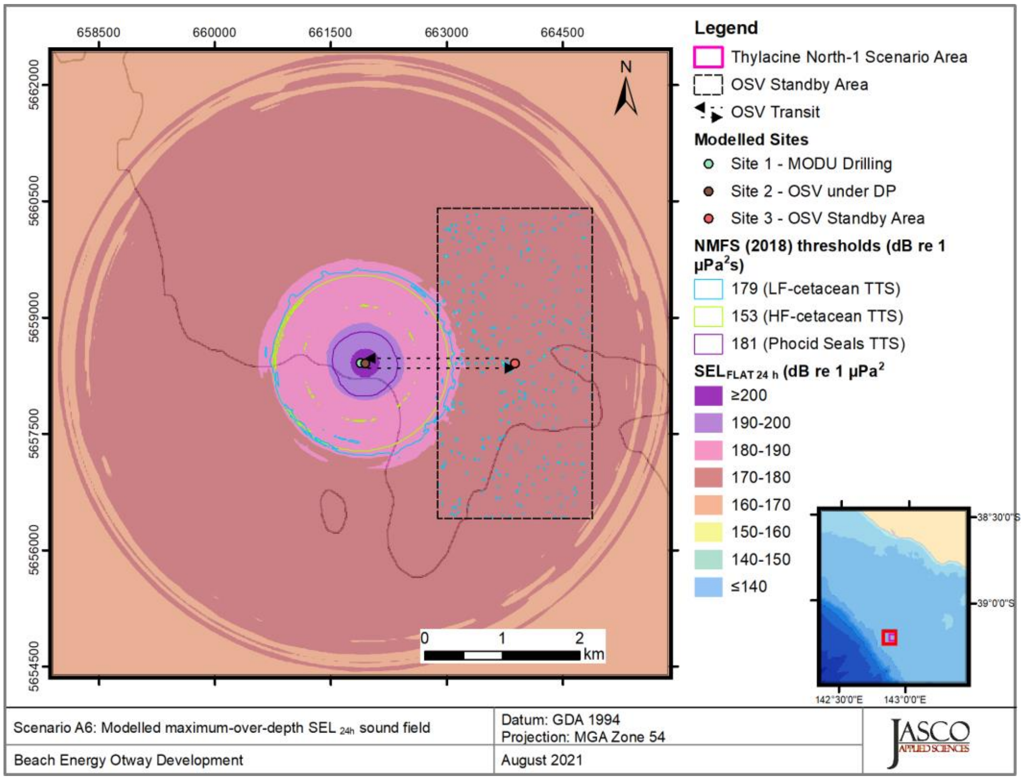


Figure 38. *Thylacine North-1, MODU 8h Resupply Operations (Scenario A6) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.*SEL24h:*

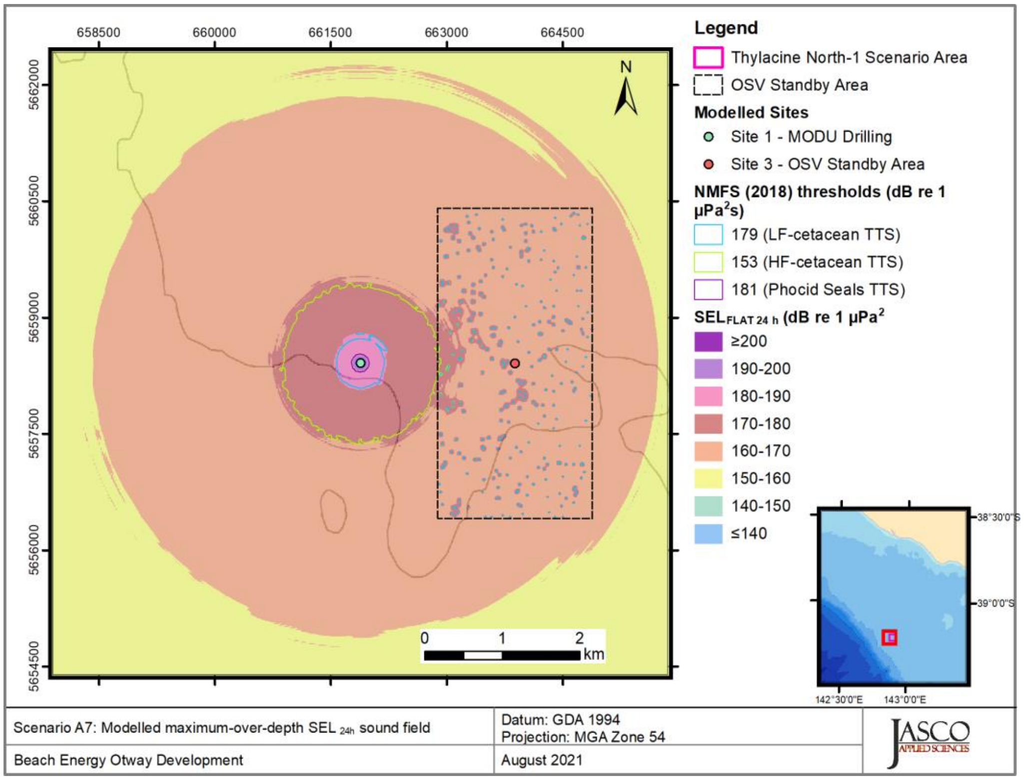


Figure 39. *Thylacine North-1, MODU Drilling and OSV standby (Scenario A7) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

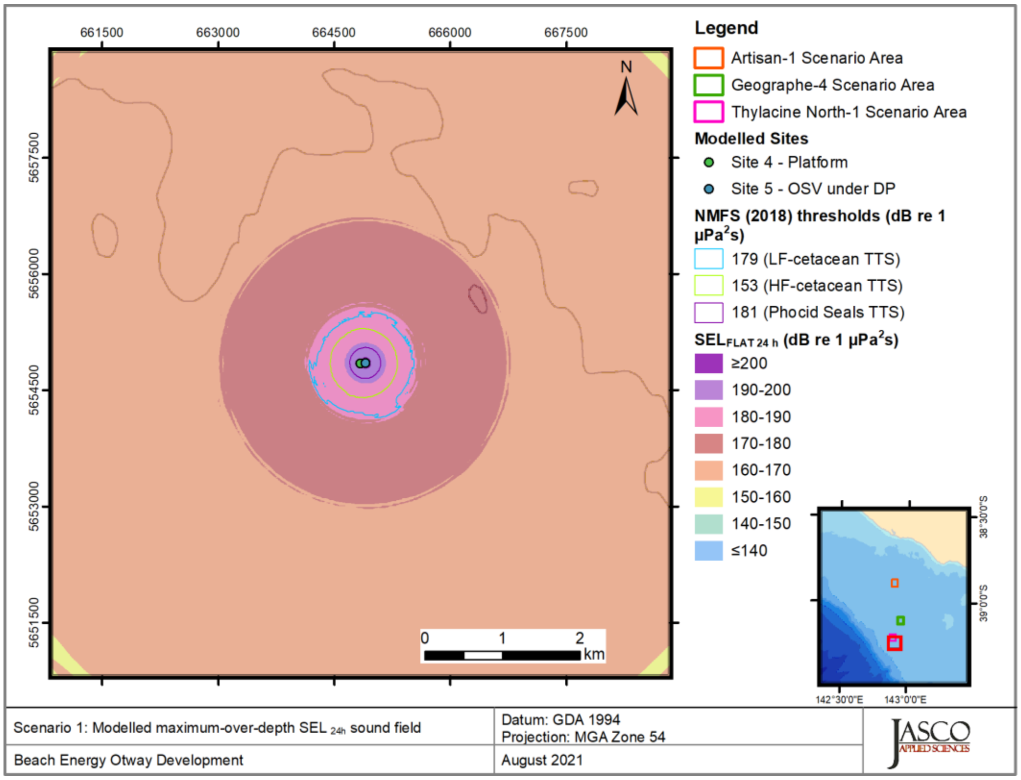


Figure 40. *Thylacine A Platform, 2 h Platform Resupply (Scenario 1) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

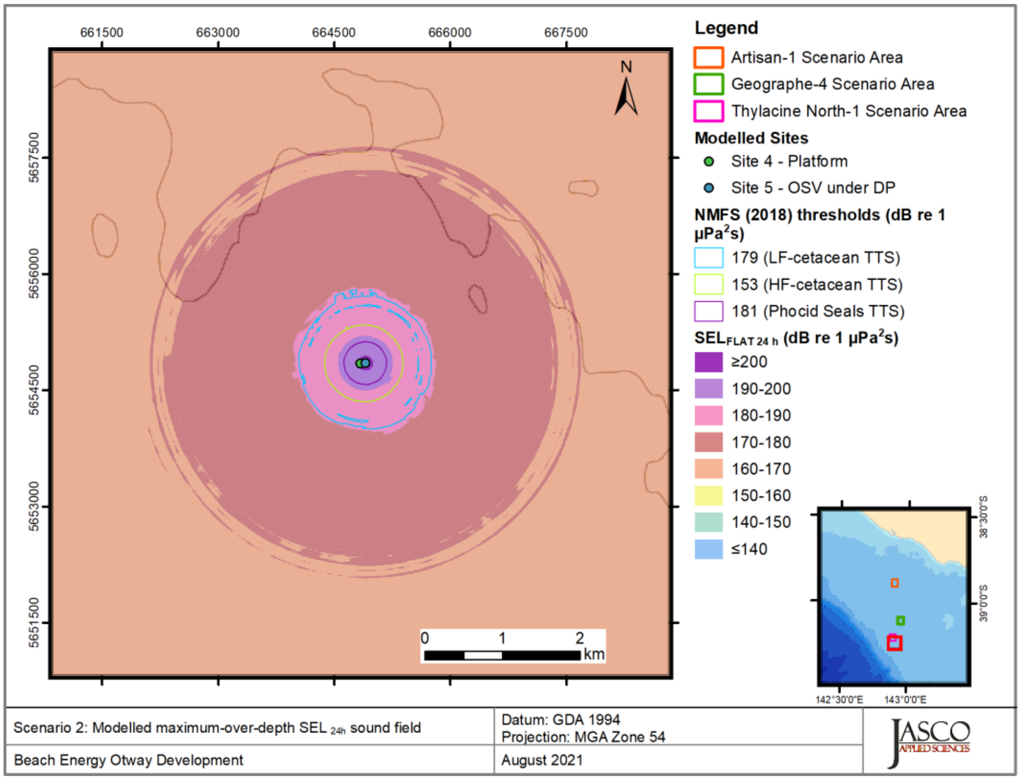


Figure 41. *Thylacine A Platform, 4 h Platform Resupply (Scenario 2) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

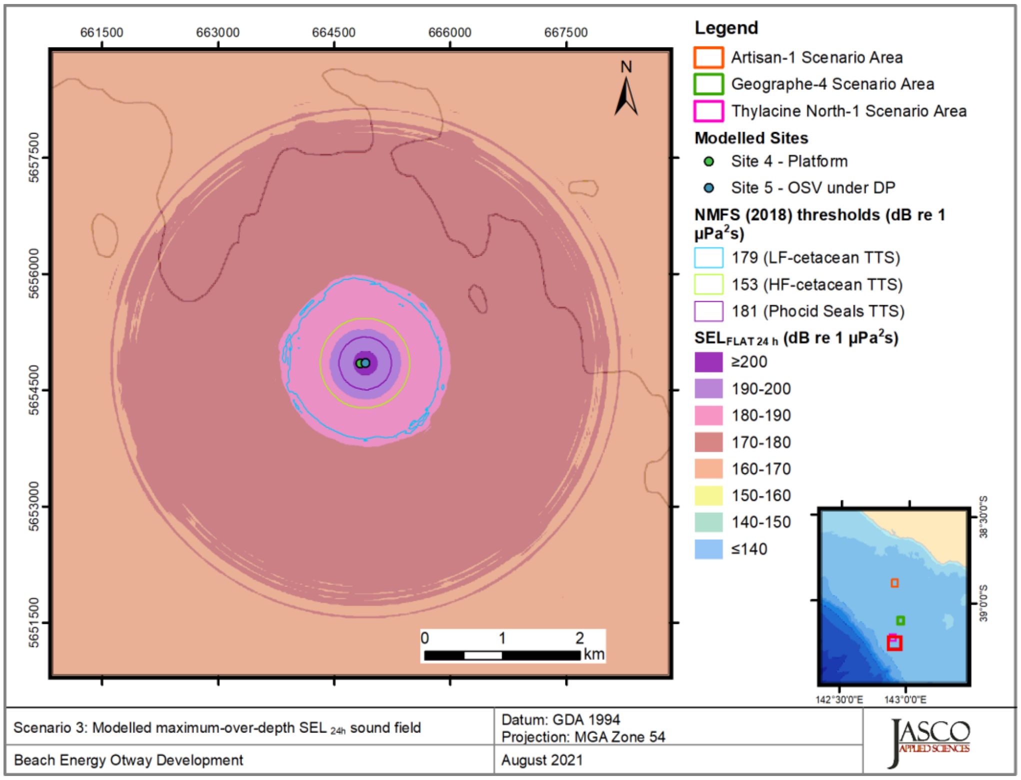


Figure 42. *Thylacine A Platform, 6 h Platform Resupply (Scenario 3) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

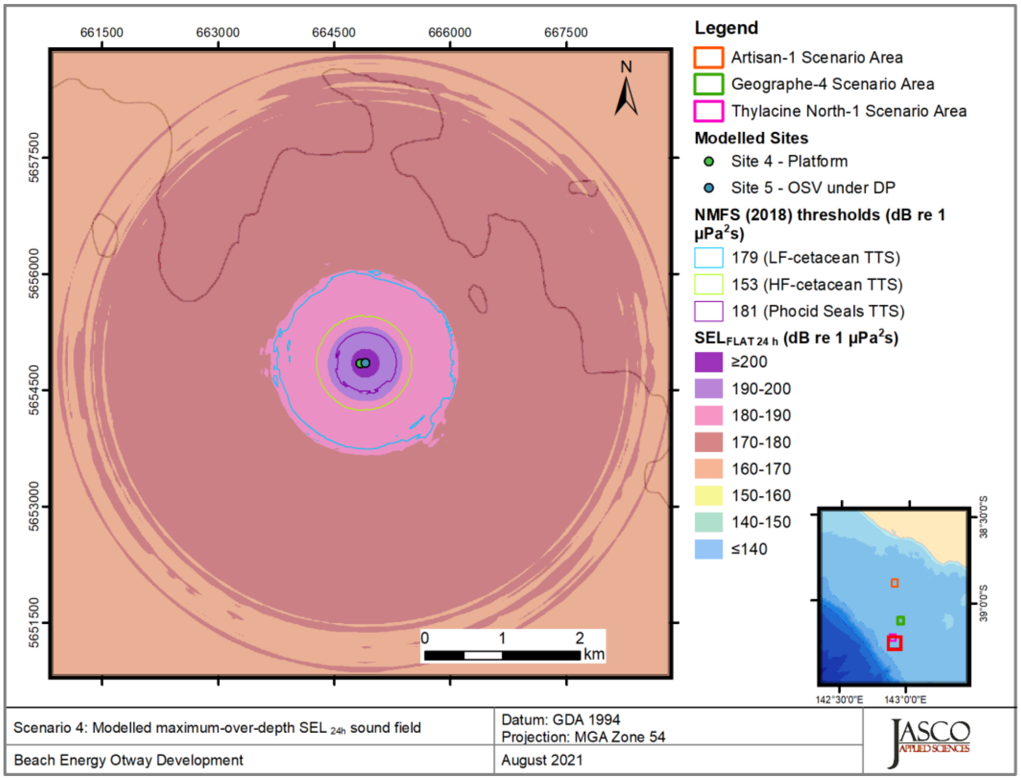


Figure 43. *Thylacine A Platform, 8 h Platform Resupply (Scenario 4) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

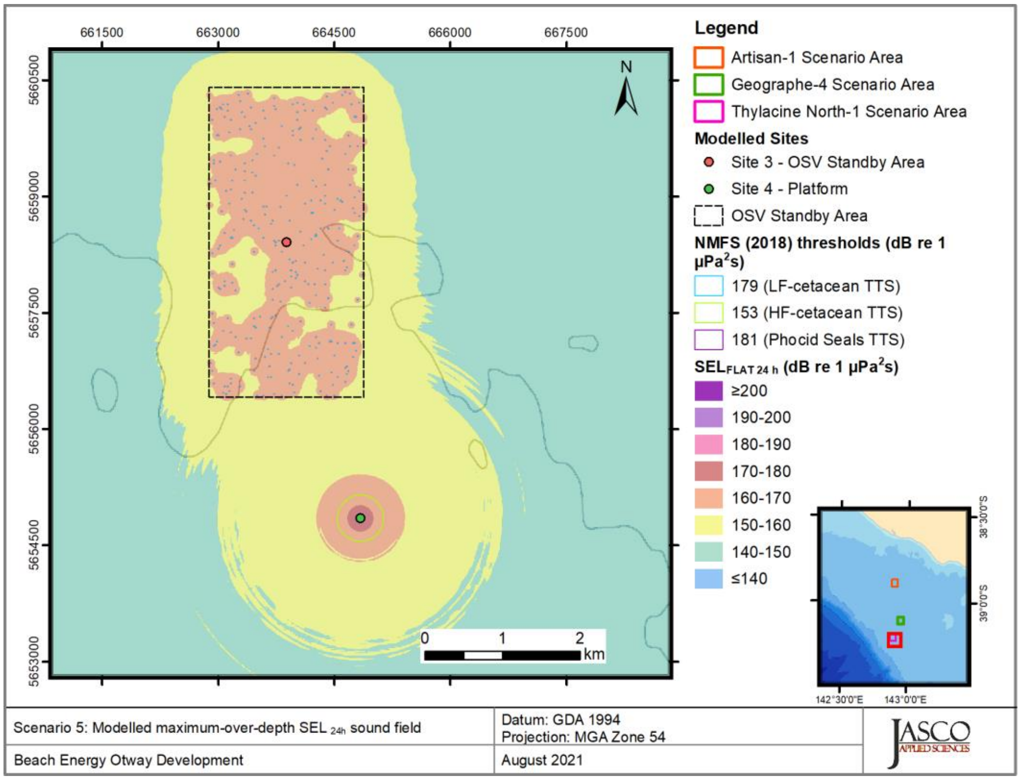


Figure 44. *Thylacine A Platform, 8h OSV standby (Scenario 5) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

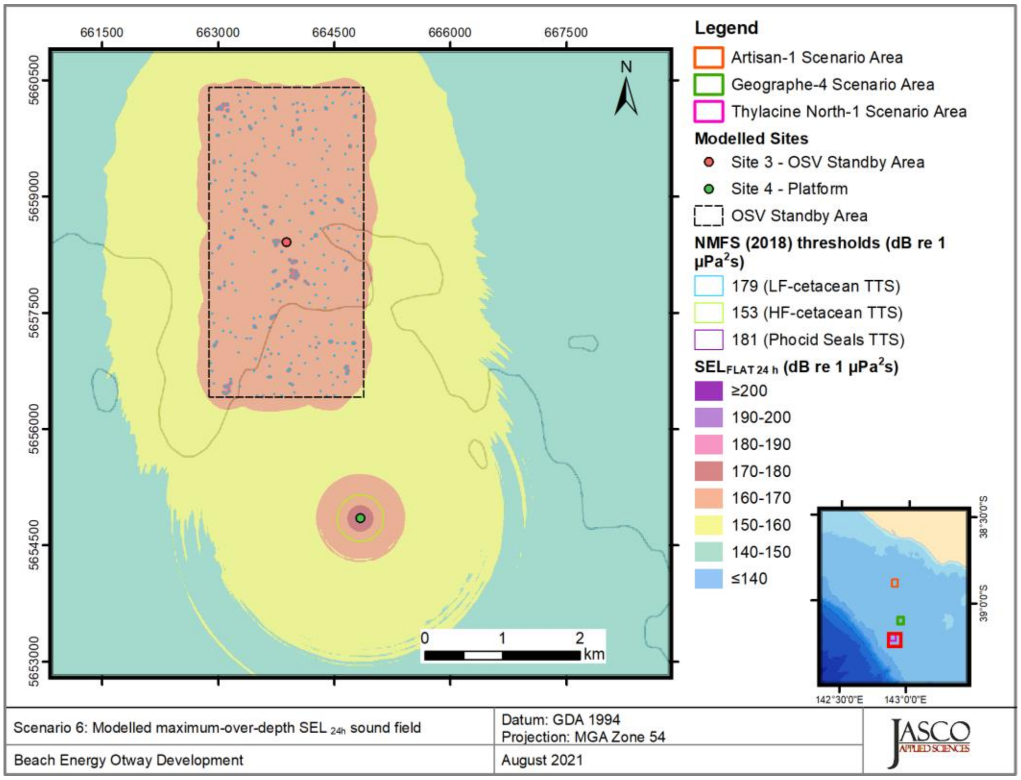


Figure 45. *Thylacine A Platform, 24h OSV standby (Scenario 6) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

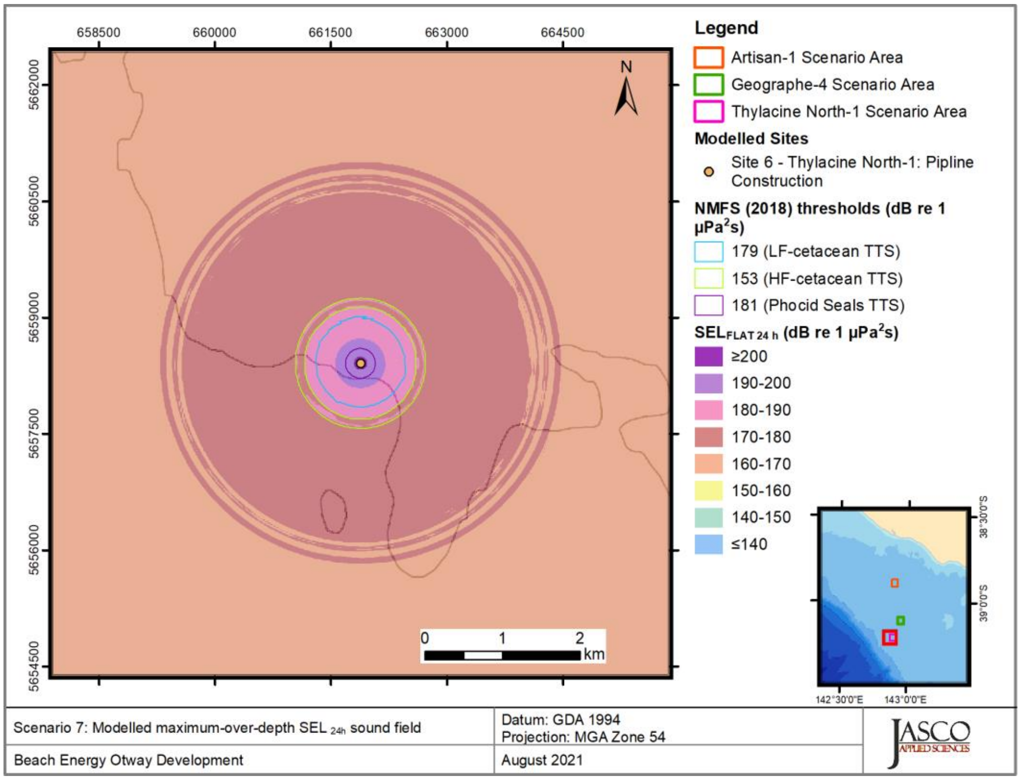


Figure 46. *Thylacine North-1, PLV stationary 20% MCR - June (Scenario 7) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

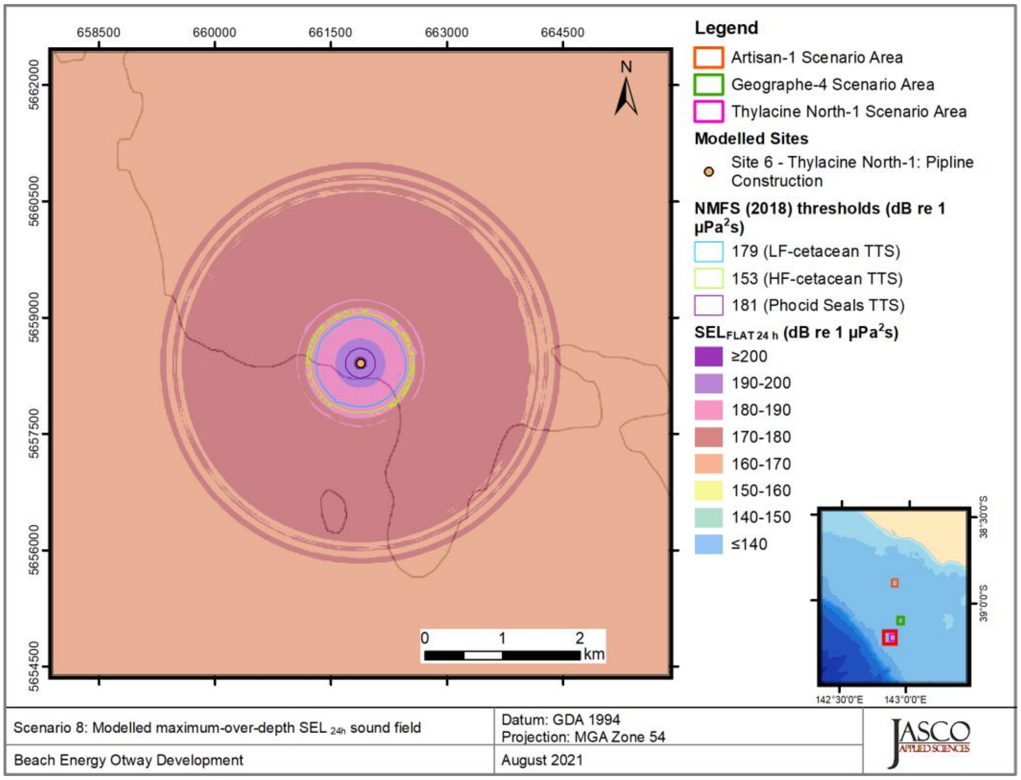


Figure 47. *Thylacine North-1, PLV stationary 20% MCR - November (Scenario 8) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

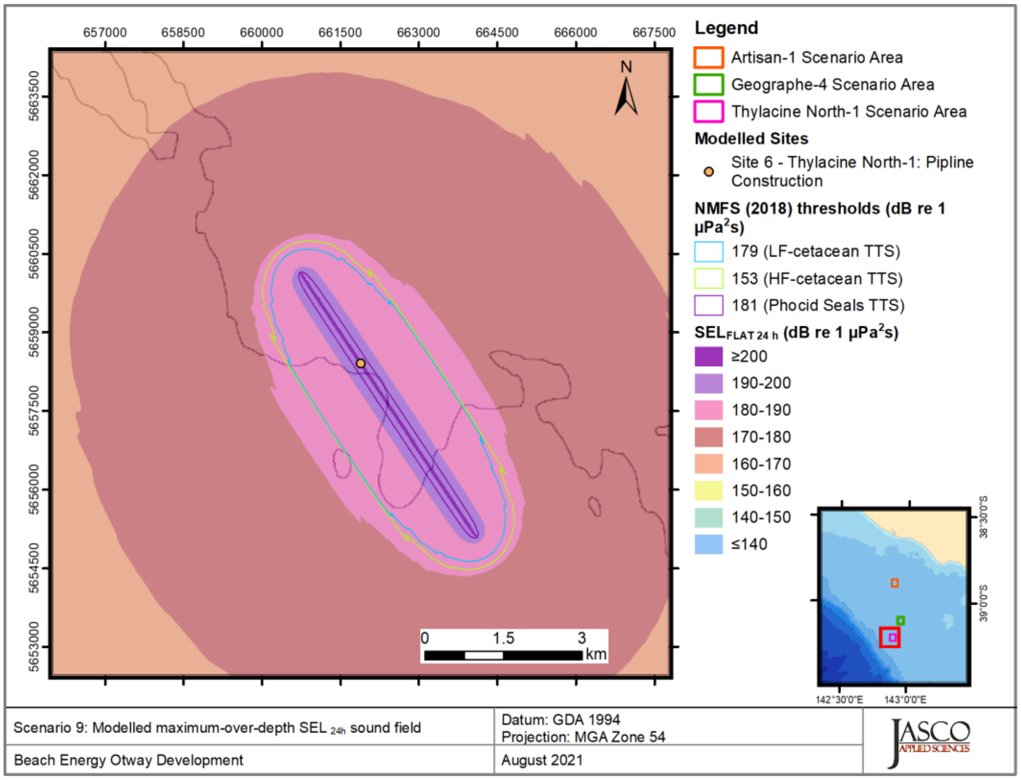


Figure 48. *Thylacine North-1, PLV pipe laying operations 20% MCR - June (Scenario 9) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

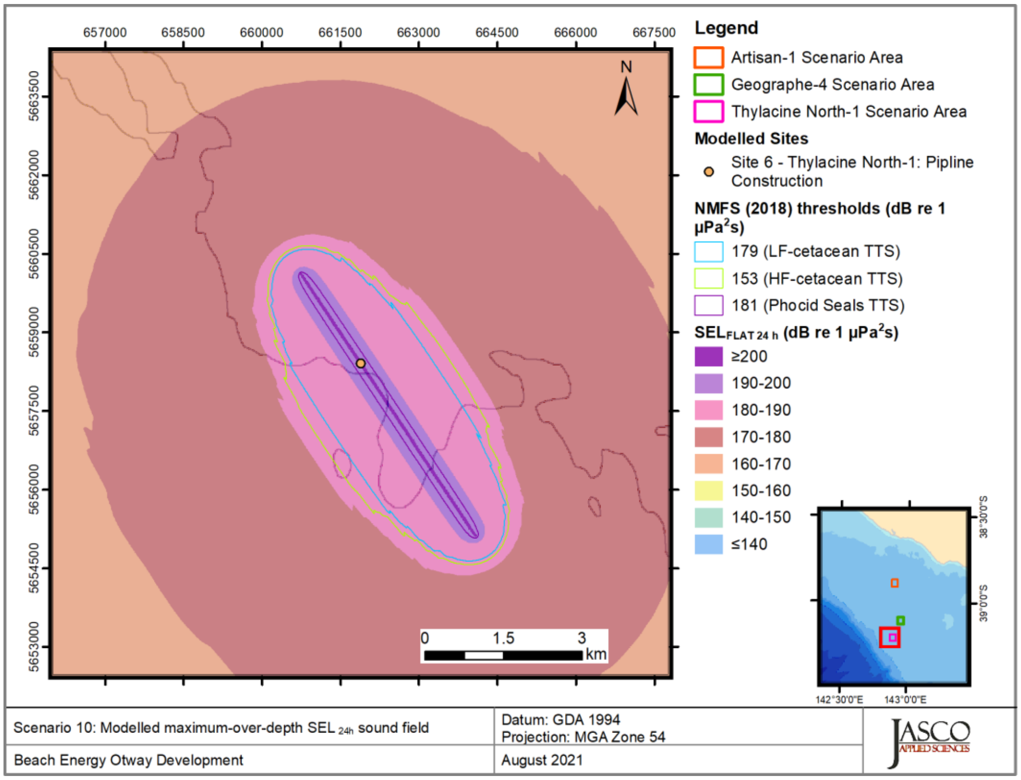


Figure 49. *Thylacine North-1, PLV pipe laying operations 20% MCR - November (Scenario 10) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

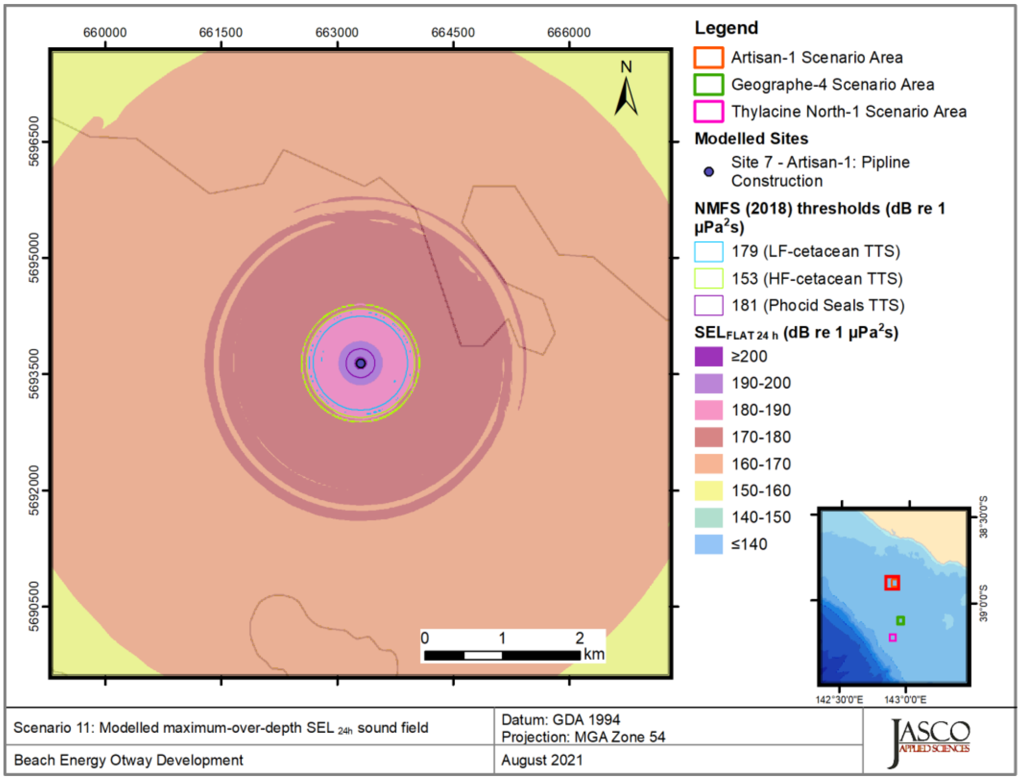


Figure 50. *Artisan-1, PLV stationary 20% MCR - June (Scenario 11) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

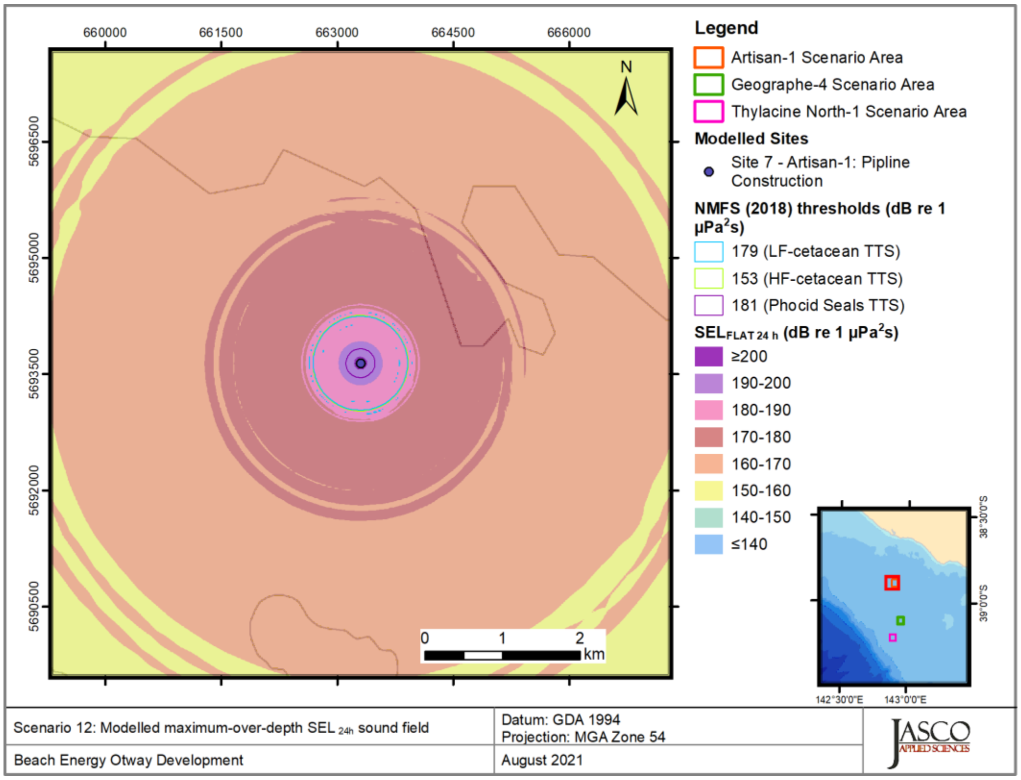


Figure 51. *Artisan-1, PLV stationary 20% MCR - November (Scenario 12) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

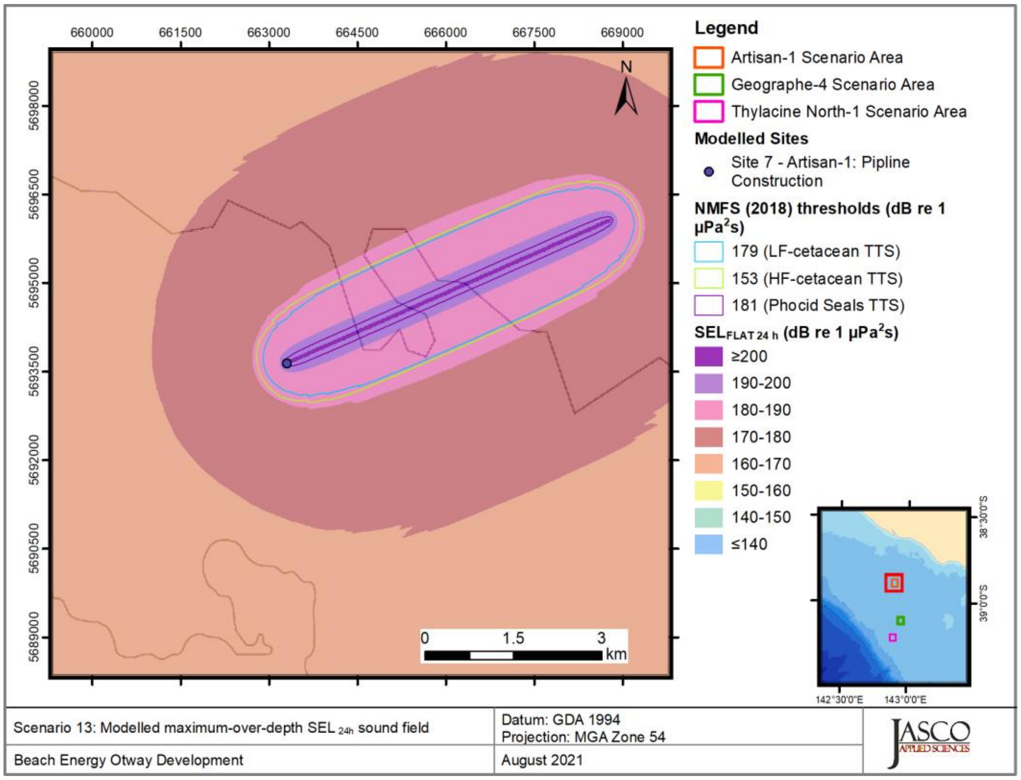


Figure 52. *Artisan-1, PLV pipe laying operations 20% MCR - June (Scenario 13) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

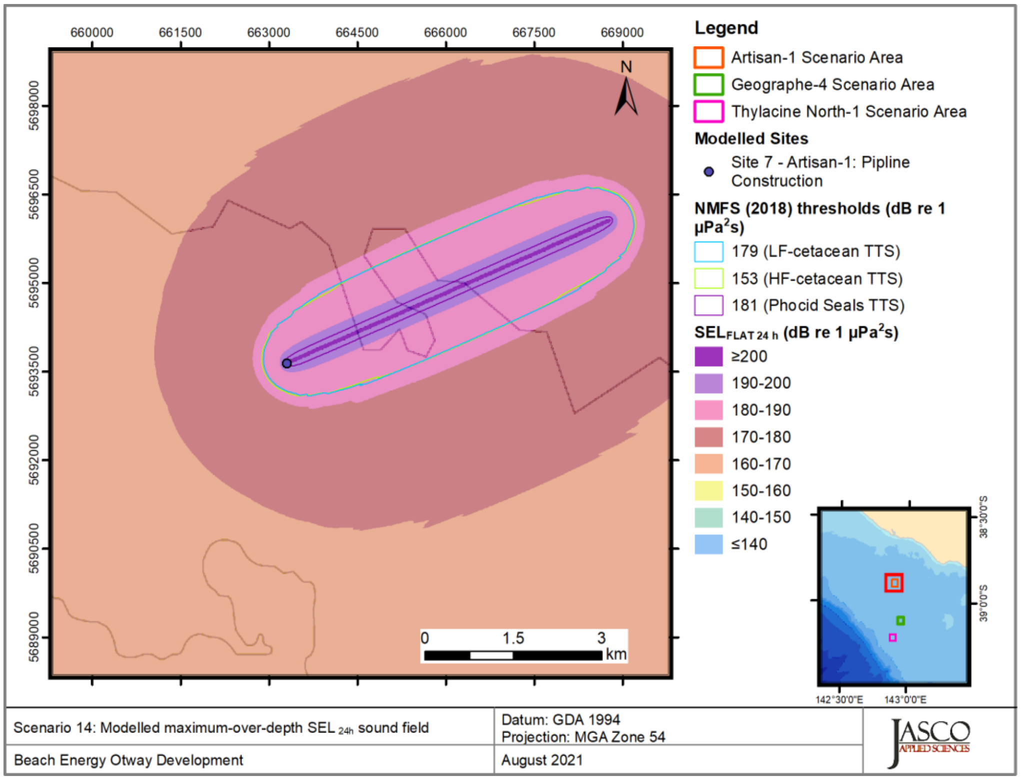


Figure 53. *Artisan-1, PLV pipe laying operations 20% MCR - November (Scenario 14) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

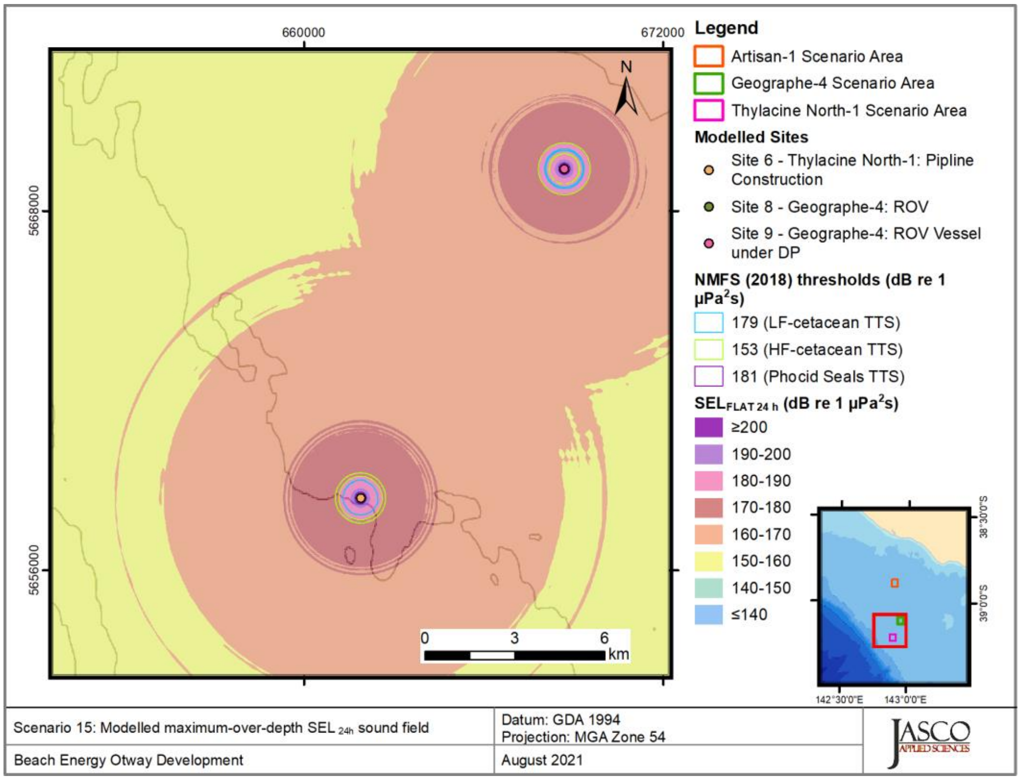


Figure 54. Thylacine North-1, PLV stationary and ROV Operations at Geographe-4 (*20% MCR*) - June (Scenario 15) SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

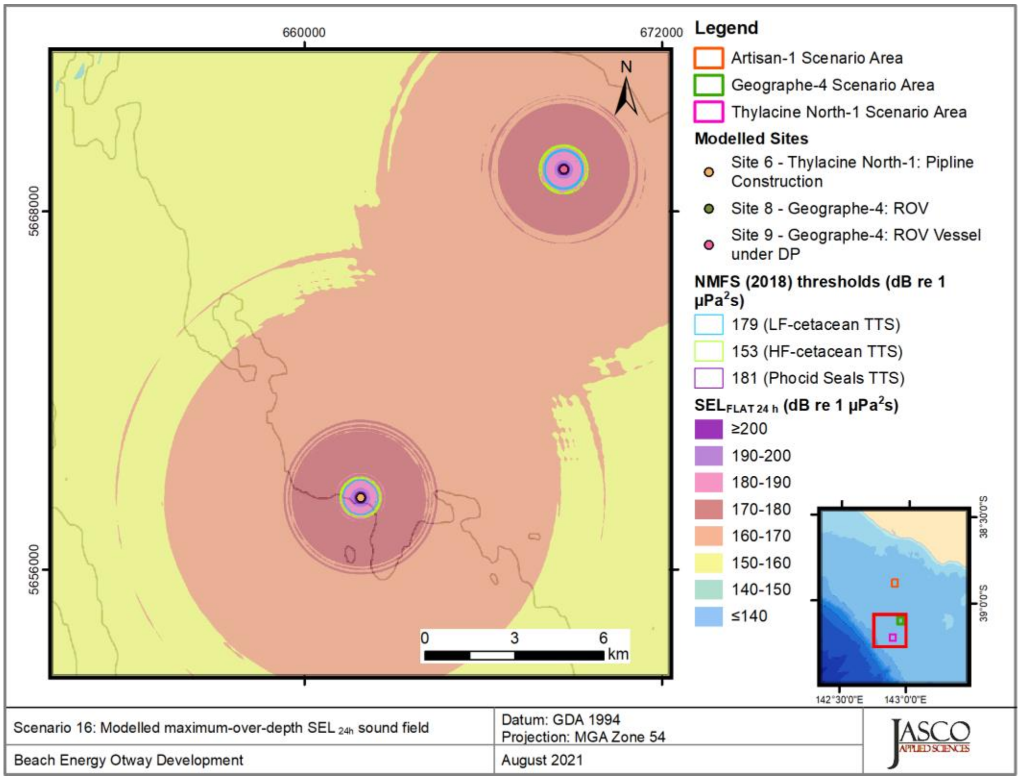


Figure 55. *Thylacine North-1, PLV stationary 20% MCR and ROV Operations at Geographe-4* (*20% MCR*) - *November (Scenario 16)* SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

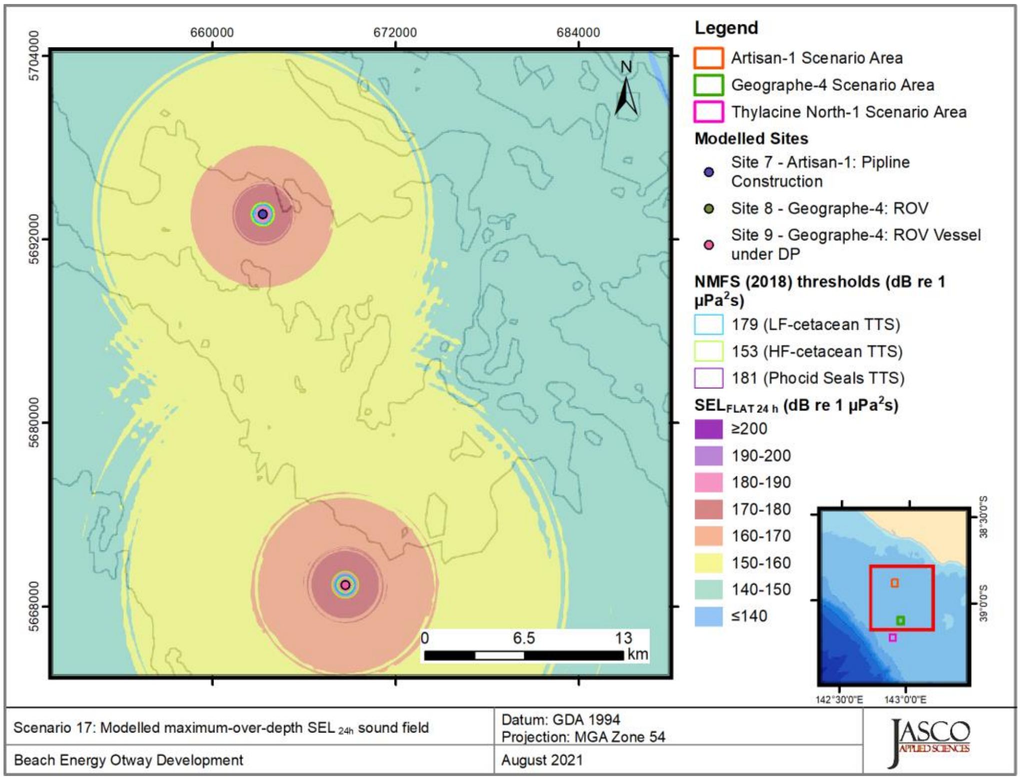


Figure 56. *Thylacine North-1, PLV stationary 20% MCR and ROV Operations at Geographe-4* (*20% MCR*) - *June (Scenario 17) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

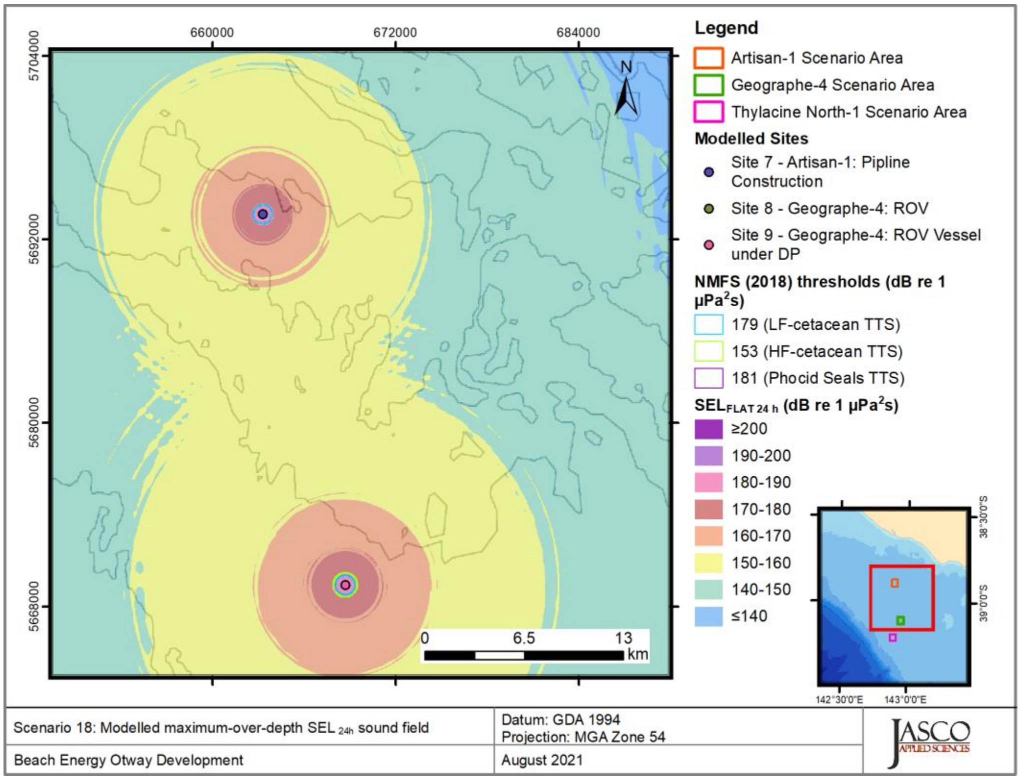


Figure 57. *Artisan-1, PLV stationary 20% MCR and ROV Operations at Geographe-4* (*20% MCR*) - *November (Scenario 18) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

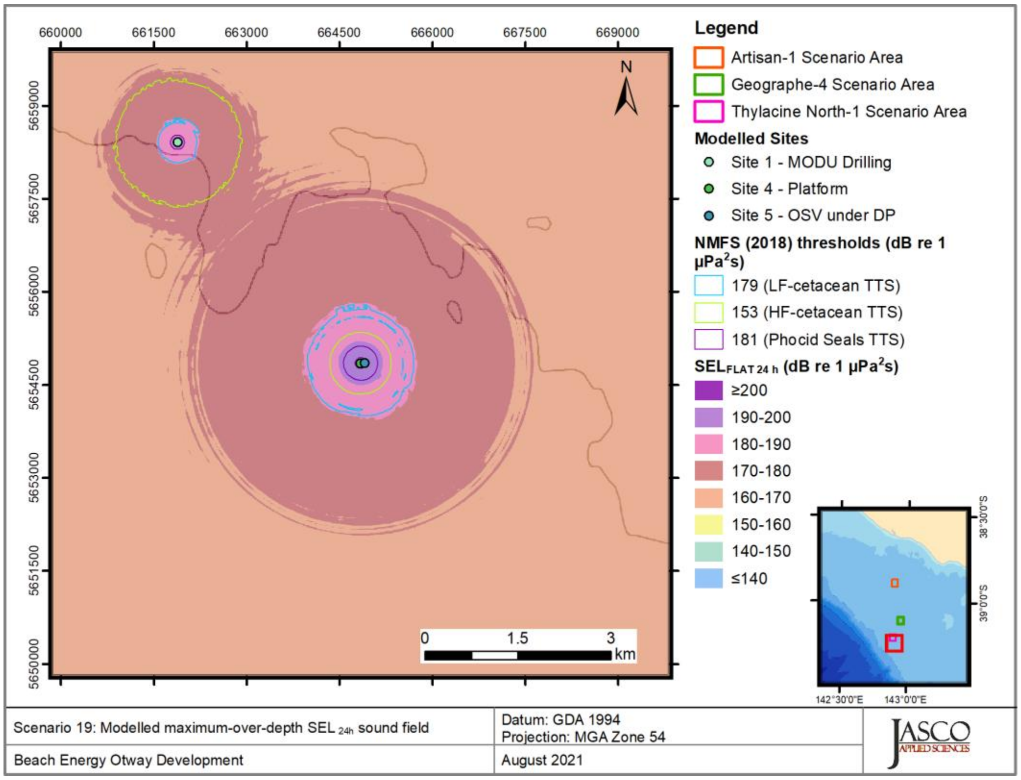


Figure 58. *Thylacine A Platform, 4h Platform Resupply and MODU Drilling (Scenario 19) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

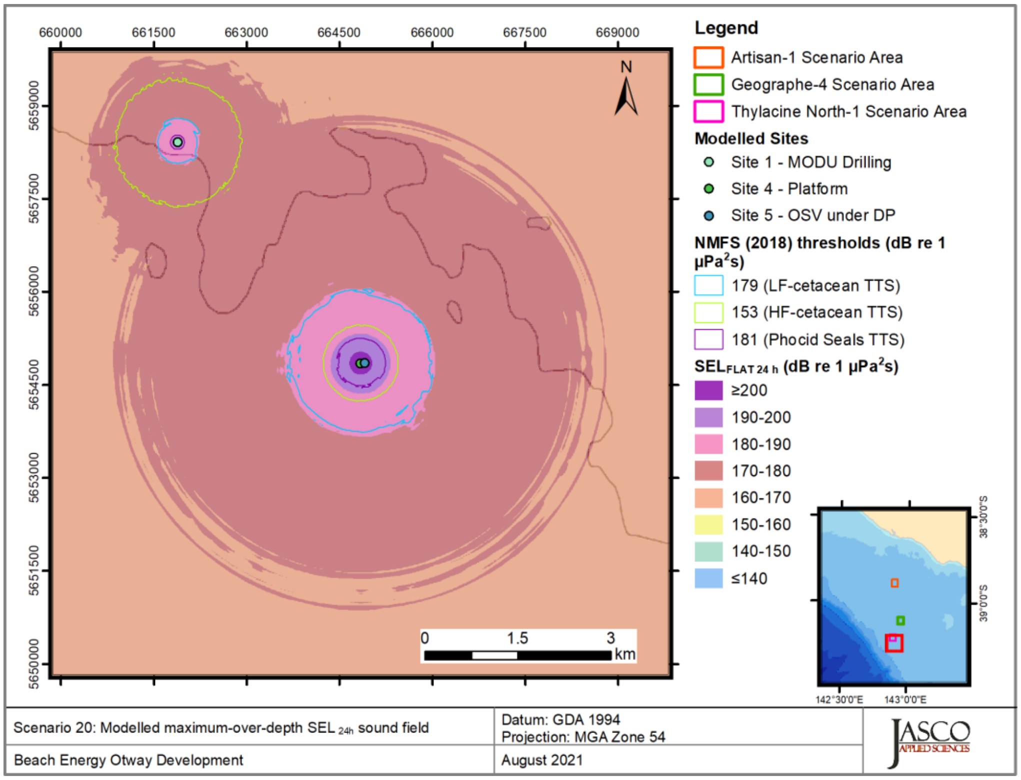


Figure 59. *Thylacine A Platform, 8h Platform Resupply and MODU Drilling (Scenario 20) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

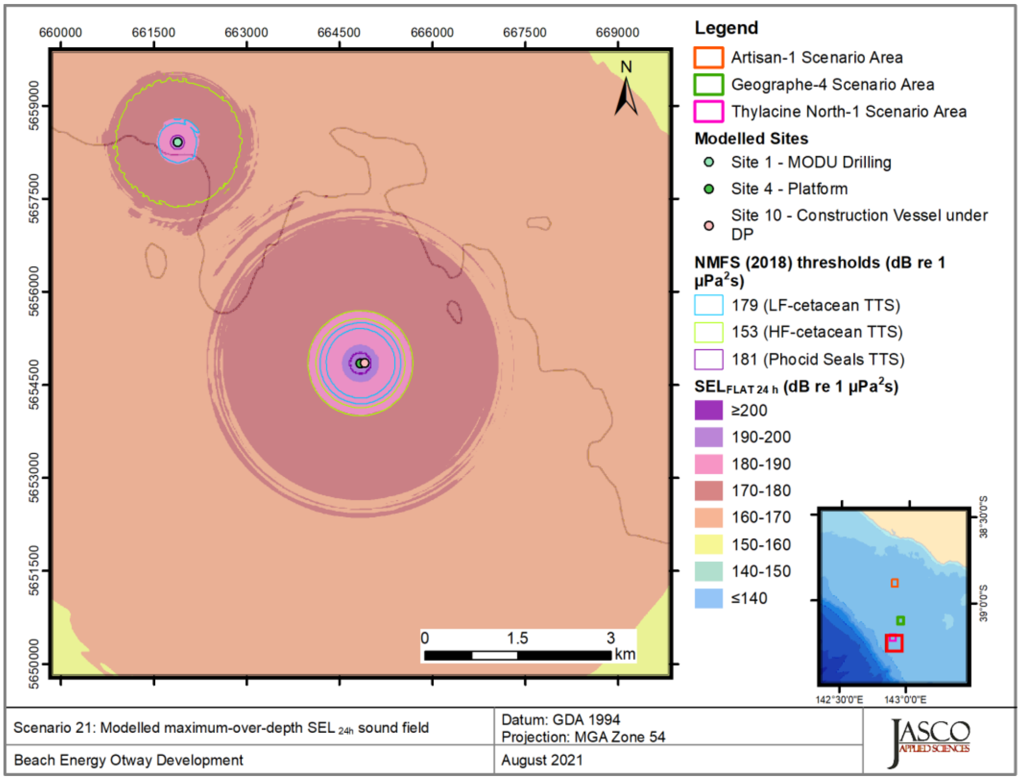


Figure 60. *Thylacine A Platform, Skid installation vessel operating at 20% MCR and MODU Drilling (Scenario 21) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

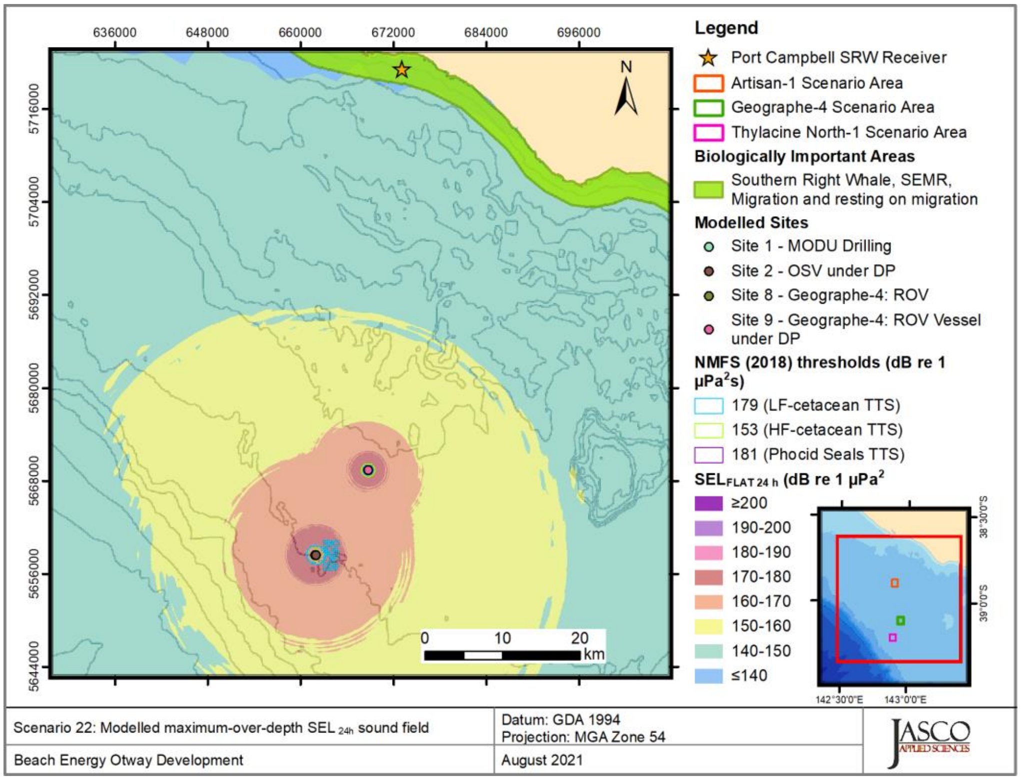


Figure 61 *Concurrent drilling operations at Thylacine North-1 and construction operations (20% MCR) at Geographe-4 (Scenario 22) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

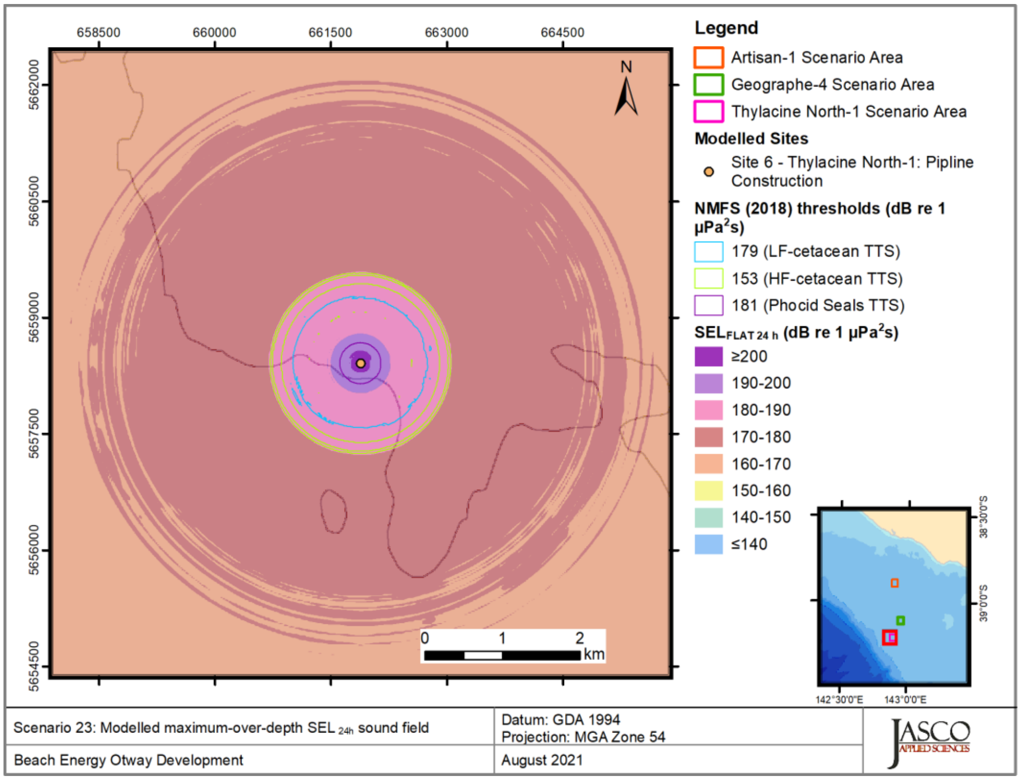


Figure 62. *Thylacine North-1, PLV stationary 40% MCR -June (Scenario 23) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

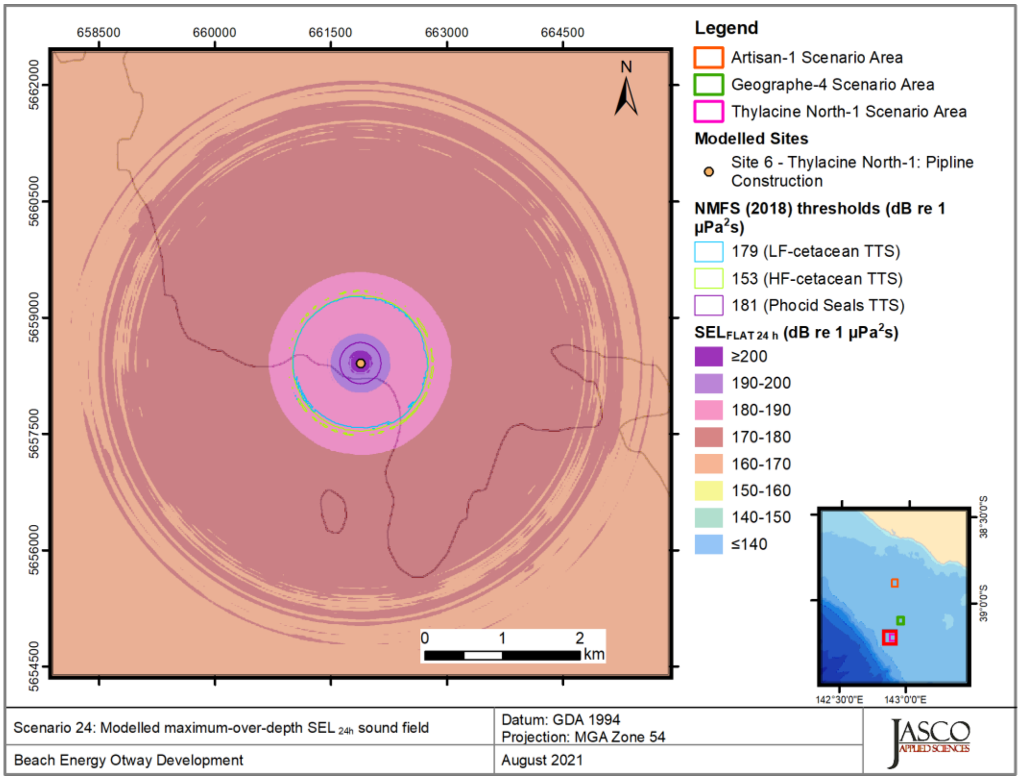


Figure 63. *Thylacine North-1, PLV stationary 40% MCR - November (Scenario 24) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

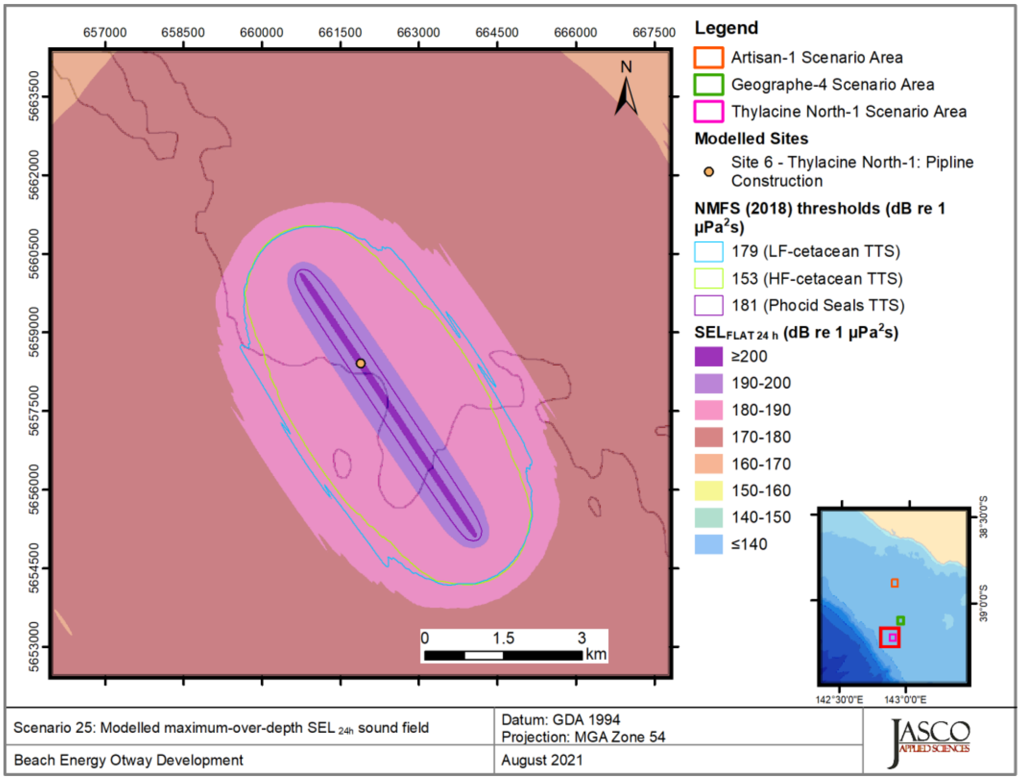


Figure 64. *Thylacine North-1, PLV pipe laying operations 40% MCR - June (Scenario 25) SEL_{24h}*: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

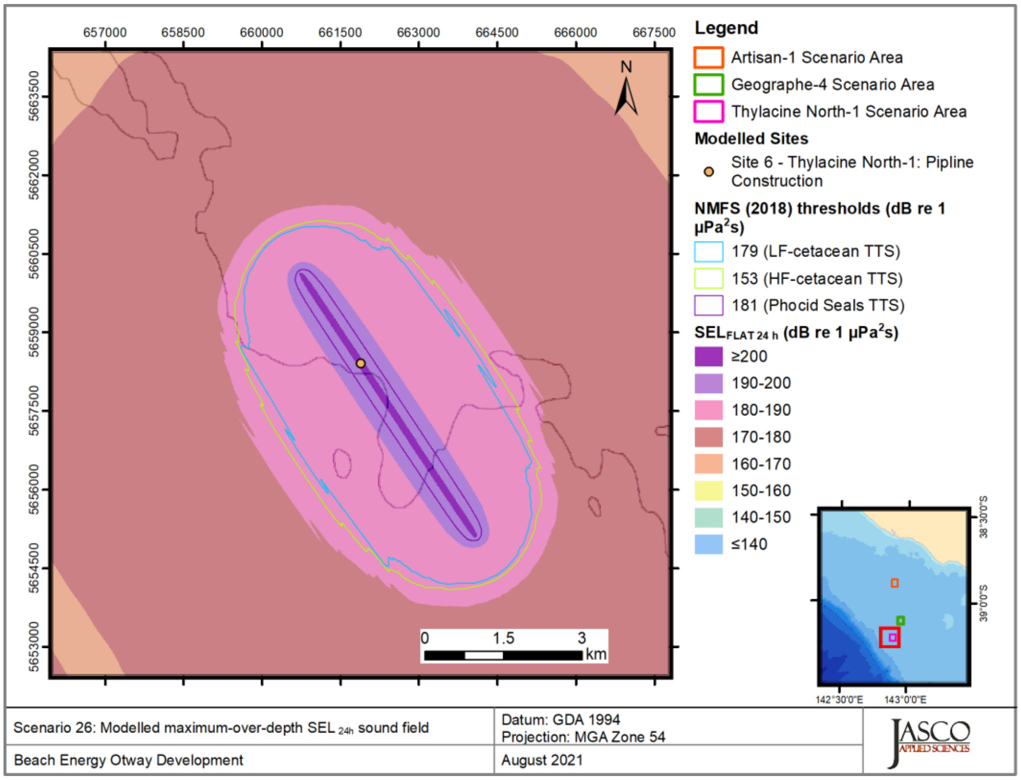


Figure 65. *Thylacine North-1, PLV pipe laying operations 40% MCR - November (Scenario 26) SEL_{24h}*: Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

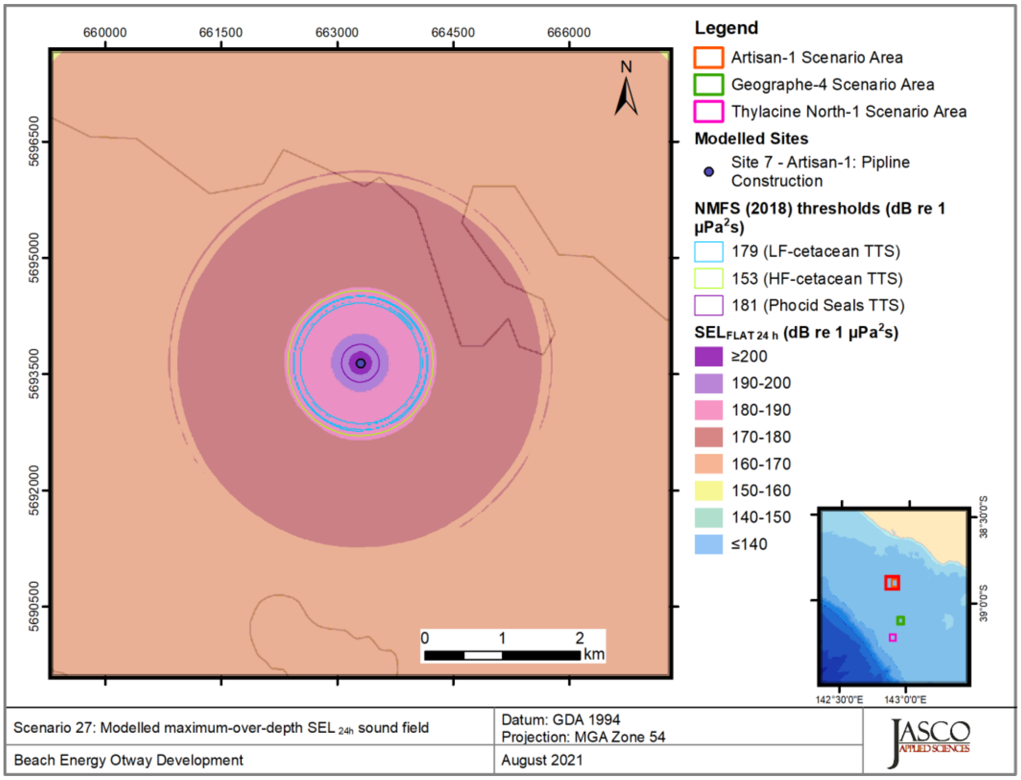


Figure 66. *Artisan-1, PLV stationary 40% MCR - June (Scenario 27) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

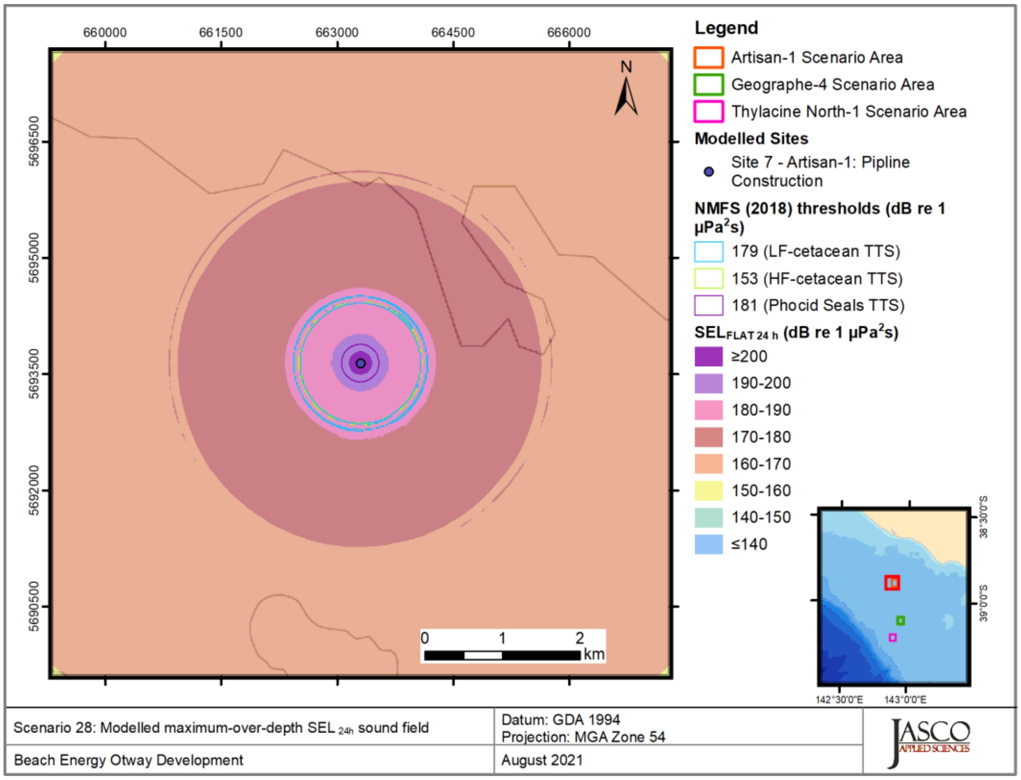


Figure 67. *Artisan-1, PLV stationary 40% MCR - November (Scenario 28) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

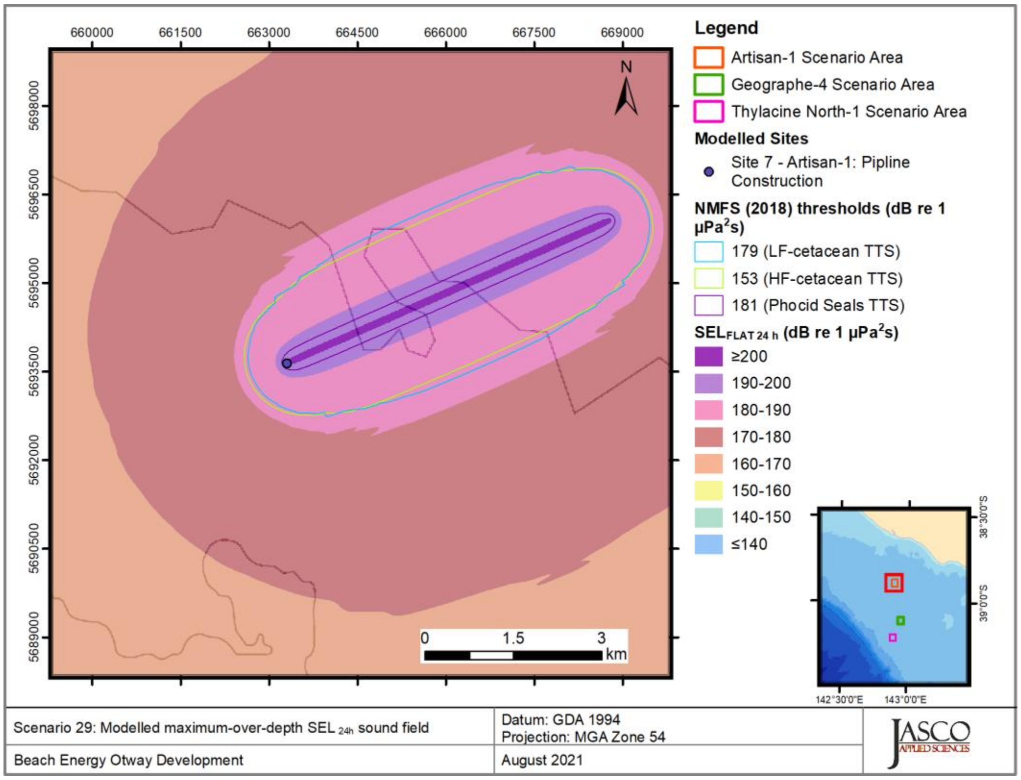


Figure 68. *Artisan-1, PLV pipe laying operations 40% MCR - June (Scenario 29) SEL_{24h}*: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

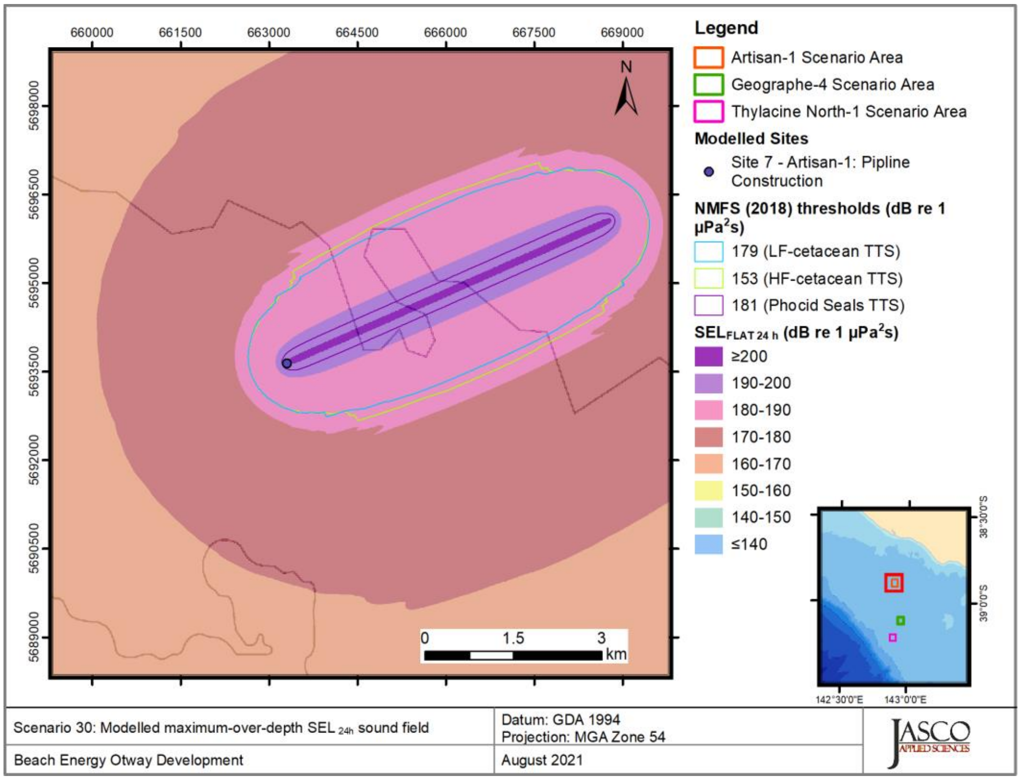


Figure 69. *Artisan-1, PLV pipe laying operations 40% MCR - November (Scenario 30) SEL_{24h}*: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

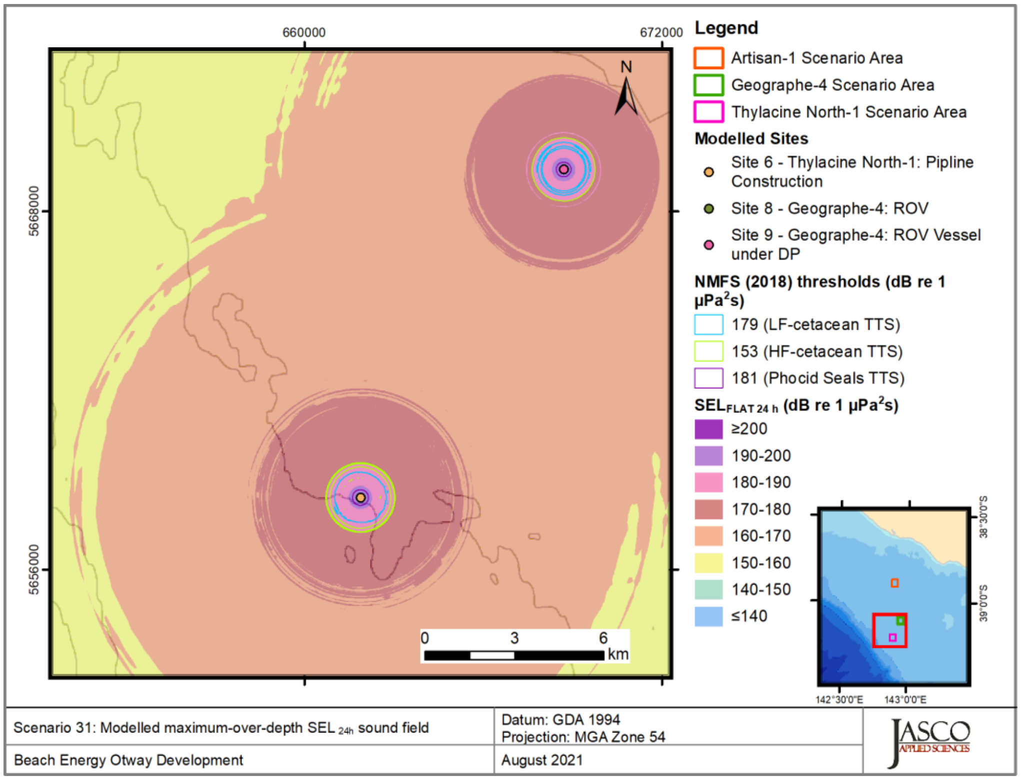


Figure 70. Thylacine North-1, PLV stationary and ROV Operations at Geographe-4 (*40% MCR*) - June (Scenario 31) SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

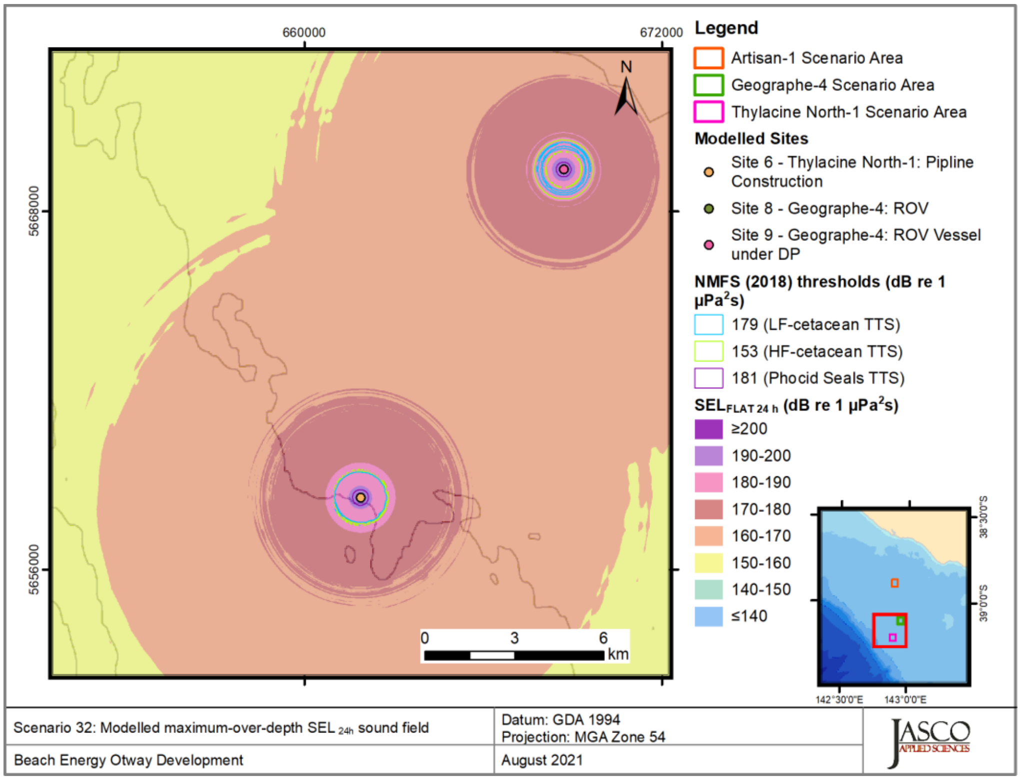


Figure 71. *Thylacine North-1, PLV stationary and ROV Operations at Geographe-4* (*40% MCR*) - *November (Scenario 32)* *SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

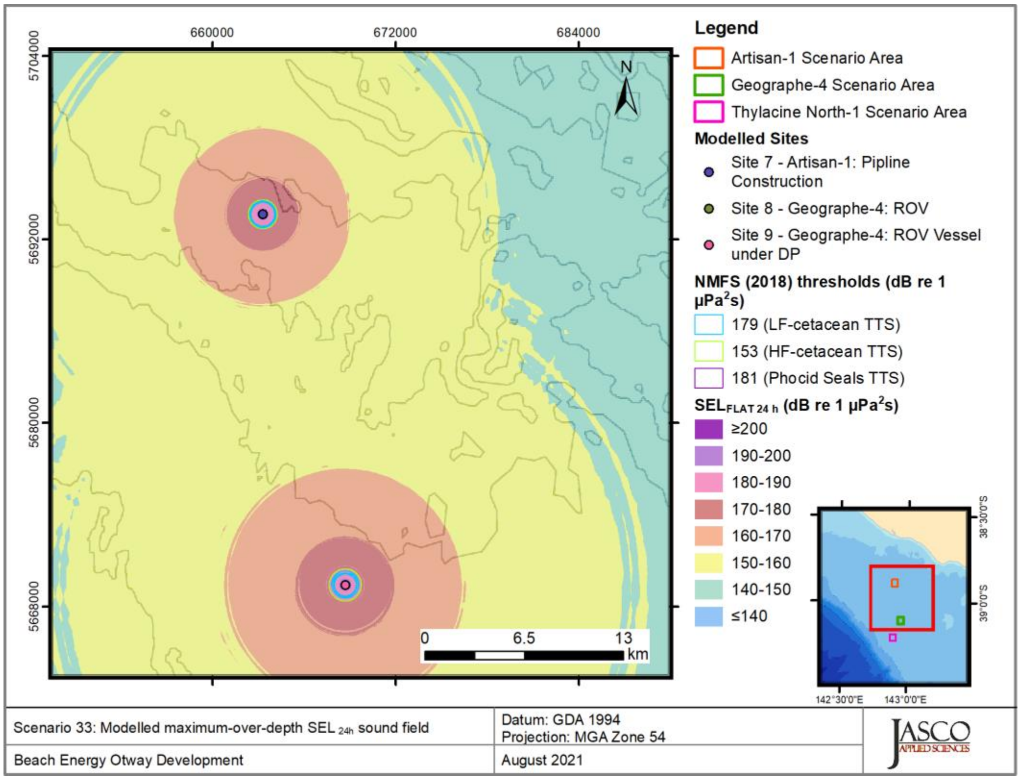


Figure 72. *Thylacine North-1, PLV stationary and ROV Operations at Geographe-4* (*40% MCR*) - *June (Scenario 33) SEL_{24h}*: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

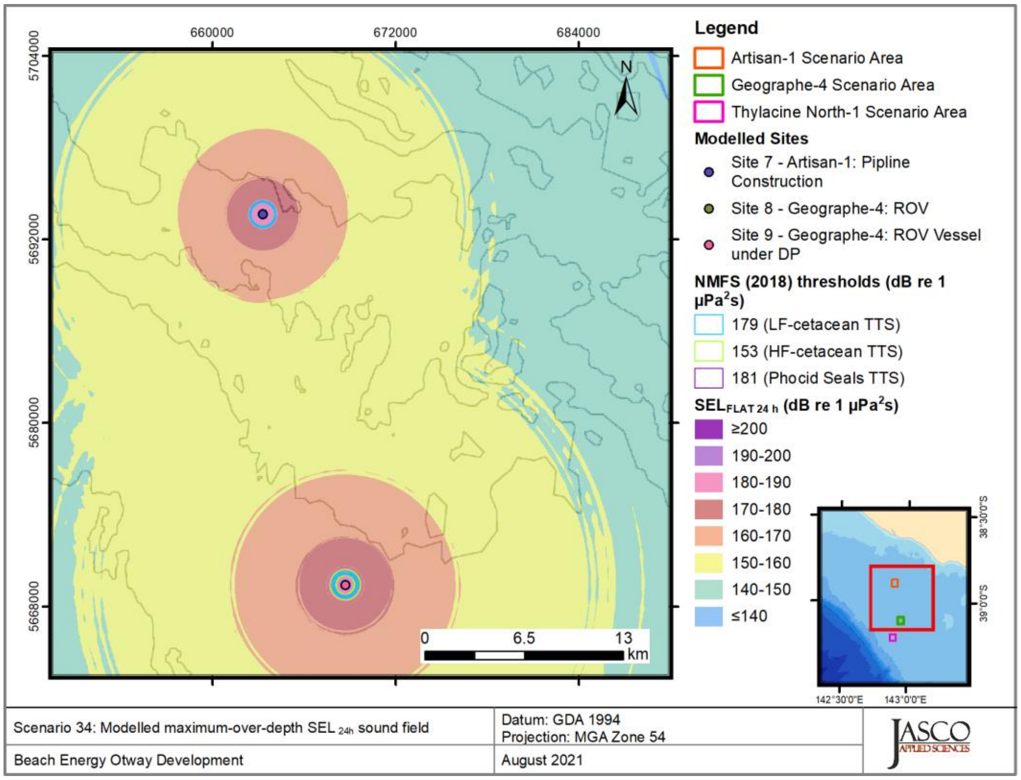


Figure 73. *Artisan-1, PLV stationary and ROV Operations at Geographe-4* (*40% MCR*) - *November (Scenario 34) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

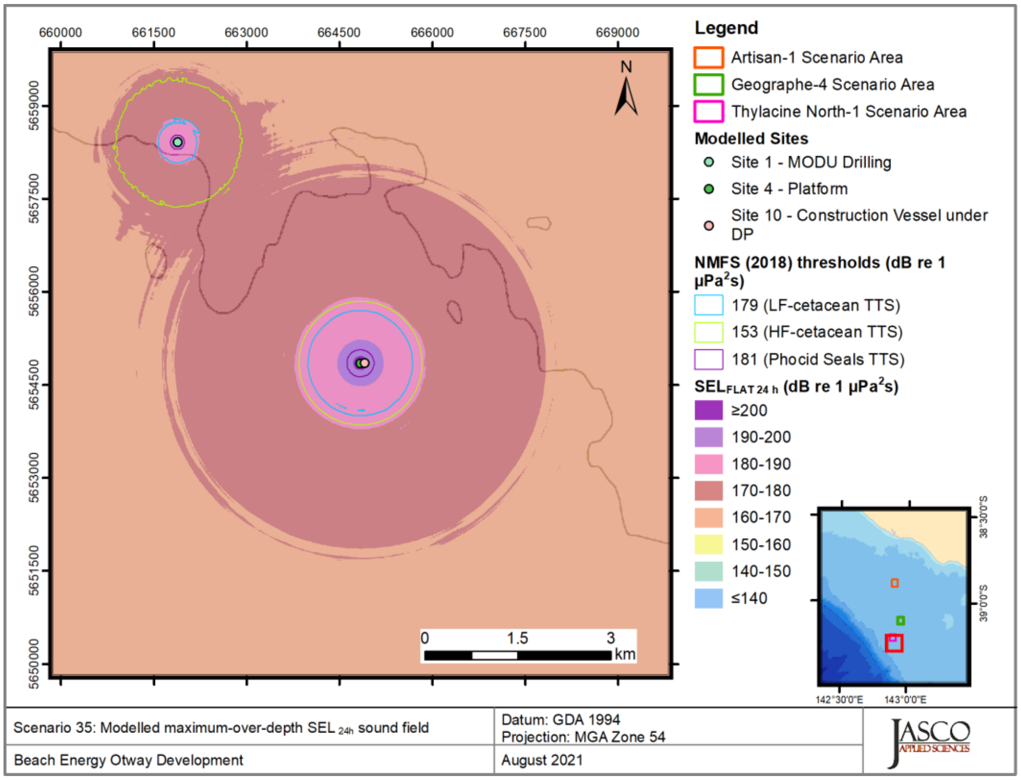


Figure 74. *Thylacine A Platform, Skid installation vessel operating at 40% MCR and MODU Drilling (Scenario 35) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

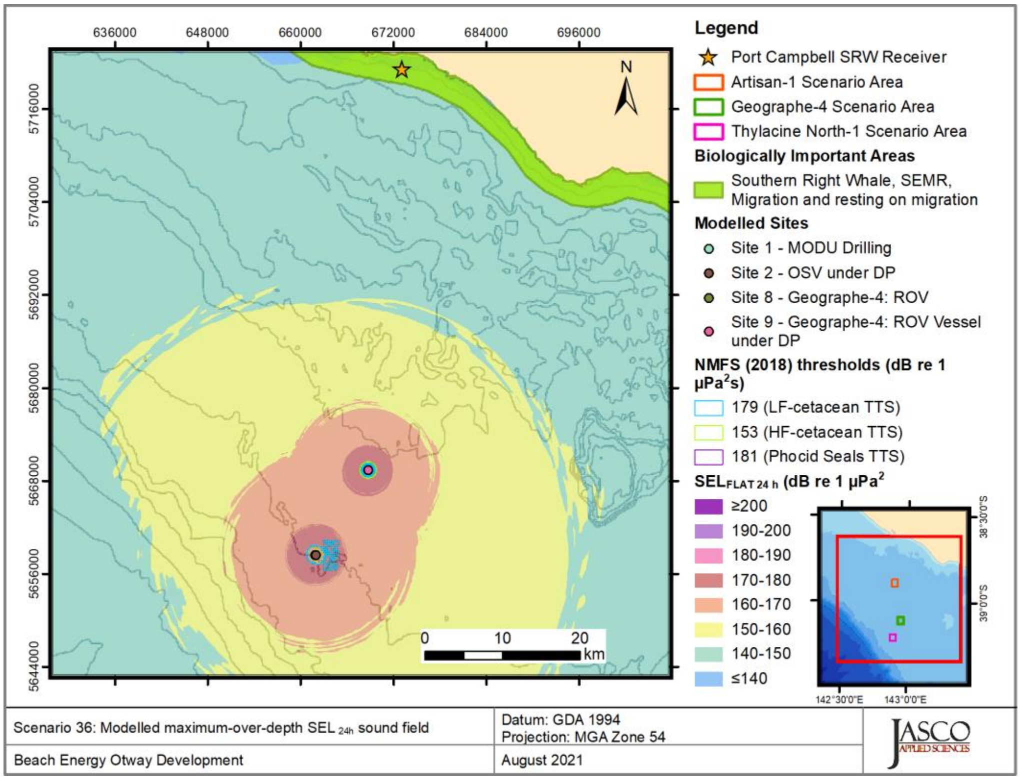


Figure 75 *Concurrent drilling operations at Thylacine North-1 and construction operations (40% MCR) at Geographe-4 (Scenario 36) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

5. Discussion

The approach applied here to model the propagation loss was based is suitable for other locations within the continental shelf portion of the Otway Basin because it is supported by measurements of very similar operational activities (McPherson et al. 2021). However, the accuracy of the modelling propagation loss within this environment depends significantly upon the frequency content of the radiating sound source together with thickness of the sand layer on the calcarenite seabed within Otway region. In general, for these types of sources (i.e., vessels and other sources with a significant amount of energy above a few hundred Hertz) the thinner the sand layer, the greater the propagation loss. Having accurate source and site-specific information reduces the amount of uncertainty results due to model inputs uncertainty particularly when seemingly small changes in parametrisation can have reasonable significant changes in predicted results.

The distances to the effect thresholds based on modelling conducted here and supported by the results of the measurement study McPherson et al. (2021) are generally smaller when compared to those originally presented in Koessler et al. (2020). The understanding of the environment gained through the measurement study allowed for the geological environment to be represented in a site-specific fashion, and a more appropriate configuration of numerical models to represent the environmental propagation loss particularly with the layered calcarenite seabed. The application of the revised modelling approach to represent other Beach Energy activities on the continental shelf of the Otway Basin would be appropriate.

The maximum-over-depth sound field maps presented above show a few instances where threshold contours form concentric ‘rings’ around a source. These are likely the product of propagation interference patterns and the calculations method to account for the loss associated with the cemented limestone seabed (Section 6.2 in McPherson et al. (2021)). Variations in the sound field can produce local maxima and minima in loss which can results in specific levels dipping below thresholds before reaching a maximum extent. Moreover, the near constant bathymetry around most sources produces axial symmetry around a given source. Together these two factors can form the observed 'rings'. Nevertheless, the maximum extent of these contours and associated tabulated radii are a valid prediction of the effect ranges that can be expected from the modelled operations.

The effect of different seasonality on predicted distances to the effect thresholds was minor but present. Considering the modelled Otway Offshore Project Construction scenarios, each scenario was modelled with a sound speed profiles for the 'worst case over the year' and for a period pygmy blue whales are present in the region, between November and January. These sound speed profiles were respectively selected as June and November. The effect thresholds applied to pygmy blue was the low-frequency cetacean SEL_{24h} thresholds based on NMFS (2018). The sound speed profile of November generally produced small distances to the low-frequency cetacean PTS and TTS threshold for the same operational activities modelled with a June SSP, see Tables 13–15. The seasonal differences were at most a few hundred metres. The receiver SPL level at the Port Campbell receiver locations presented in Table 10 are therefore expected to be lower in in November.

The SEL_{24h} is a cumulative metric that reflects the dosimetric impact of noise levels within 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. The corresponding SEL_{24h} radii represent an unlikely worst-case scenario. More realistically, marine mammals (as well as fish and turtles) are unlikely to stay in the same location for 24 hours. Therefore, a reported radius for SEL_{24h} criteria does not mean that marine fauna travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with impairment (either PTS or TTS) if it remained in that location for 24 hours.

Literature Cited

[NMFS] National Marine Fisheries Service (US). 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p. https://www.fisheries.noaa.gov/webdam/download/75962998.

[NOAA] National Oceanic and Atmospheric Administration (US). 2019. *ESA Section 7 Consultation Tools for Marine Mammals on the West Coast* (webpage), 27 Sep 2019. https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west. (Accessed 10 Mar 2020).

Austin, M.E., D.E. Hannay, and K.C. Bröker. 2018. Acoustic characterization of exploration drilling in the Chukchi and Beaufort seas. *Journal of the Acoustical Society of America* 144: 115-123. https://doi.org/10.1121/1.5044417

Carnes, M.R. 2009. *Description and Evaluation of GDEM-V 3.0*. US Naval Research Laboratory, Stennis Space Center, MS. NRL Memorandum Report 7330-09-9165. 21 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/a494306.pdf.

Connell, S.C., M.W. Koessler, and C.R. McPherson. 2021. *Otway Offshore Project – Construction Program: Assessing Marine Fauna Sound Exposures*. Document Number 02407, Version 1.0 Technical report by JASCO Applied Sciences for Beach Energy Limited.

Coppens, A.B. 1981. Simple equations for the speed of sound in Neptunian waters. *Journal of the Acoustical Society of America* 69(3): 862-863. https://doi.org/10.1121/1.382038.

Duncan, A.J., A.L. Maggi, and T. Gourlay. 2012. *Sound exposure level and ocean wave modelling for the Enterprise 3D seismic survey (Port Campbell)*. Document Number C2012-32 v2.2 (FINAL). CMST report for Origin Energy.

Illingworth and Rodkin Inc. 2014. *Cook Inlet Exploratory Drilling Program – underwater sound source verification assessment, Cook Inlet, Alaska.* . Prepared for BlueCrest Energy, Inc. by Illingworth & Rodkin, Inc., Petaluma, California. https://www.federalregister.gov/documents/2014/09/11/2014-21662/takes-of-marine-mammals-incidental-to-specified-activities-taking-marine-mammals-incidental-to.

James, N.P. and Y. Bone. 2010. *Neritic carbonate sediments in a temperate realm: southern Australia*. Springer Science & Business Media.

Koessler, M.W., M.-N.R. Matthews, and C.R. McPherson. 2020. *Otway Offshore Project – Drilling Program: Assessing Marine Fauna Sound Exposures*. Document Number 02033, Version 1.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

Matthews, M.-N.R., M.W. Koessler, and C.R. McPherson. 2020. *Otway Offshore Project – Construction Program: Assessing Marine Fauna Sound Exposures*. Document Number 02112, Version 2.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

Matthews, M.-N.R., S. Connell, and C.R. McPherson. 2021. *Otway Offshore Project – Construction Program: Addendum – Combined Drilling and Construction Activities*. Document Number 02393, Version 1.0 DRAFT. Technical report by JASCO Applied Sciences for Beach Energy Limited. .

McPherson, C.R., Z. Li, C.C. Wilson, K.A. Kowarski, and M. Koessler. 2021. *Beach Otway Development Acoustic Monitoring: Characterisation, Validation, and Marine Mammals*. Document Number 02424, Version 2.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, et al. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. ASA S3/SC1.4 TR-2014. SpringerBriefs in Oceanography. ASA Press and Springer. https://doi.org/10.1007/978-3-319-06659-2.

Spence, J.H., R. Fischer, M.A. Bahtiarian, L. Boroditsky, N. Jones, and R. Dempsey. 2007. *Review of Existing and Future Potential Treatments for Reducing Underwater Sound from Oil and Gas Industry Activities*. Report Number NCE 07-001. Report by Noise Control Engineering, Inc. for the Joint Industry Programme on E&P Sound and Marine Life. 185 p.

Teague, W.J., M.J. Carron, and P.J. Hogan. 1990. A comparison between the Generalized Digital Environmental Model and Levitus climatologies. *Journal of Geophysical Research* 95(C5): 7167-7183. https://doi.org/10.1029/JC095iC05p07167.

Whiteway, T. 2009. *Australian Bathymetry and Topography Grid, June 2009*. GeoScience Australia, Canberra. http://pid.geoscience.gov.au/dataset/ga/67703.

Wood, M.A. and C.R. McPherson. 2018. *VSP Acoustic Modelling: Enterprise 1 Drilling Program - Otway Basin*. Document Number 01670, Version 1.1. Technical report by JASCO Applied Sciences for Beach Energy Limited.

Appendix A. Acoustic Metrics

A.1. Pressure Related Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 µPa. Because the perceived loudness of sound, especially impulsive noise such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate noise and its effects on marine life. We provide specific definitions of relevant metrics used in the accompanying report. Where possible we follow the ANSI and ISO standard definitions and symbols for sound metrics, but these standards are not always consistent.

The sound pressure level (SPL; L_p; dB re 1 µPa) is the rms pressure level in a stated frequency band over a specified time window (*T*, s) containing the acoustic event of interest. It is important to note that SPL always refers to a rms pressure level and therefore not instantaneous pressure:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)dt \Big/ p_0^2 \right) \tag{A-1}$$

The SPL represents a nominal effective continuous sound over the duration of an acoustic event, such as the emission of one acoustic pulse, a marine mammal vocalization, the passage of a vessel, or over a fixed duration. Because the window length, *T*, is the divisor, events with similar sound exposure level (SEL) but more spread out in time have a lower SPL.

The sound exposure level (SEL; L_E; $L_{E,p}$; dB re 1 µPa^2·s) is a measure related to the acoustic energy contained in one or more acoustic events (*N*). The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (*T*):

$$L_E = 10\log_{10}\left(\int_T p^2(t)dt \Big/ T_0 p_0^2 \right) \tag{A-2}$$

where T_0 is a reference time interval of 1 s. The SEL continues to increase with time when non-zero pressure signals are present. It therefore can be construed as a dose-type measurement, so the integration time used must be carefully considered in terms of relevance for impact to the exposed recipients.

SEL can be calculated over periods with multiple acoustic events or over a fixed duration. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, SEL can be computed by summing (in linear units) SEL of the *N* individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}} \right). \tag{A-3}$$

Appendix B. Methods and Parameters

This section describes the specifications of the seismic source that was used at all sites and the environmental parameters used in the propagation models.

B.1. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure B-1).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure B-1(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure B-1(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.

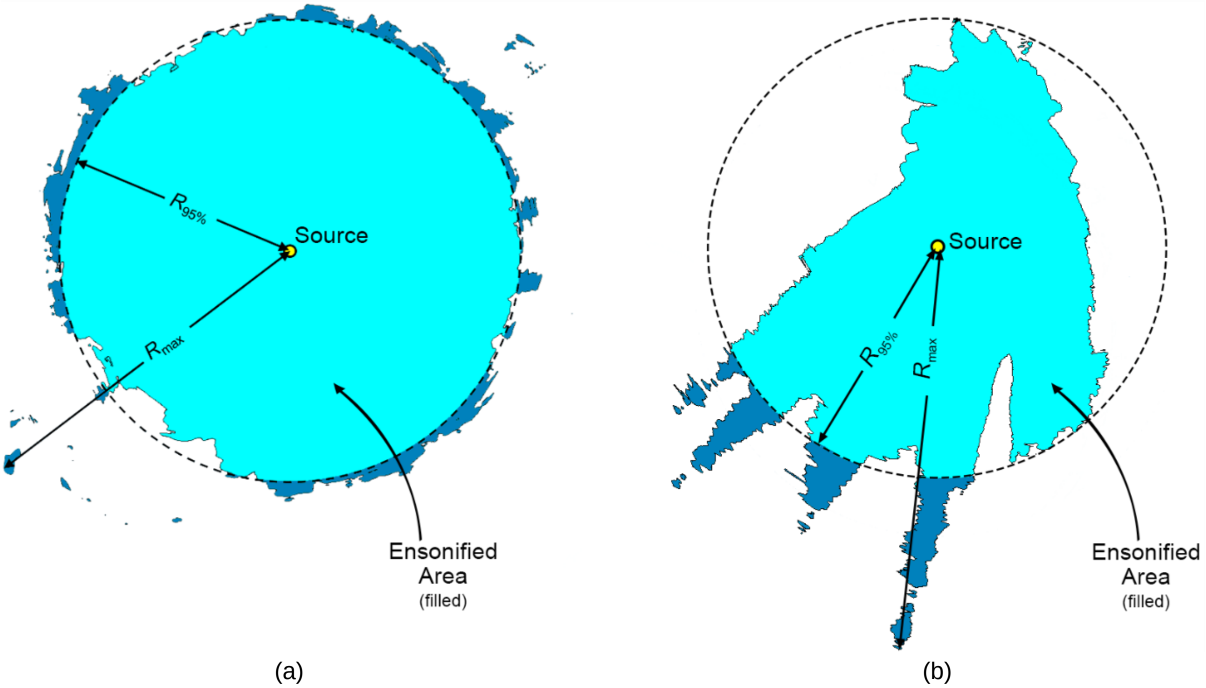


Figure B-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

B.2. Environmental Parameters

B.2.1. Bathymetry

Water depths throughout the modelled areas were extracted from the Australian Bathymetry and Topography Grid, a 9 arc-second grid rendered for Australian waters (Whiteway 2009). Bathymetry data were re-gridded onto a Map Grid of Australia (MGA) coordinate projection (Zone 54) with a regular grid spacing of 100 × 100 m.

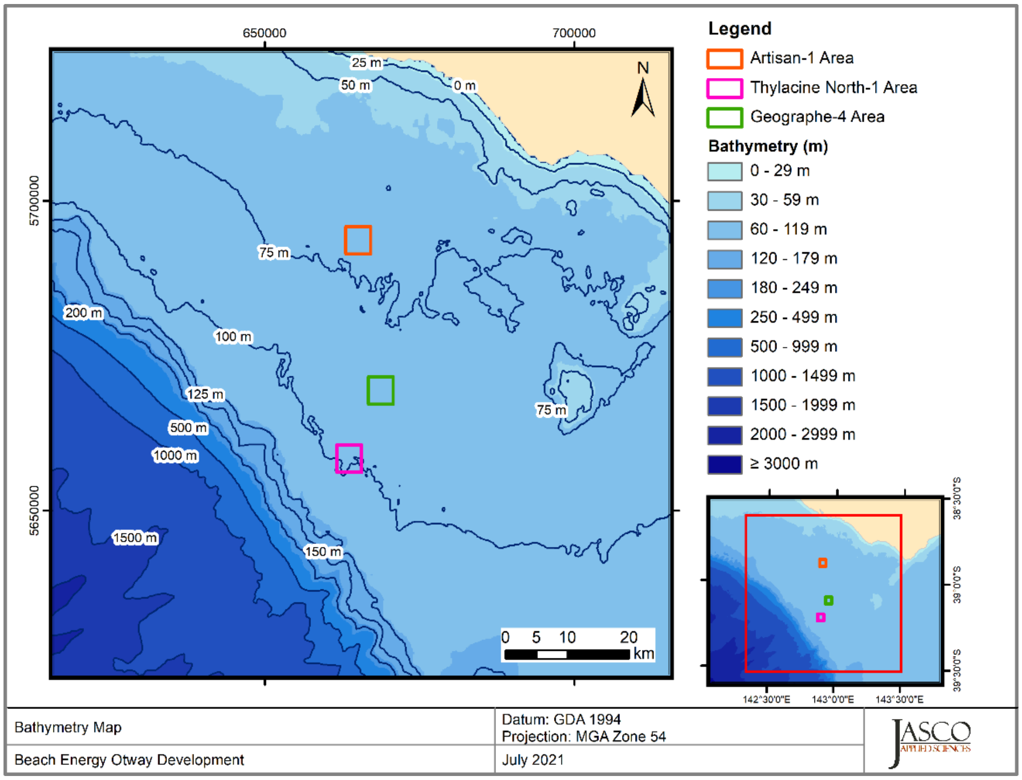


Figure B-2. Bathymetry in the modelled area.

B.2.2. Sound speed profile

The sound speed profile in the area was derived from temperature and salinity profiles from the U.S. Naval Oceanographic Office's *Generalized Digital Environmental Model V 3.0* (GDEM; Teague et al. 1990, Carnes 2009). GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the U.S. Navy's Master Oceanographic Observational Data Set (MOODS). The climatology profiles include 78 fixed depth points to a maximum depth of 6800 m (where the ocean is that deep). The GDEM temperature-salinity profiles were converted to sound speed profiles according to Coppens (1981).

Mean monthly sound speed profiles were derived from the GDEM profiles at distances less than 7 km around the modelled site. The June sound speed profile is expected to be most favourable to longer-range sound propagation across the entire year. As such, June was selected for sound propagation modelling to ensure precautionary estimates of distances to received sound level thresholds. For the pygmy blue whale period between November and January November is expected to be most favourable to longer-range propagation in that period. Figure B-3 shows the resulting profiles, which were used as input to the sound propagation modelling.

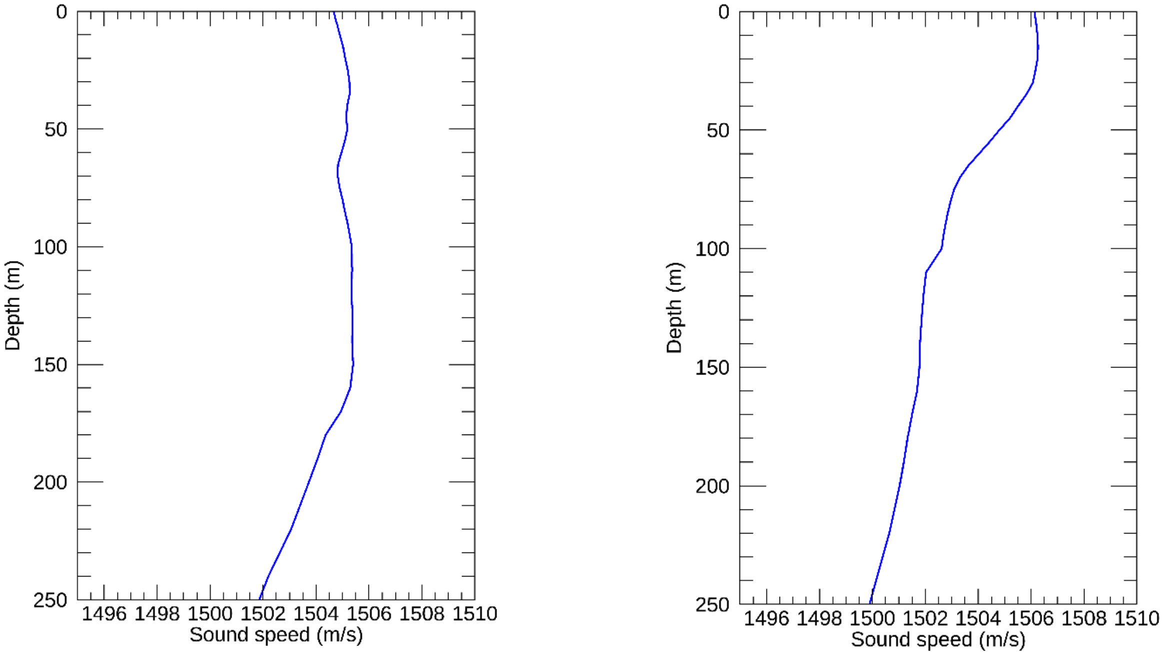


Figure B-3. The modelling sound speed profile corresponding to June (left) and November (right) Profiles are calculated from temperature and salinity profiles from *Generalized Digital Environmental Model* V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

B.2.3. Geoacoustics

The propagation model used in this study consider a single geoacoustic profile for each development area. These profiles determine how sound is reflected from the seabed, as well as how it is transmitted, reflected and absorbed into the sediment layers. As in previous acoustic studies in the area, the modelling area was divided into two seabed types (Wood and McPherson 2018). Both areas are located on the continental shelf, however the seabed in the Thylacine North-1 and were modelled as being characterised by well-cemented carbonate caprock (calcarenite), overlying semi-cemented carbonate rock (calcarenite). This contrast in seabed environment is consistent with larger scale geological data and interpretations of the Australian continental shelf environment (James and Bone 2010). Table B-1 present the geoacoustic profile used at the modelled sites in each respective development area.

Table B-1. *Thylacine North-1*: Geoacoustic profile. Each parameter varies linearly within the stated range.

Depth below seafloor (m)	**Predicted lithology**	**Density (g/cm³)**	**Compressional wave**		**Shear wave**	
			Speed (m/s)	Attenuation (dB/λ)	Speed (m/s)	Attenuation (dB/λ)
0–0.5	Well-cemented carbonate caprock	2.7	2600	0.50	1200	0.5
0.5–20	Increasingly cemented calcarenite	2.2	2000	0.30	900	0.27
20-40		2.3	2120	0.34	960	0.32
40-60		2.4	2240	0.38	1020	0.41
60-80		2.5	2360	0.42	1080	0.45
80–100		2.6	2480	0.46	1140	0.5
>100	Well-cemented calcarenite	2.7	2600	0.5	1200	0.5

Appendix G Sound Modelling Report – Connell and Koessler 2023

Technical Memo

DATE: 11 December 2023

DOCUMENT: 03248 Version 1.0

FROM: Steven Connell, Matthew Koessler (JASCO Applied Sciences (Australia) Pty Ltd)

TO: Glen Nicholson (Beach Energy)

Subject: Beach Otway Project, Additional Modelling at Well Location South

JASCO Applied Sciences (JASCO) performed additional modelling of underwater sound levels associated with the Beach Energy's exploration, development, and operations within the Otway basin. This study supplements work conducted to date, including drilling and construction results previously presented in Koessler and McPherson (2021), Koessler et al. (2020), Matthews et al. (2020) and Matthews et al. (2021). Additional modelling results have been added to better represent the southern part of the development area at a representative southern well location. In this report location is referred to as "Well Location South".

Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), and as accumulated sound exposure levels (SEL, L_E) as appropriate for non-impulsive (continuous) noise sources. For the non-time dependent scenarios, marine mammal behavioural threshold based on the current interim NOAA (2019) criterion for marine mammals of 120 dB re 1 µPa (SPL; L_p) for non-impulsive sound sources are summarised in Section 2.

For the time-dependent scenarios, the modelled maximum distances to permanent threshold shift (PTS) and temporary threshold shift (TTS) criteria for low-frequency cetaceans Southall et al. (2019)., which are based on SEL accumulated over a period of time are summarised in Section 2.

Summary tables of results are provided in Table 1 and 2 below.

Table 1. Maximum (R_{max}) horizontal distances (in km) to sound pressure level (SPL) for the NOAA (2019) behavioural response threshold from the most appropriate location for considered sources per scenario. OSV: Offshore Supply Vessel, MODU: Mobile Offshore Drilling Unit

Scenario number	Well Area	Description	R_{max} (km)
1	Well Location South	MODU Drilling	1.46
2		OSV under Transit	0.41
3		MODU Drilling + OSV under DP (4hr) + OSV under Transit (20hr) (Resupply Ops)	19.6
4		MODU Drilling + OSV under Transit	2.21

Table 2. Summary: Maximum (R_{max}) horizontal distances (in km) for the frequency-weighted LF-cetacean SEL_{24h} TTS thresholds based on Southall et al. (2019) from the most appropriate location for considered sources per scenario. OSV: Offshore Supply Vessel, MODU: Mobile Offshore Drilling Unit

Scenario number	Well Area	Description	R_{max} (km)
1	Well Location South	MODU Drilling	0.23
2		OSV under Transit	0.01
3		MODU Drilling + OSV under DP (4hr) + OSV under Transit (20hr) (Resupply Ops)	1.48
4		MODU Drilling + OSV under Transit	0.23

1. Acoustic Modelling Scenario Details

The modelled sites considered within this additional modelling are provided in Table 3, with the associated modelled scenarios detailed below and provided in Table 4. An overview of the considered scenarios is as follows:

1. MODU Drilling at Well Location South.
2. OSV vessel on standby in a 2x4 km box 2 km east of Well Location South for 24 hours.
3. MODU drilling at Well Location South with OSV under DP alongside MODU performing resupply for 4 hours and OSV vessel on standby in a 2x4 km box 2 km east of Well Location South for 20 hours.
4. MODU drilling at Well Location South with OSV vessel on standby in a 2x4 km box 2 km east of Well Location South for 24 hours.

Table 3. Location details for the modelled sites. OSV: Offshore Supply Vessel, MODU: Mobile Offshore Drilling Unit.

Well	Site	Source	Latitude (S)	Longitude (E)	MGA (GDA94), Zone 54		Water depth (m)
					X (m)	Y (m)	
Well Location South	1	MODU	39° 44' 54.61"	143° 09' 49.54"	685382	5597917	156
	2	OSV (DP)	39° 44' 54.56"	143° 09' 52.23"	685446	5597917	156
	3	OSV (transit)	39° 44' 53.04"	143° 11' 13.52"	687382	5597917	136

Table 4. Description of modelled scenarios, OSV: Offshore Supply Vessel, MODU: Mobile Offshore Drilling Unit.

Scenario	Site	Location	Operation Description
1	1	Well Location South	MODU Drilling
2	3		OSV under Transit
3	1,2,3		MODU Drilling + OSV under DP (4 hr) + OSV under Transit (20 hr) (Resupply Ops)
4	1,3		MODU Drilling + OSV under Transit

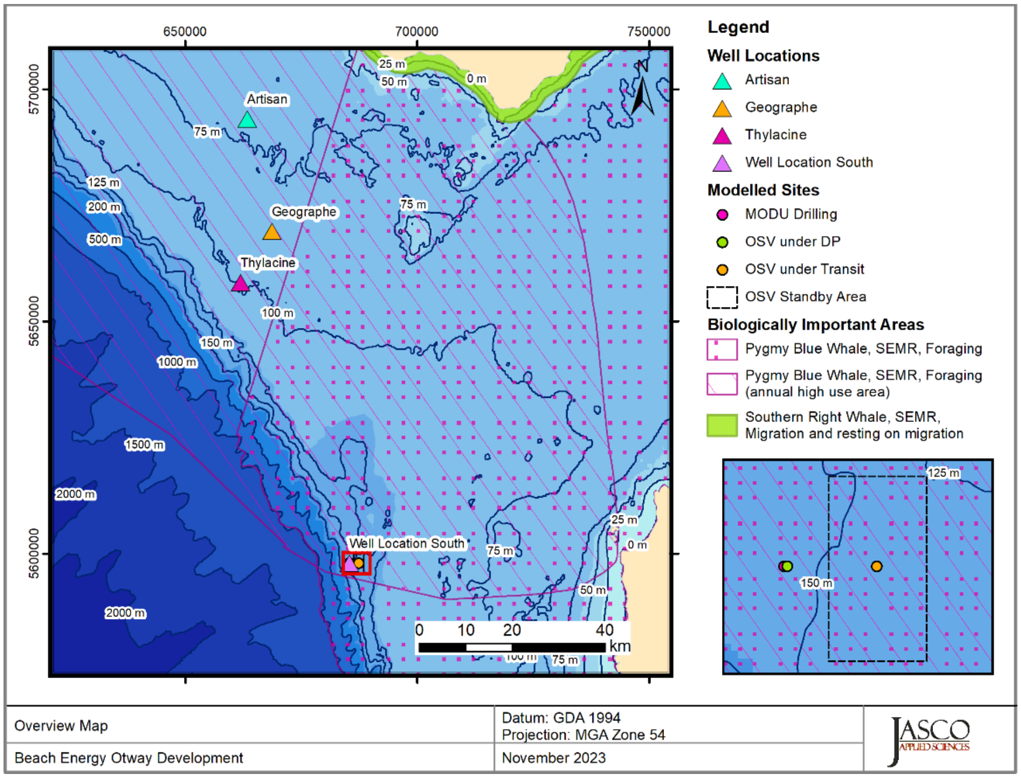


Figure 1. Overview map of the Beach Otway development area.

2. Noise Effect Criteria

To assess the potential effects of a sound-producing activity, it is necessary to establish exposure criteria (thresholds) for which sound levels may be expected to have a negative effect on animals. Whether acoustic exposure levels might injure or disturb marine fauna is an active research topic. Since 2007, several expert groups have developed SEL-based assessment approaches for evaluating auditory injury, with key works including Southall et al. (2007), Finneran and Jenkins (2012), Popper et al. (2014), United States National Marine Fisheries Service (NMFS 2018) and Southall et al. (2019). The number of studies that investigate the level of behavioural disturbance to marine fauna by anthropogenic sound has also increased substantially.

Two sound level metrics, SPL, and SEL, are commonly used to evaluate non-impulsive noise and its effects on marine life. In this report, the duration of the SEL accumulation is defined as integrated over a 24 h time period. Appropriate subscripts indicate any applied frequency weighting applied. The acoustic metrics in this report reflect the updated ANSI and ISO standards for acoustic terminology, ANSI S1.1 (2013) and ISO 18405:2017 (2017).

The following thresholds and guidelines for this study were chosen because they represent the best available science, and sound levels presented in literature for fauna with no defined thresholds:

1. Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from Southall et al. (2019) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in marine mammals for non-impulsive sources.
2. Marine mammal behavioural threshold based on the current interim U.S. National Oceanic and Atmospheric Administration (NOAA) (2019) criterion for marine mammals of 120 dB re 1 µPa (SPL; L_p) for non-impulsive sound sources.

3. Sound exposure guidelines for fish, fish eggs, and larvae (Popper et al. 2014).
4. Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from Finneran et al. (2017) for the onset of PTS and TTS in turtles for non-impulsive sources.

Additional detail on thresholds, guidelines and weighting functions can be found in Koessler et al. (2020), Matthews et al. (2020) and Matthews et al. (2021).

3. Methods

For a detailed description of the employed modelling method and input parameters refer to Koessler et al. (2020), Matthews et al. (2020), Matthews et al. (2021), Connell et al. (2021) and McPherson et al. (2021). The environmental parameters used in the propagation models are described in Appendix B.2. An analysis of seasonal sound speed profiles in Koessler and McPherson (2021) indicated that June was the month most conducive to sound propagation and was chosen for modelling. Modelling also accounted for site-specific bathymetric variations (see Appendix B.2.1) and local geoacoustic properties (see Appendix B.2.3).

3.1. Vessel and MODU Noise Sources

The MODU drilling and OSV under DP and on transit was based on measurements sourced from McPherson et al. (2021). The MODU was the *Ocean Onyx* and the loudest drill measurement was chosen while the OSV was the *Siem Sapphire*. For vessel details see Koessler et al. (2020) while a brief a summary of the measured source levels and spectra for the MODU and OSV used here are provided as follows:

- For the MODU drilling, mean levels from Section 5.5.1 in McPherson et al. (2021) were used.
- For scenarios where the OSV was under dynamic positioning (DP) the average spectrum from Section 5.5.2 in McPherson et al. (2021) was used.
- For scenarios where the OSV was transiting or standing by the average slow transit (7 knots) spectrum in McPherson et al. (2021) was used.

Figure 2 presents a summary plot of considered source spectra.

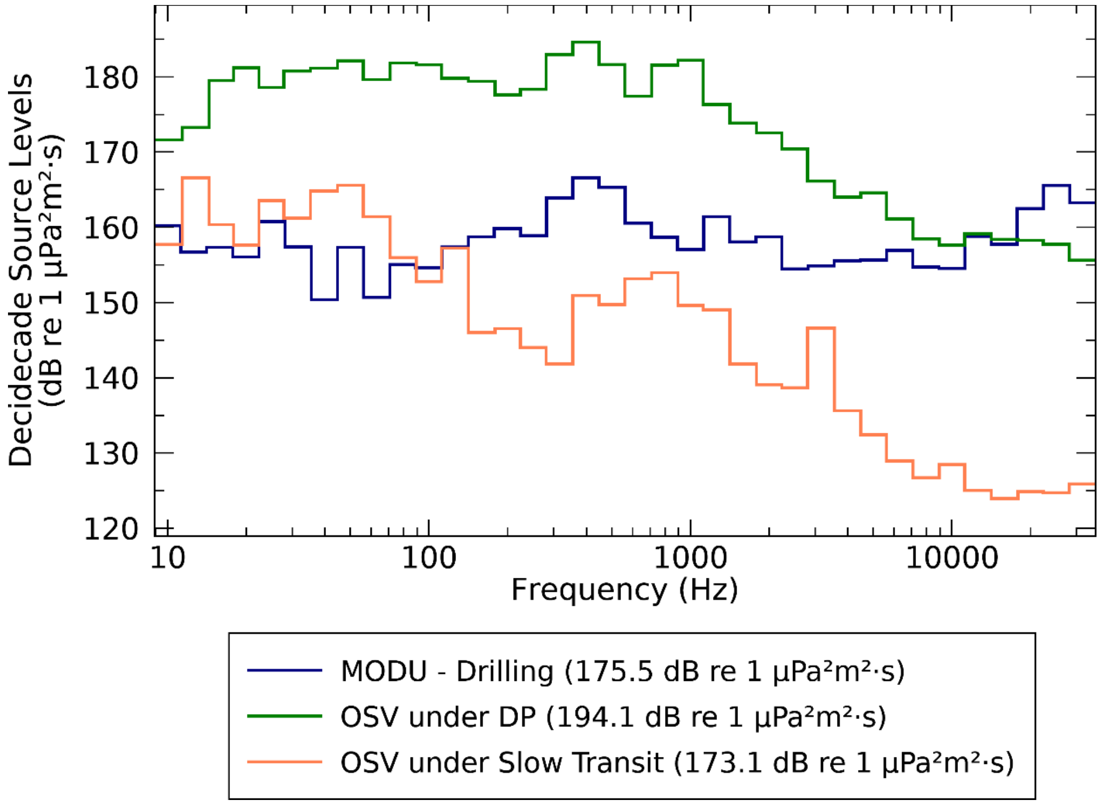


Figure 2. Energy source level (ESL) spectra (in decidecade frequency-band) for all sound sources.

4. Results

Results below are presented in two forms, tables of distances to isopleth contours (Section 4.1) and sound footprint maps (Section 4.2).

4.1. Tabulated Results

Table 5. *All Scenarios:* Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario. A dash indicates the level was not reached within the limits of the modelling resolution (20 m). OSV: Offshore Supply Vessel, DP: Dynamic Positioning, MODU: Mobile Offshore Drilling Unit.

SPL (L_p; dB re 1 µPa)	**Scenario 1 MODU Drilling**		**Scenario 2 OSV under Transit**		**Scenario 3 MODU Drilling + OSV under DP + OSV under Transit**		**Scenario 4 MODU Drilling + OSV under Transit**	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	0.02	0.02	–	–
170[A]	–	–	–	–	0.02	0.02	–	–
160	–	–	–	–	0.09	0.09	–	–
158[B]	–	–	–	–	0.11	0.11	–	–
150	0.02	0.02	–	–	0.23	0.22	0.02	0.02
140	0.07	0.07	0.03	0.03	1.21	1.07	0.07	0.07
130	0.25	0.24	0.09	0.09	5.77	4.76	0.25	0.24
120[C]	1.46	1.26	0.41	0.40	19.6	15.4	2.21	2.02
110	7.24	6.36	1.69	1.54	64.3	45.8	7.84	6.40

[A] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).

[B] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).

[C] Threshold for marine mammal behavioural response to continuous noise from NOAA (2019).

Table 6. *All Scenarios:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on Southall et al. (2019) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelling resolution (20 m). A slash indicates that the area is less than an area associated with the modelled resolution (0.0013 km^2). OSV: Offshore Supply Vessel, DP: Dynamic Positioning, MODU: Mobile Offshore Drilling Unit.

Hearing group	Frequency-weighted SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)	Scenario 1 MODU Drilling		Scenario 2 OSV under Transit		Scenario 3 MODU Drilling + OSV under DP + OSV under Transit		Scenario 4 MODU Drilling + OSV under Transit	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS									
Low-Frequency (LF) cetaceans	199	–	–	–	–	0.10	0.02	–	–
High-frequency (HF) cetaceans	198	–	–	–	–	0.05	/	–	–
Very High-frequency (VHF) cetaceans	173	0.13	0.06	–	–	0.17	0.07	0.13	0.06
Otariid seals	219	–	–	–	–	0.03	/	–	–
Turtles	220	–	–	–	–	0.05	/	–	–
TTS									
Low-Frequency (LF) cetaceans	179	0.23	0.16	0.01	0.11	1.48	5.10	0.23	0.28
High-frequency (HF) cetaceans	178	0.09	0.02	–	–	0.12	0.03	0.09	0.02
Very High-frequency (VHF) cetaceans	153	1.43	5.97	0.01	0.11	1.53	6.87	1.44	6.08
Otariid seals	199	–	–	–	–	0.05	/	–	–
Turtles	200	–	–	–	–	0.08	0.01	–	–

4.2. Sound Field Maps

Maps of the estimated sound fields, threshold contours, and isopleths of interest for SPL (Section 4.2.1) and SEL_{24h} (Section 4.2.2) sound fields are presented below.

4.2.1. SPL Maps

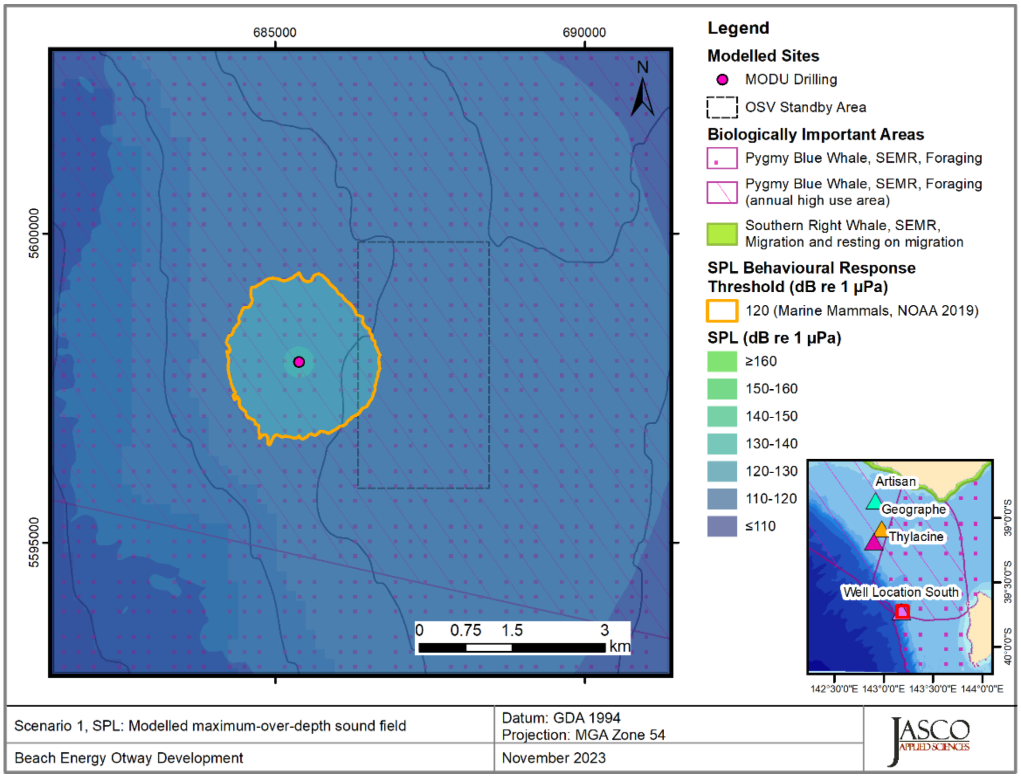


Figure 3. *Well Location South, MODU Drilling*, SPL: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals.

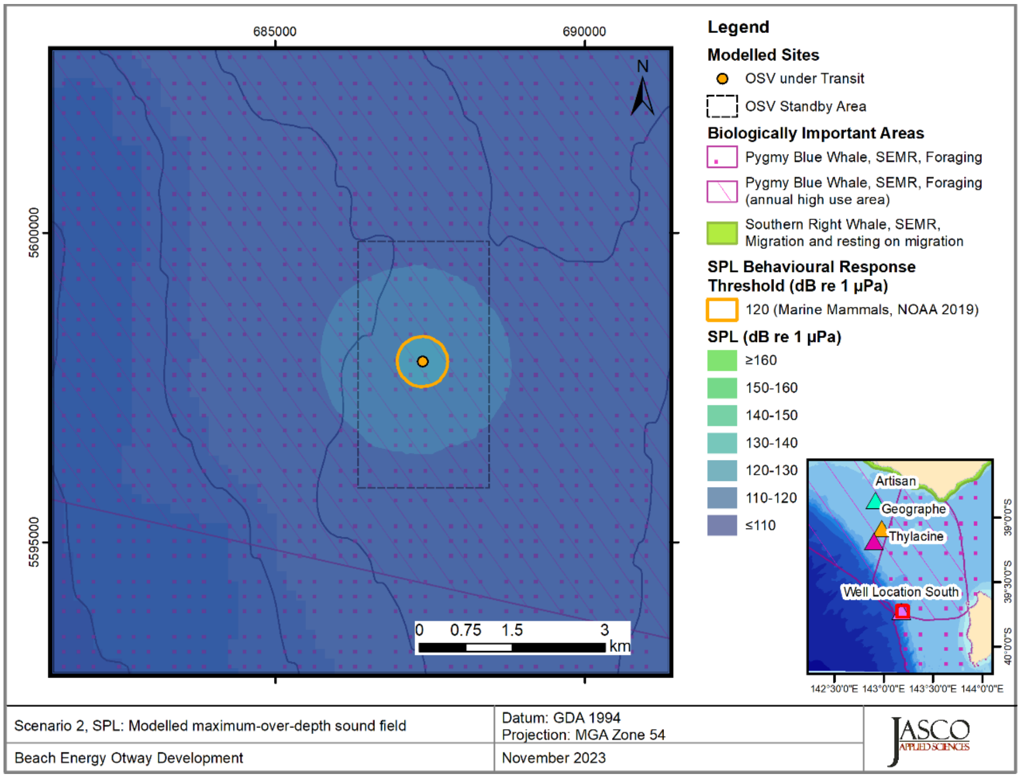


Figure 4. *Well Location South, OSV under Transit*, SPL: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals.

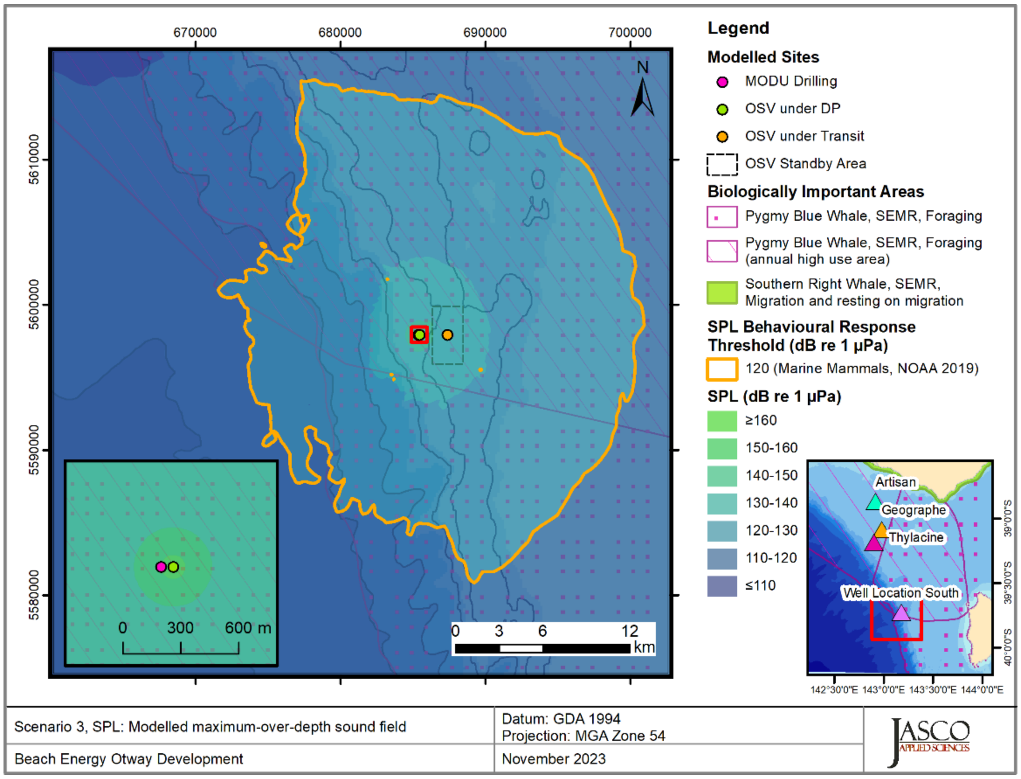


Figure 5. *Well Location South, MODU Drilling, OSV under DP, and OSV under Transit*, SPL: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals.

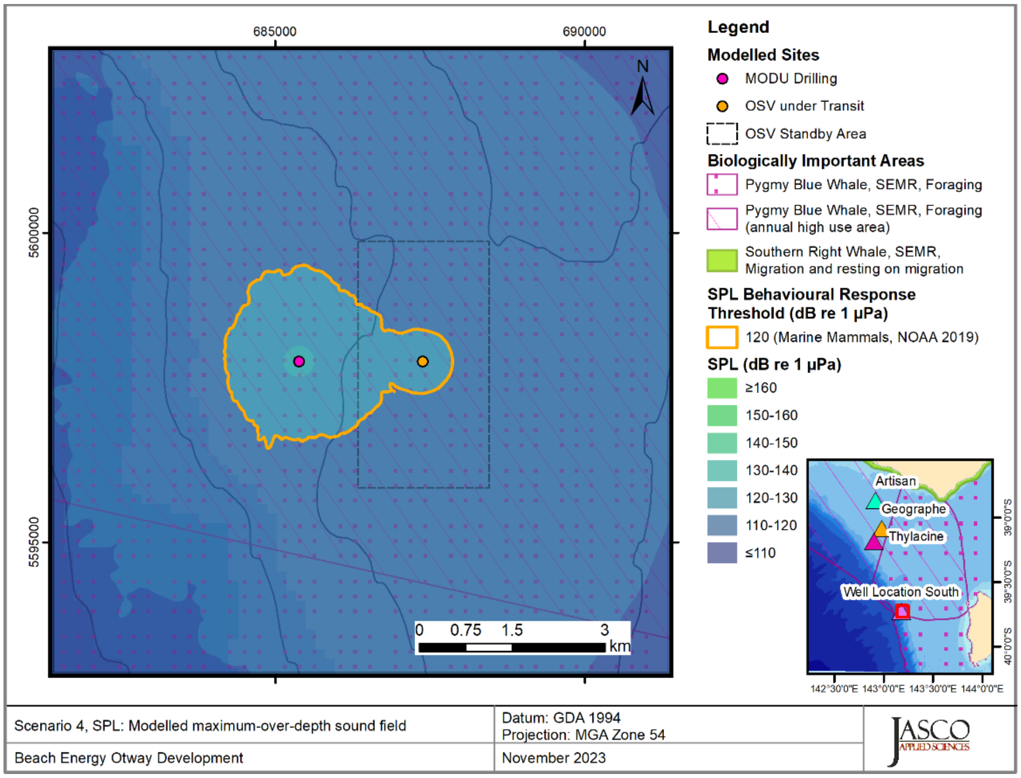


Figure 6. *Well Location South, MODU Drilling and OSV under transit*, SPL: Sound level contour map of unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals.

4.2.2. Accumulated SEL_{24h} Maps

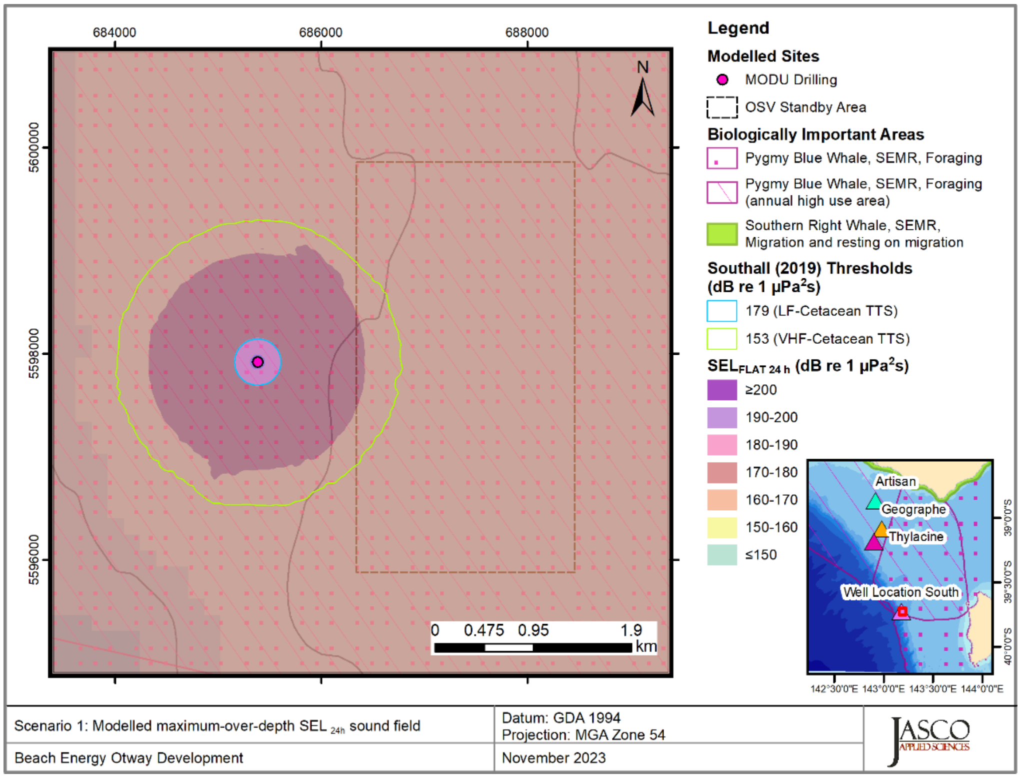


Figure 7. *Well Location South, MODU Drilling*, sound level contour map of unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such they could not be displayed on a map.

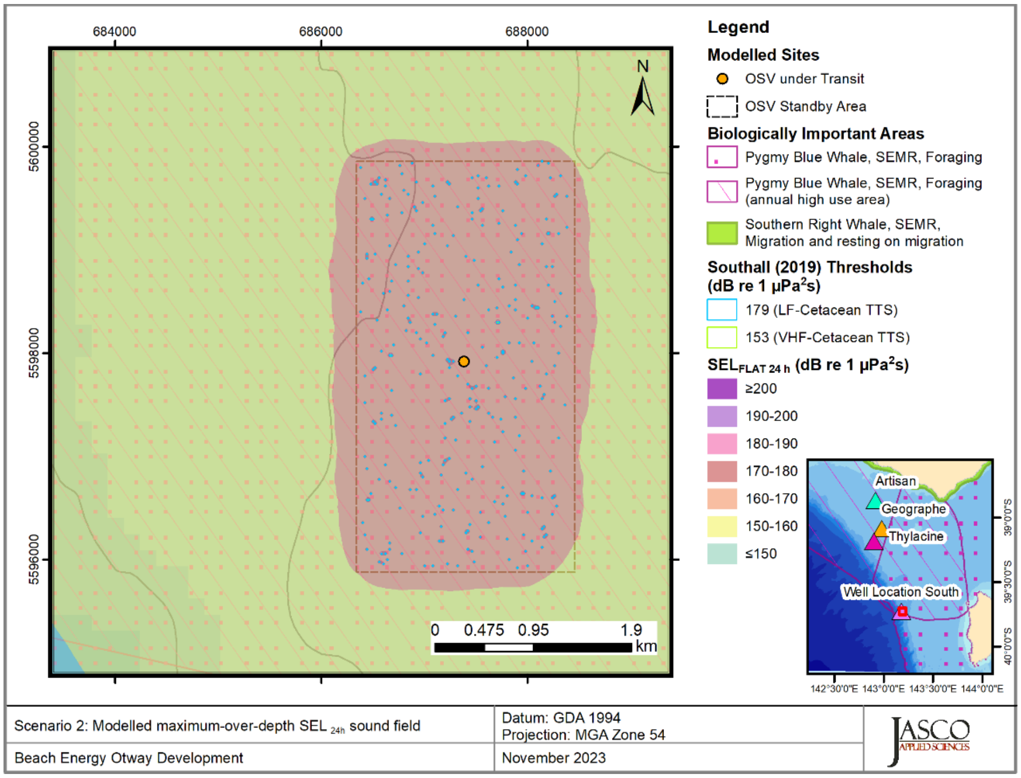
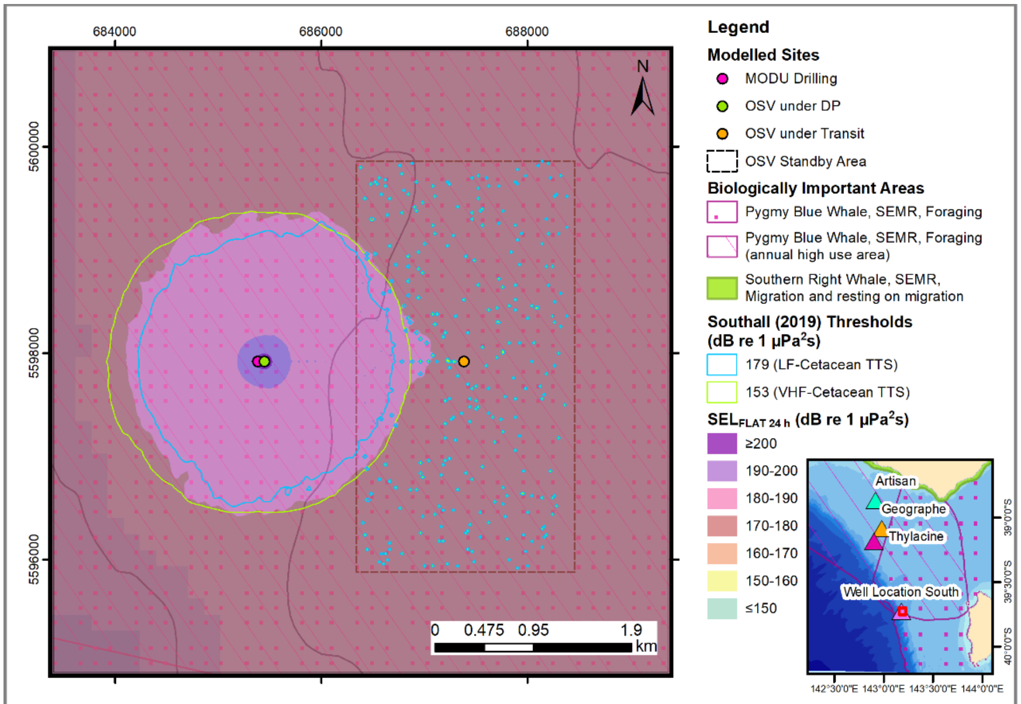


Figure 8. *Well Location South, OSV under Transit*, sound level contour map of unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such they could not be displayed on a map.



Scenario 3: Modelled maximum-over-depth SEL $_{24h}$ sound field	Datum: GDA 1994 Projection: MGA Zone 54
Beach Energy Otway Development	November 2023

JASCO APPLIED SCIENCES

Figure 9. *Well Location South, MODU Drilling, OSV under DP (4h), and OSV under Transit (20h)*, sound level contour map of unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such they could not be displayed on a map.

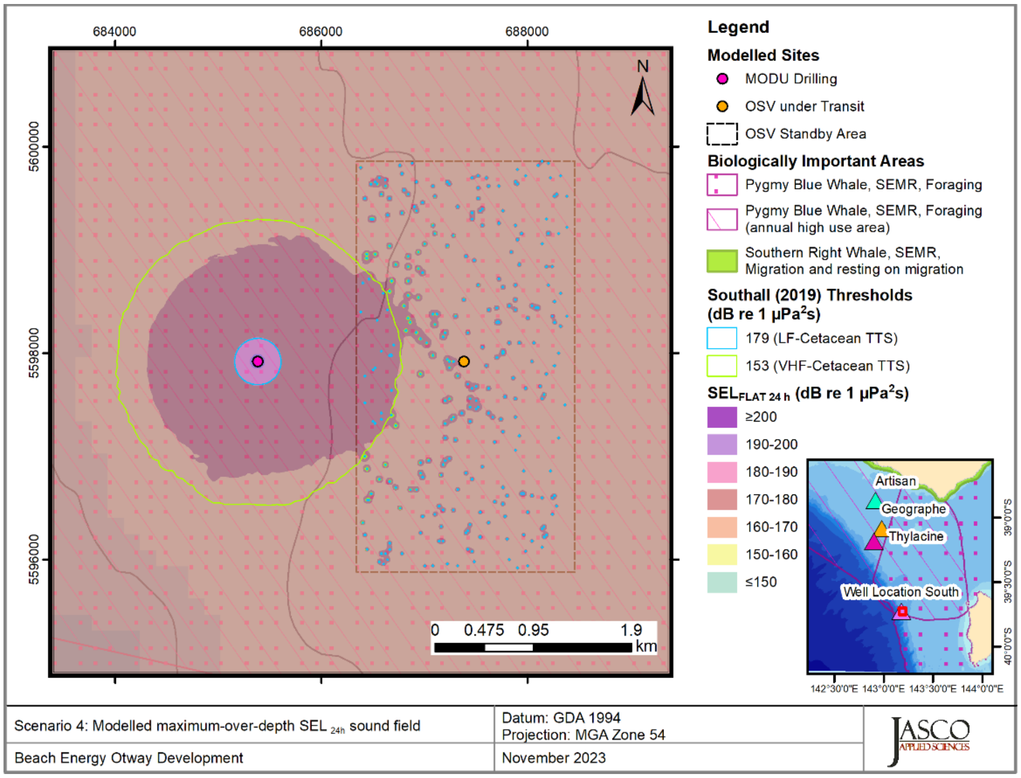


Figure 10. *Well Location South, MODU Drilling and OSV under transit*, sound level contour map of unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such they could not be displayed on a map.

Glossary

1/3-octave

One third of an octave. *Note*: A 1/3-octave is approximately equal to one decidecade (1/3 oct ≈ 1.003 ddec).

absorption

The conversion of sound energy to heat energy. Specifically, the reduction of sound pressure amplitude due to particle motion energy converting to heat in the propagation medium.

acoustic noise

Sound that interferes with an acoustic process.

acoustic self-noise

Sound at a receiver caused by the deployment, operation, or recovery of a specified receiver, and its associated platform (ISO 18405:2017).

ambient sound

Sound that would be present in the absence of a specified activity (ISO 18405:2017). It is usually a composite of sound from many sources near and far, e.g., shipping vessels, seismic activity, precipitation, sea ice movement, wave action, and biological activity.

attenuation

The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium. Attenuation depends on frequency—higher frequency sounds are attenuated faster than lower frequency sounds.

auditory frequency weighting

The process of applying an auditory frequency-weighting function. An example for marine mammals are the auditory frequency-weighting functions published by Southall et al. (2007).

auditory frequency-weighting function

Frequency-weighting function describing a compensatory approach accounting for a species' (or functional hearing group's) frequency-specific hearing sensitivity.

background noise

Combination of ambient sound, acoustic self-noise, and, where applicable, sonar reverberation (ISO 18405:2017) that is detected, measured, or recorded with a signal.

bandwidth

A range within a continuous band of frequencies. Unit: hertz (Hz).

broadband level

The total level measured over a specified frequency range. If the frequency range is unspecified, the term refers to the entire measured frequency range.

cavitation

A rapid formation and collapse of vapor cavities (i.e., bubbles or voids) in water, most often caused by a rapid change in pressure. Fast-spinning vessel propellers typically cause cavitation, which creates a lot of noise.

cetacean

Member of the order Cetacea. Cetaceans are aquatic mammals and include whales, dolphins, and porpoises.

compressional wave

A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called a longitudinal wave. In seismology/geophysics, it's called a primary wave or P-wave. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

continuous sound

A sound whose sound pressure level remains above the **background noise** during the observation period and may gradually vary in intensity with time, e.g., sound from a marine vessel.

decade

Logarithmic frequency interval whose upper bound is ten times larger than its lower bound (ISO 80000-3:2006). For example, one decade up from 1000 Hz is 10,000 Hz, and one decade down is 100 Hz.

decibel (dB)

Unit of level used to express the ratio of one value of a power quantity to another on a logarithmic scale. Especially suited to quantify variables with a large dynamic range.

decidecade

One tenth of a decade. Approximately equal to one third of an octave (1 ddec ≈ 0.3322 oct), and for this reason sometimes referred to as a 1/3-octave.

decidecade band

Frequency band whose bandwidth is one decidecade. *Note*: The bandwidth of a decidecade band increases with increasing centre frequency.

energy source level

A property of a sound source equal to the sound exposure level measured in the far field plus the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 $\mu Pa^2\ m^2\ s$.

ensonified

Exposed to sound.

far field

The zone where, to an observer, sound originating from an array of sources (or a spatially distributed source) appears to radiate from a single point.

frequency

The rate of oscillation of a periodic function measured in cycles per unit time. The reciprocal of the period. Unit: hertz (Hz). Symbol: f. 1 Hz is equal to 1 cycle per second.

frequency weighting

The process of applying a frequency-weighting function.

frequency-weighting function

The squared magnitude of the sound pressure transfer function (ISO 18405:2017). For sound of a given frequency, the frequency-weighting function is the ratio of output power to input power of a specified filter, sometimes expressed in decibels. Examples include the following:

- *Auditory frequency-weighting function*: compensatory frequency-weighting function accounting for a species' (or functional hearing group's) frequency-specific hearing sensitivity.
- *System frequency-weighting function*: frequency-weighting function describing the sensitivity of an acoustic recording system, which typically consists of a hydrophone, one or more amplifiers, and an analog-to-digital converter.

functional hearing group

Category of animal species when classified according to their hearing sensitivity, hearing anatomy, and susceptibility to sound. For marine mammals, initial groupings were proposed by Southall et al. (2007), and revised groupings are developed as new research/data becomes available. Revised groupings proposed by Southall et al. (2019) include low-frequency cetaceans, high-frequency cetaceans, very high-frequency cetaceans, phocid carnivores in water, other carnivores in water, and sirenians. See auditory frequency-weighting functions, which are often applied to these groups. Example hearing groups for fish include species for which the swim bladder is involved in hearing, species for which the swim bladder is not involved in hearing, and species without a swim bladder (Popper et al. 2014).

geoacoustic

Relating to the acoustic properties of the seabed.

hearing threshold

For a given species or functional hearing group, the sound level for a given signal that is barely audible (i.e., that would be barely audible for a given individual in the presence of specified **background noise** during a specific percentage of experimental trials).

hertz (Hz)

Unit of frequency defined as one cycle per second. Often expressed in multiples such as kilohertz (1 kHz = 1000 Hz).

high-frequency (HF) cetaceans

See functional hearing group. *Note*: The mid- and high-frequency cetaceans groups proposed by Southall et al. (2007) were renamed high- and very-high-frequency cetaceans, respectively, by Southall et al. (2019).

hydrophone

An underwater sound pressure transducer. A passive electronic device for recording or listening to underwater sound.

hydrostatic pressure

The pressure at any given depth in a static liquid that is the result of the weight of the liquid acting on a unit area at that depth, plus any pressure acting on the surface of the liquid. Unit: pascal (Pa).

impulsive sound

Qualitative term meaning sounds that are typically transient, brief (less than 1 s), broadband, with rapid rise time and rapid decay. They can occur in repetition or as a single event. Sources of impulsive sound include, among others, explosives, seismic airguns, and impact pile drivers.

isopleth

A line drawn on a map through all points having the same value of some specified quantity (e.g., sound pressure level isopleth).

knot (kn)

Unit of vessel speed equal to 1 nautical mile per hour.

level

A measure of a quantity expressed as the logarithm of the ratio of the quantity to a specified reference value of that quantity. For example, a value of sound pressure level with reference to 1 μPa^2 can be written in the form *x* dB re 1 μPa^2.

low-frequency (LF) cetaceans

See functional hearing group.

median

The 50th percentile of a statistical distribution.

mid-frequency (MF) cetaceans

See functional hearing group. *Note*: The mid-frequency cetaceans group proposed by Southall et al. (2007) was renamed high-frequency cetaceans by Southall et al. (2019).

monopole source level (MSL)

A source level that has been calculated using an acoustic model that accounts for the effect of the sea-surface and seabed on sound propagation, assuming a point source (monopole). Often used to quantify source levels of vessels or industrial operations from measurements. See also radiated noise level.

M-weighting

A set of auditory frequency-weighting functions proposed by Southall et al. (2007).

mysticete

Member of the Mysticeti, a suborder of cetaceans. Also known as baleen whales, mysticetes have baleen plates (rather than teeth) that they use to filter food from water (or from sediment as for grey whales). This group includes rorquals (Balaenopteridae, such as blue, fin, humpback, and minke whales), right and bowhead whales (Balaenidae), and grey whales (*Eschrichtius robustus*).

non-impulsive sound

Sound that is not an impulsive sound. Not necessarily a continuous sound.

octave

The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

odontocete

Member of Odontoceti, a suborder of cetaceans. These whales, dolphins, and porpoises have teeth (rather than baleen plates). Their skulls are mostly asymmetric, an adaptation for their echolocation. This group includes sperm whales, killer whales, belugas, narwhals, dolphins, and porpoises.

otariid

Member of the family Otariidae, one of the three groupings of pinnipeds (along with phocids and walrus). These eared seals, commonly called fur seals and sea lions, are adapted to semi-aquatic life; they use their large fore flippers for propulsion underwater and can walk on all four limbs on land.

otariid pinnipeds underwater (OW)

See functional hearing group.

other marine carnivores in water (OCW)

See functional hearing group.

parabolic equation method

A computationally efficient solution to the acoustic wave equation that is used to model propagation loss. The parabolic equation approximation omits effects of backscattered sound (which are negligible for most ocean-acoustic propagation problems), simplifying the computation of propagation loss.

permanent threshold shift (PTS)

An irreversible loss of hearing sensitivity caused by excessive noise exposure. Considered auditory injury. Compare with temporary threshold shift.

phocid

Member of the family Phocidae, one of the three groupings of pinnipeds (along with otariids and walrus). These true/earless seals are more adapted to in-water life than are otariids, which have more terrestrial adaptations. Phocids use their hind flippers to propel themselves underwater.

phocid pinnipeds underwater (PW), phocid carnivores in water (PCW)

See functional hearing group.

pinniped

Member of the superfamily Pinnipedia, which is composed of phocids (true seals or earless seals), otariids (eared seals or fur seals and sea lions), and walrus.

point source

A source that radiates sound as if from a single point.

propagation loss (PL)

Difference between a source level (SL) and the level at a specified location, $\mathrm{PL}(x) = \mathrm{SL} - L(x)$. Unit: decibel (dB). See also transmission loss.

radiated noise level (RNL)

A source level that has been calculated assuming sound pressure decays geometrically with distance from the source, with no influence of the sea-surface or seabed. Often used to quantify source levels of vessels or industrial operations from measurements. See also monopole source level.

received level

The level of a given field variable measured (or that would be measured) at a given location.

reference value

Standard value of a quantity used for calculating underwater sound level. The reference value depends on the quantity for which the level is being calculated:

Quantity	Reference value
Sound pressure	$p_0{}^2$ = 1 μPa^2 or p_0 = 1 μPa
Sound exposure	E_0 = 1 μPa^2 s
Sound particle displacement	$\delta_0{}^2$ = 1 pm^2
Sound particle velocity	$u_0{}^2$ = 1 nm^2/s^2
Sound particle acceleration	$a_0{}^2$ = 1 μm^2/s^4

shear wave

A mechanical vibration wave in which the direction of particle motion is perpendicular to the direction of propagation. Also called a secondary wave or S-wave. Shear waves propagate only in solid media, such as sediments or rock. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

sirenians (SI)

Members of the order Sirenia, which includes several manatee species and the dugong. See also functional hearing group.

sound

A time-varying disturbance in the pressure, stress, or material displacement of a medium propagated by local compression and expansion of the medium. In common meaning, a form of energy that propagates through media (e.g., water, air, ground) as pressure waves.

sound exposure

Time integral of squared sound pressure over a stated time interval in a stated frequency band. The time interval can be a specified time duration (e.g., 24 h) or from start to end of a specified event (e.g., a pile strike, an airgun pulse, a construction operation). Unit: pascal squared second (Pa^2 s). Symbol: E.

sound exposure level (SEL)

The level (L_E) of the sound exposure (E) in a stated frequency band and time window: $L_E = 10\log_{10}(E/E_0)$ (ISO 18405:2017). Unit: decibel (dB). Reference value (E_0) for sound in water: 1 μPa^2 s.

sound exposure spectral density

Distribution as a function of frequency of the time-integrated squared sound pressure per unit bandwidth of a sound having a continuous spectrum (ISO 18405:2017). Unit: pascal squared second per hertz (Pa^2 s/Hz).

sound field

Region containing sound waves.

sound pressure

The contribution to total pressure caused by the action of sound (ISO 18405:2017). Unit: pascal (Pa). Symbol: p.

sound pressure level (SPL), rms sound pressure level

The level (L_p) of the time-mean-square sound pressure (p_{rms}^2) in a stated frequency band and time window: $L_p = 10\log_{10}(p_{\mathrm{rms}}^2/p_0^2) = 20\log_{10}(p_{rms}/p_0)$, where rms is the abbreviation for root-mean-square. Unit: decibel (dB). Reference value (p_0^2) for sound in water: 1 µPa^2. SPL can also be expressed in terms of the root-mean-square (rms) with a reference value of p_0 = 1 µPa. The two definitions are equivalent.

sound speed profile

The speed of sound in the water column as a function of depth below the water surface.

source level (SL)

A property of a sound source equal to the sound pressure level measured in the far field plus the propagation loss from the acoustic centre of the source to the receiver position. Unit: decibel (dB). Reference value: 1 µPa^2 m^2.

spectrum

Distribution of acoustic signal content over frequency, where the signal's content is represented by its power, energy, mean-square sound pressure, or sound exposure.

surface duct

The upper portion of a water column within which the gradient of the sound speed profile causes sound to refract upward and therefore reflect repeatedly off the surface resulting in relatively long-range sound propagation with little loss.

temporary threshold shift (TTS)

Reversible loss of hearing sensitivity caused by noise exposure. Compare with permanent threshold shift.

thermocline

A depth interval near the ocean surface that experiences larger temperature gradients than the layers above and below it due to warming or cooling by heat conduction from the atmosphere and by warming from the sun.

transmission loss (TL)

The difference between a specified level at one location and that at a different location: $\mathrm{TL}(x_1,x_2) = L(x_1) - L(x_2)$ (ISO 18405:2017). Unit: decibel (dB). See also propagation loss.

unweighted

Term indicating that no frequency-weighting function is applied.

very high-frequency (VHF) cetaceans

See functional hearing group.

wavelength

Distance over which a wave completes one cycle of oscillation. Unit: metre (m). Symbol: λ.

Literature Cited

[ISO] International Organization for Standardization. 2006. *ISO 80000-3:2006 Quantities and units – Part 3: Space and time*. https://www.iso.org/standard/31888.html.

[ISO] International Organization for Standardization. 2017. *ISO 18405:2017. Underwater acoustics – Terminology*. Geneva. https://www.iso.org/standard/62406.html.

[NMFS] National Marine Fisheries Service (US). 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p. https://media.fisheries.noaa.gov/dam-migration/tech_memo_acoustic_guidance_(20)_(pdf)_508.pdf.

[NOAA] National Oceanic and Atmospheric Administration (US). 2019. *ESA Section 7 Consultation Tools for Marine Mammals on the West Coast* (webpage), 27 Sep 2019. https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west.

ANSI S1.1-2013. 2013. *American National Standard Acoustical Terminology*. American National Standards Institute, NY, USA.

Buckingham, M.J. 2005. Compressional and shear wave properties of marine sediments: Comparisons between theory and data. *Journal of the Acoustical Society of America* 117: 137-152. https://doi.org/10.1121/1.1810231.

Carnes, M.R. 2009. *Description and Evaluation of GDEM-V 3.0*. US Naval Research Laboratory, Stennis Space Center, MS. NRL Memorandum Report 7330-09-9165. 21 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/a494306.pdf.

Connell, S.C., M.W. Koessler, and C.R. McPherson. 2021. *Otway Offshore Project – Construction Program: Assessing Marine Fauna Sound Exposures*. Document Number 02407, Version 1.0 Technical report by JASCO Applied Sciences for Beach Energy Limited.

Coppens, A.B. 1981. Simple equations for the speed of sound in Neptunian waters. *Journal of the Acoustical Society of America* 69(3): 862-863. https://doi.org/10.1121/1.382038.

Duncan, A.J., A.N. Gavrilov, N. Alexander, R.D. McCauley, I.M. Parnum, and J.M. Collis. 2013. Characteristics of sound propagation in shallow water over an elastic seabed with a thin cap-rock layer. *Journal of the Acoustical Society of America* 134(1): 207-215. https://doi.org/10.1121/1.4809723.

Finneran, J.J. and A.K. Jenkins. 2012. *Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis*. SPAWAR Systems Center Pacific, San Diego, CA, USA. 64 p.

Finneran, J.J., E. Henderson, D.S. Houser, K. Jenkins, S. Kotecki, and J. Mulsow. 2017. *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*. Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). 183 p.

Heap, A.D. 2009. *Marine Sediments (MARS) Database* (webpage). Commonwealth of Australia (Geoscience Australia), Creative Commons Attribution 4.0 International Licence. http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_69869.

Koessler, M.W., M.-N.R. Matthews, and C.R. McPherson. 2020. *Otway Offshore Project – Drilling Program: Assessing Marine Fauna Sound Exposures*. Document Number 02033, Version 1.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

Koessler, M.W. and C. McPherson. 2021. *Beach Otway Project: Additional and Revised Modelling Study*. Document Number 02502, Version 1.0. Technical Memo by JASCO Applied Sciences for Beach Energy Limited.

Matthews, M.-N.R., M.W. Koessler, and C.R. McPherson. 2020. *Otway Offshore Project – Construction Program: Assessing Marine Fauna Sound Exposures*. Document Number 02112, Version 2.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

Matthews, M.-N.R., S. Connell, and C.R. McPherson. 2021. *Otway Offshore Project – Construction Program: Addendum – Combined Drilling and Construction Activities*. Document Number 02393, Version 1.0 DRAFT. Technical report by JASCO Applied Sciences for Beach Energy Limited. .

McPherson, C.R., Z. Li, C.C. Wilson, K.A. Kowarski, and M. Koessler. 2021. *Beach Otway Development Acoustic Monitoring: Characterisation, Validation, and Marine Mammals*. Document Number 02424, Version 2.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, et al. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. ASA S3/SC1.4 TR-2014. SpringerBriefs in Oceanography. ASA Press and Springer. https://doi.org/10.1007/978-3-319-06659-2.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, et al. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals* 33(4): 411-521. https://doi.org/10.1080/09524622.2008.9753846.

Southall, B.L., J.J. Finneran, C.J. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals* 45(2): 125-232. https://doi.org/10.1578/AM.45.2.2019.125.

Teague, W.J., M.J. Carron, and P.J. Hogan. 1990. A comparison between the Generalized Digital Environmental Model and Levitus climatologies. *Journal of Geophysical Research* 95(C5): 7167-7183. https://doi.org/10.1029/JC095iC05p07167.

Whiteway, T. 2009. *Australian Bathymetry and Topography Grid, June 2009*. GeoScience Australia, Canberra. http://pid.geoscience.gov.au/dataset/ga/67703.

Appendix A. Acoustic Metrics

A.1. Pressure Related Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 μPa. Because the perceived loudness of sound, especially impulsive noise such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate noise and its effects on marine life. We provide specific definitions of relevant metrics used in the accompanying report. Where possible we follow the ANSI and ISO standard definitions and symbols for sound metrics, but these standards are not always consistent.

The sound pressure level (SPL; L_p; dB re 1 μPa) is the rms pressure level in a stated frequency band over a specified time window (T, s) containing the acoustic event of interest. It is important to note that SPL always refers to a rms pressure level and therefore not instantaneous pressure:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)dt \Big/ p_0^2\right) \tag{A-1}$$

The SPL represents a nominal effective continuous sound over the duration of an acoustic event, such as the emission of one acoustic pulse, a marine mammal vocalization, the passage of a vessel, or over a fixed duration. Because the window length, T, is the divisor, events with similar sound exposure level (SEL) but more spread out in time have a lower SPL.

The sound exposure level (SEL; L_E; $L_\mathrm{E,p}$; dB re 1 μPa^2·s) is a measure related to the acoustic energy contained in one or more acoustic events (N). The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T):

$$L_E = 10\log_{10}\left(\int_T p^2(t)dt \Big/ T_0 p_0^2\right) \tag{A-2}$$

where T_0 is a reference time interval of 1 s. The SEL continues to increase with time when non-zero pressure signals are present. It therefore can be construed as a dose-type measurement, so the integration time used must be carefully considered in terms of relevance for impact to the exposed recipients.

SEL can be calculated over periods with multiple acoustic events or over a fixed duration. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, SEL can be computed by summing (in linear units) SEL of the N individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{\mathrm{L}_{E,i}}{10}}\right). \tag{A-3}$$

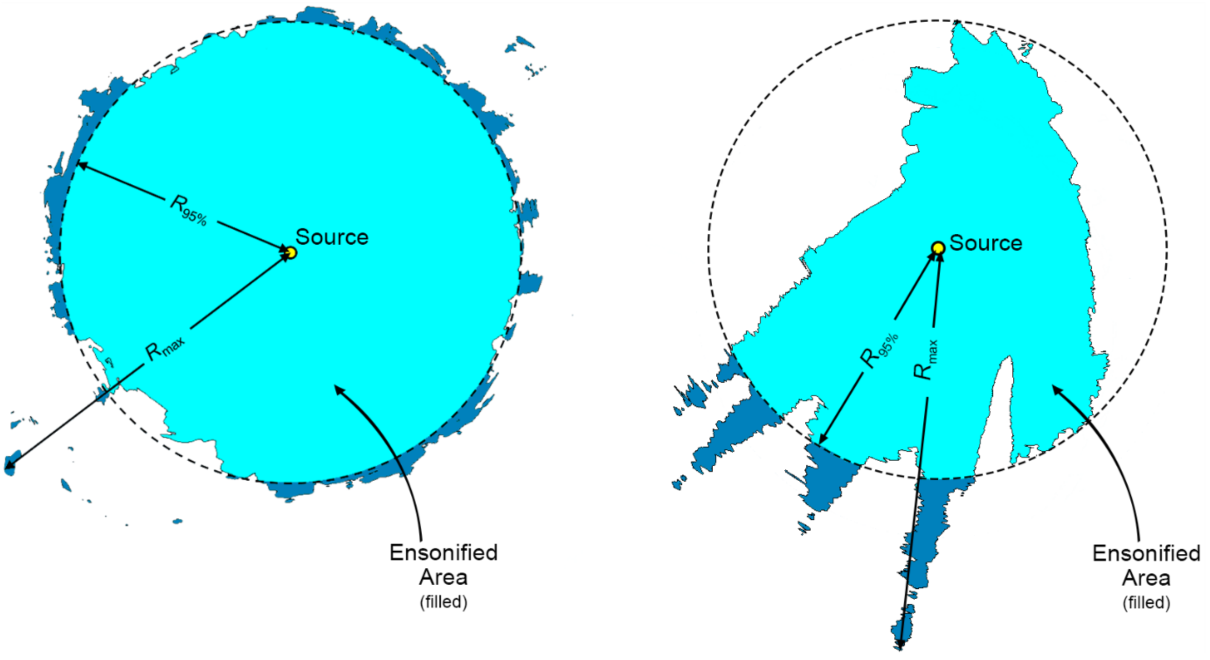
Appendix B. Methods and Parameters

This section describes the specifications of the seismic source that was used at all sites and the environmental parameters used in the propagation models.

B.1. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure B-1).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure B-1(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure B-1(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.



(a) (b)

Figure B-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

B.2. Environmental Parameters

B.2.1. Bathymetry

Water depths throughout the modelled areas were extracted from the Australian Bathymetry and Topography Grid, a 9 arc-second grid rendered for Australian waters (Whiteway 2009). Bathymetry data were re-gridded onto a Map Grid of Australia (MGA) coordinate projection (Zone 54) with a regular grid spacing of 250 × 250 m.

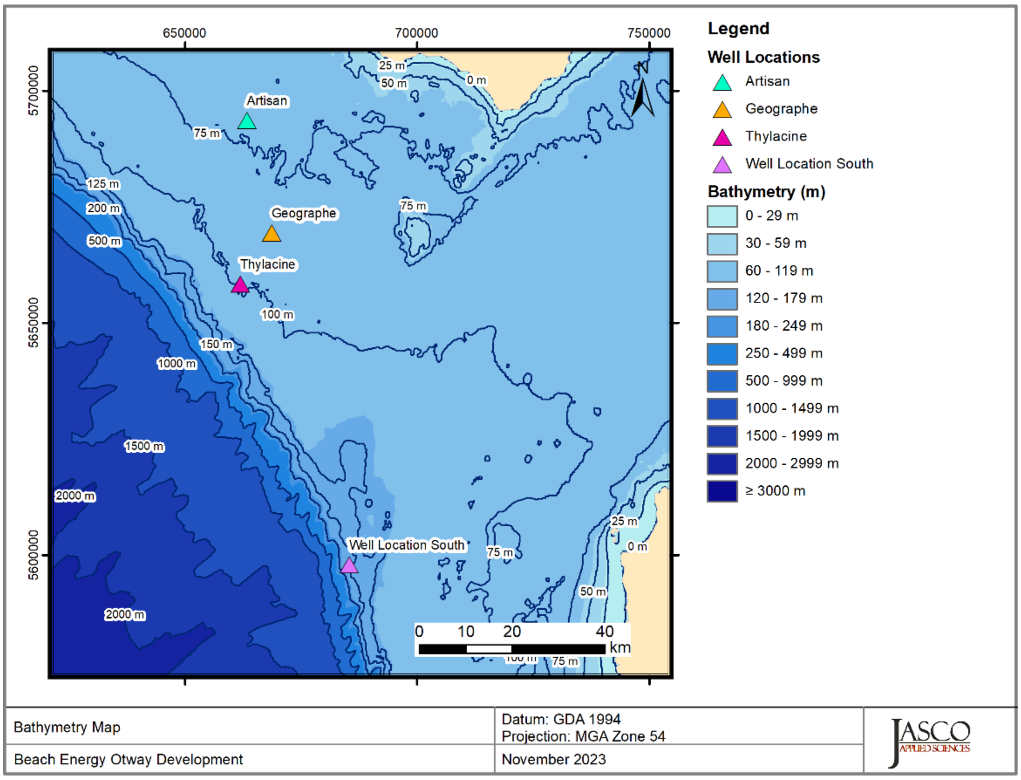


Figure B-2. Bathymetry map of the Beach Otway development area.

B.2.2. Sound speed profile

The sound speed profile in the area was derived from temperature and salinity profiles from the U.S. Naval Oceanographic Office's *Generalized Digital Environmental Model V 3.0* (GDEM; Teague et al. 1990, Carnes 2009). GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the U.S. Navy's Master Oceanographic Observational Data Set (MOODS). The climatology profiles include 78 fixed depth points to a maximum depth of 6800 m (where the ocean is that deep). The GDEM temperature-salinity profiles were converted to sound speed profiles according to Coppens (1981).

Mean monthly sound speed profiles were derived from the GDEM profiles at distances less than 7 km around the modelled site. The June sound speed profile is expected to be most favourable to longer-range sound propagation across the entire year. As such, June was selected for sound propagation modelling to ensure precautionary estimates of distances to received sound level thresholds. For the pygmy blue whale period between November and January November is expected to be most favourable to longer-range propagation in that period. Figure B-3 shows the resulting profiles, which were used as input to the sound propagation modelling.

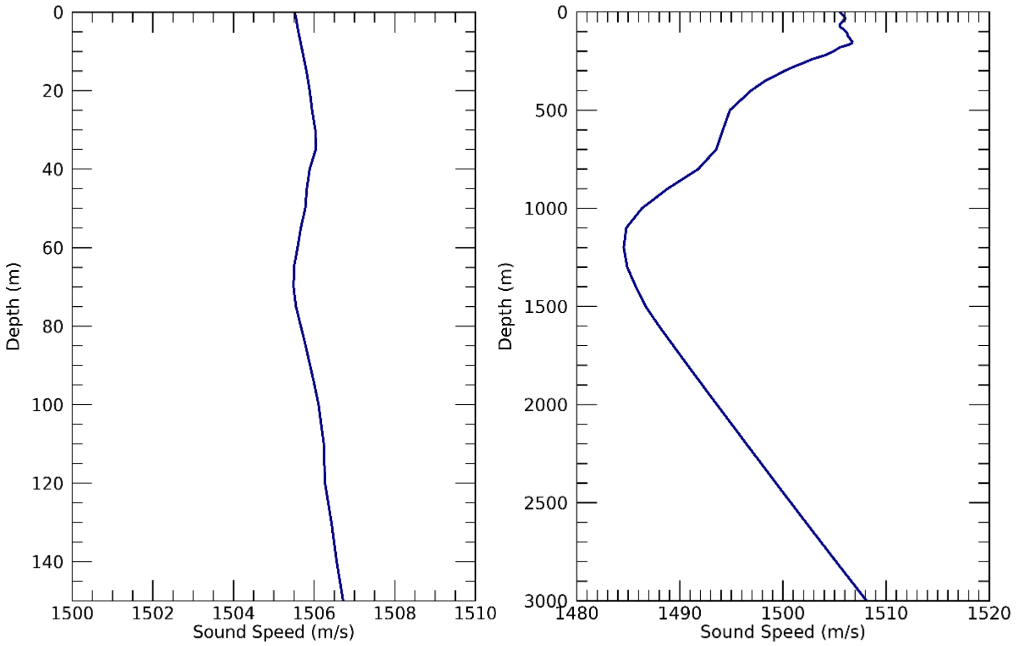


Figure B-3. The modelling sound speed profile corresponding to June for the top 150 m (left) and 3000 m (right) Profiles are calculated from temperature and salinity profiles from *Generalized Digital Environmental Model* V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

B.2.3. Geoacoustics

A single geoacoustic profile was used for modelling. Geoacoustic parameters used for all modelled sites were derived from sedimentary grain size measurements from the Australian Government's Marine Sediments (MARS) database (Heap 2009). On average, the surficial grain size indicates silty sand is present throughout the modelled area. Representative grain sizes were used in the grain-shearing model proposed by Buckingham (2005) to estimate the geoacoustic parameters required by the sound propagation models. Table B-1 lists the geoacoustic parameters used for modelling. This profile is expected to better represent the slope environment and may yield less accurate towards the continental shelf. On the shelf it is possible that a less reflective seabed type consisting of limestone may be present (Duncan et al. 2013). It is expected that towards the shelf the estimate to threshold ranges may be overestimated.

Table B-1. Geoacoustic profile for all modelled sites.

Depth below seafloor (m)	Predicted lithology	Density (g/cm^3)	Compressional wave		Shear wave	
			Speed(m/s)	Attenuation(dB/λ)	Speed(m/s)	Attenuation(dB/λ)
0–10	Silty carbonate sand to semi-cemented limestone	1.88	1605–1700	0.35–0.70	255	3.65
10–20		1.88–1.89	1700–1755	0.70–0.85		
20–50		1.89–1.90	1755–1850	0.85–1.15		
50–100		1.90–1.92	1850–1950	1.15–1.35		
100–200		1.92–1.96	1950–2100	1.35–1.60		
200–500		1.96–2.05	2100–2355	1.60–1.95		
>500		2.05	2355	1.95		

Appendix H Sound Modelling Report – McPherson et al. 2021

Beach Otway Development Acoustic Monitoring

Characterisation, Validation, and Marine Mammals

JASCO Applied Sciences (Australia) Pty Ltd

Submitted to:

Phil Wemyss
Beach Energy Limited
Contract: BE00032123

Authors:

Craig R. McPherson
Zizheng Li
Collen C. Wilson
Katie A. Kowarski
Matthew W. Koessler

20 June 2021

P001359-006
Document 02424
Version 2.0

Suggested citation:

McPherson, C.R., Z. Li, C.C. Wilson, K.A. Kowarski, and M.W. Koessler. 2021. Beach Otway Development Acoustic Monitoring: Characterisation, Validation, and Marine Mammals. Document 02424, Version 2.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

Contents

Figures

Tables

Executive Summary

Overview

JASCO Applied Sciences (Australia), JASCO, completed a monitoring study for Beach Energy (Operations) Ltd (Beach Energy) in relation to the exploration drilling activities at the Artisan-1 well with the aim of completing an acoustic characterisation of the drilling and associated vessel activity within the Otway Basin. Through this characterisation, validation of the modelling predictions used in Beach Energy Otway Environment Plans (EPs) for the development drilling activities was required.

The exploration well Artisan-1, drilled by the *Ocean Onyx*, was selected for the monitoring program because the predicted distances to thresholds for effects on marine mammals, including pygmy blue whales, were farthest at this location in the modelling study used for the EP (Koessler et al. 2020), as well as because it was the first well in the Otway drilling campaign.

Four JASCO Autonomous Multichannel Acoustic Recorders (AMARs) in C-lander moorings were deployed in February and retrieved in early April. Stations 1 through 4 were deployed at distances of 0.336, 1.13, 5.11, and 25 km from the *Ocean Onyx*. The AMARs recorded continuously at 24-bit resolution and 64 kHz sample rate for the entire deployment. The three stations closest to the *Ocean Onyx* were configured with a single hydrophone, whilst the station 25 km away was configured with three hydrophones to provide directional processing of received sounds.

To assist in the characterisation of *Ocean Onyx* and attendant support vessels, the vessels conducted specific activities under dynamic positioning and followed a nominated transit track between the *Ocean Onyx* and Geelong Supply Base. No specific operational requests were made of the *Ocean Onyx* and vessels during normal drilling activities due to the complexity of operationally meeting any requests. Over the course of the monitoring program, the MODU and support vessels engaged in different operational states with different uncontrollable contributors, such as variable drilling operations, resupply and support operations, weather conditions, and merchant shipping.

Data Analysis

The data was analysed to determine total ocean sound levels, which presented the expansive data in a manner that documented the underwater sound conditions near Artisan-1 and allowed a comparison over time, and with external factors that affect sound levels, such as weather and human activities. The data was presented using a range of graphical and statistical representations. JASCO's ShipSound software was used to determine the source levels for the Ocean Onyx during drilling activities and the support vessels whilst under dynamic positioning and transit.

ShipSound calculates two kinds of vessel source levels from the data window: Radiated Noise Level (RNL) and Monopole Source Level (MSL). RNL is equal to the measured sound pressure level, back-propagated according to the distance between a source and the hydrophone using an empirical propagation loss approach. MSL is equal to the measured sound pressure level scaled according to a numerical acoustic propagation loss (PL) model that accounts for the effect of the local environment on sound propagation (i.e., sea-surface reflection, water column refraction and absorption, and bottom loss).

The presence of sounds produced by marine mammals were searched for using a combination of automated detector-classifiers (referred to as automated detectors) and manual review by experienced analysts. The manual review was limited to only a subset (0.5%) of acoustic data, as this was not the primary aim of the project.

Results

The analysis of data at the two stations furthest from the Ocean Onyx, 3 and 4 (5 and 25 km), found a positive correlation between wind speeds and wave heights and sound levels for frequencies over 100 Hz, with the relationship with wind speed being stronger than that for wave height. For both of these stations shipping is a strong contributor. Most days recorded a significant number of vessel detections, with the contributions at Station 4 typically between 40 and approximately 100 Hz. The station most representative of a typical ambient soundscape within the region, Station 4, had a median broadband ambient noise of 104.5 dB re 1 µPa. Dolphins and pygmy blue whales were identified in the data. The data for pygmy blue whales indicates an apparent trend in the animals early in the recording being more to the east and later in the recording being more to the west, through the directional analysis of data from Station 4, but the data were too sparse (and the analysis too limited) to confirm anything about animal movements. Extended analysis may provide more details about their presence and movements during the drilling activities.

The provided drill logs for the Artisan-1 well were reviewed to identify periods of activity defined as drilling, as this was the activity considered in the modelling study Koessler et al. (2020). Seventy ten-minute time periods were deemed suitable for use, which resulted in the MSL being calculated over three different drilling depth ranges and presented as mean and maximum levels. MSL's were calculated for support vessels during dynamic positioning trials and transit, with results summarised in Table 1.

Table 1. Project drill rig and support vessel monopole source levels (MSLs).

Vessel	Measurement	Monopole source level (dB re 1 µPa m)	
		Mean	Maximum
Ocean Onyx	Drilling 26”x42” hole from 95-172 m	175.2	180.0
	Drilling 17.5” hole from 365-621 m	169.3	171.0
	Drilling 12.25” hole up to 1851 m	162.7	170.6
Siem *Sapphire*	Dynamic Positioning Trial	193.9	194.2
	Transit at 7 kn	171.6	173.6
	Transit at 9 kn	185.0	—*
Siem *Aquamarine*	Transit at 9 kn	182.8	—*
Siem *Topaz*	Transit at 9 kn	185.2	—*

* Not reported.

Validation

The Monopole Source Levels determined through the measurement study differed from those either estimated for use in the modelling study or those determined using proxy sources. The key differences are as follows:

- The support vessels are quieter than estimated when they are under slow transit speeds, such as 7 kn.
- The support vessels are louder than estimated when they are travelling at faster transit speeds, with 9 kn used to represent these speeds and the associated MSL.
- The support vessels are louder than estimated when holding station or moving under dynamic positioning.
- The drilling operations of the *Ocean Onyx* are both louder at some frequencies and quieter at others than those for the proxy rig the *Polar Pioneer* (Austin et al. 2018), although the results presented for the *Polar Pioneer* did not examine the changes in level with increased drilling depth (over time) as completed within this study.

The results from the measurement study could not be directly compared to the modelling presented in Koessler et al. (2020) due to the differences in actual events compared to the nominal representative scenarios developed and evaluated as part of the EP assessment process. Additionally, the measurements were obtained at a receiver located 1.2 m off the seafloor, which is not the maximum-over-depth results reported in the modelling study. The ranges obtained from the measurement study are reported in relation to the Artisan-1 well location, and thus the centre of the *Ocean Onyx*. The ranges in the modelling study are reported from a range of locations, including the centroids of multiple sources, thus it is not possible to report the measurement results in a similar fashion using the small number of recording locations used in this study.

The accuracy of the broadband calculated propagation loss for the Otway Basin continental shelf environment depends significantly upon the frequency content of the radiating sound source together with thickness of the sand layer on carbonate seabed (calcarenite) likely to occur within the region. In general, the thinner the sand layer, the greater the overall propagation loss.

When comparing SPL data fits for Stations 1–3, the loss rate is higher than what would have been expected in this environment, considering the higher monopole source levels for the support vessel on DP derived from trial measurements. The differences are likely attributable to the potential absence of a sand veneer.

Comparisons were conducted using JASCO's Marine Operations Noise Model (MONM), a wide-angle parabolic equation model which applies the BELLHOP Gaussian beam acoustic ray-trace model at higher frequencies, and JASCO's wavenumber integration model (VSTACK) which can fully account for the elasto-acoustic properties of the sub-bottom. The agreement between the models was excellent when only a comparatively thin (1 m thick) layer of sand overlies the carbonate seabed structure. In an environment such as this, MONM could have been used without correction. However, the comparisons indicate a much higher rates of loss, as would be expected if no (or only a very thin) sand layer were present.

A better understanding of the propagation loss environment, and the revision of the representation and treatment of it through the measurement study, enabled the modelling scenarios for the activities at Artisan-1 presented in Koessler et al. (2020) to be recalculated. The revised results for distances to maximum-over-depth SPL isopleths are presented in Table 2, and the revised results for distances to maximum-over-depth SEL thresholds presented in Table 3.

The understanding of the environment gained through the measurement study allowed for both the geological environment to be represented in a site-specific fashion and the use of a more appropriate configuration of numerical models to represent the propagation loss. The application of the revised modelling approach to represent other Beach Energy activities on the continental shelf of the Otway Basin would be appropriate.

Table 2. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to the marine mammal behavioural response threshold of 120 dB re 1 µPa sound pressure level (SPL) from the most appropriate location for considered sources per scenario (see table footnotes).

SPL (L_p; dB re 1 µPa)	MODU (Scenario 5)		OSV standby (Scenario 6)		MODU and OSV resupply (Scenario 7)[A]		MODU and OSV standby (Scenario 8)[B]	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
120[C]	1.17	1.09	0.37	0.35	7.02	6.41	2.09	1.9

[A] Radial distance reported from the mid-point between the Mobile Offshore Drilling Unit (MODU) and the Offshore Support Vessel (OSV) on dynamic positioning (DP) in resupply operations

[B] Radial distances for isopleths/thresholds that envelope the MODU and OSV were reported from the mid-point between the MODU and the centre of the OSV standby area. Otherwise radial distances reported from the OSV in the standby area.

[C] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

A dash indicates the level was not reached within the limits of the modelling resolution (25 m).

Table 3. Maximum (R_{max}) horizontal distances (in km) to frequency-weighted 24 hour sound exposure level (SEL_{24h}) thresholds for permanent threshold shift (PTS) and temporary threshold shift (TTS) thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2).

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa² s)^B	MODU (Scenario 5)		OSV standby (Scenario 6)		MODU and OSV resupply (Scenario 7)^A		MODU and OSV standby (Scenario 8)^A	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS									
LF cetaceans	199	–	–	–	–	–	–	–	–
MF cetaceans	198	–	–	–	–	–	–	–	–
HF cetaceans	173	0.19	0.11	–	–	0.2	0.12	0.19	0.11
Phocid seals	201	–	–	–	–	–	–	–	–
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	–	–	–	–	–	–	–	–
TTS									
LF cetaceans	179	0.31	0.31	1.01	0.35	0.95	2.78	0.31	0.66
MF cetaceans	178	0.13	0.05	–	–	0.16	0.06	0.13	0.05
HF cetaceans	153	1.07	3.44	1.01	0.18	1.09	3.86	1.06	3.64
Phocid seals	181	0.12	0.05			0.35	0.28	0.12	0.05
Otariid seals	199	–	–	–	–	–	–	–	–
Turtles	200	–	–	–	–	–	–	–	–

[A] Radial distance reported from the centre of the MODU, unless indicated otherwise.

[B] Frequency weighted.

A dash indicates the level was not reached within the limits of the modelling resolution (25 m).

1. Introduction

JASCO Applied Sciences (Australia), JASCO, completed a monitoring study for Beach Energy (Operations) Ltd (Beach Energy) in relation to the exploration drilling activities at the Artisan-1 well with the aim of completing an acoustic characterisation of the drilling and associated vessel activity within the Otway Basin. Through this characterisation, it was then required to validate the modelling predictions used in Beach Energy Otway Environment Plans (EPs) for the development drilling activities. These validation results are applicable for drilling, construction, and operational activities within the Otway Basin.

The exploration well Artisan-1 was selected for the monitoring program, because the predicted distances to thresholds for effects on marine mammals, including pygmy blue whales, were farthest at this location in the modelling study used for the EP (Koessler et al. 2020), as well as because it was the first well in the Otway drilling campaign.

This report presents an overview of the operations, environment, and measurement approaches (Section 2); general information about the marine acoustic environment (Section 3); the methods used for the data analysis, presentation, and modelling validation (Section 4); results of the monitoring program (Section 5); the validation analysis (Section 6); and a discussion of the program results and findings (Section 7).

The location of the four acoustic recording stations and the Artisan-1 well are provided in Table 4 and shown in Figure 1. One JASCO Autonomous Multichannel Acoustic Recorders (AMAR) was deployed at each recording station.

Table 4. Artisan-1 well and acoustic recording stations, including distance to Artisan-1.

Item	Latitude (S)	Longitude (E)	MGA Zone 54 (GDA94)		Water depth (m)	Distance to Artisan-1 (km)
			X (m)	*Y* (m)		
Artisan-1 (well)	38° 53.49077'	142° 52.94869'	663262.0	5693578.0	71.6	–
Station 1	38° 53.39316'	142° 53.14475'	663549.2	5693753.0	71.7	0.336
Station 2	38° 53.16585'	142° 53.61184'	664233.1	5694159.0	70.5	1.13
Station 3	38° 52.04100'	142° 55.95360'	667662.6	5696169.0	68.9	5.11
Station 4	38° 56.93456'	143° 9.71333'	687345.7	5686671.0	73.6	25.05

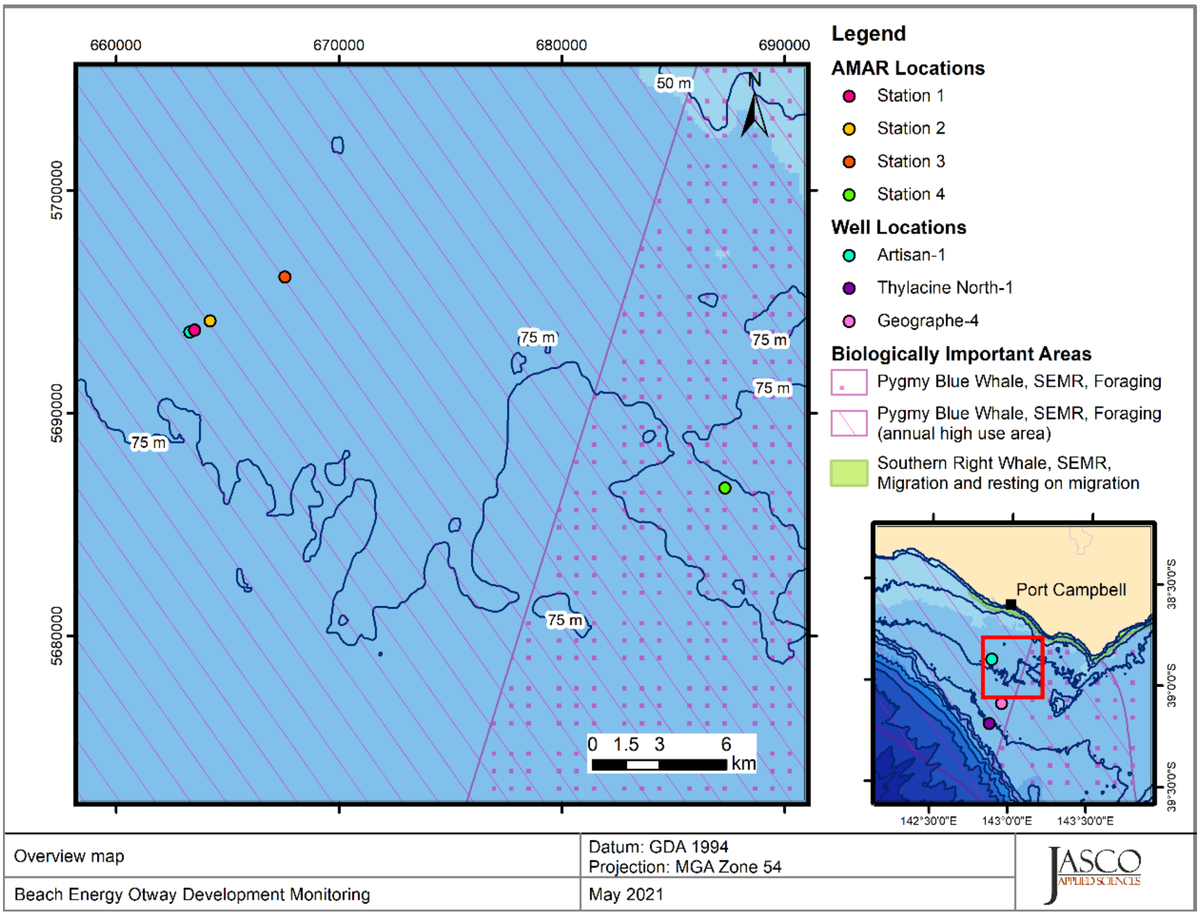


Figure 1. Otway Development Area showing location of the JASCO recorder stations.

2. Background Information

2.1. Operational Overview and Logs

The Otway Development Drilling Campaign being undertaken by Beach Energy utilises the *Ocean Onyx* Mobile Offshore Drilling Unit (MODU) (Figure 2). It is held in position via anchors and chains, as opposed to using thrusters, and has dimensions of approximately 100 m in length and width, and a draft of 22.7 m.

Figure 2. *Ocean Onyx* semi-submersible platform.

The following information was provided by Beach Energy:

- Drilling activity logs for the *Ocean Onyx,*
- Daily operational logs for the Development Drilling program,
- Daily vessel activity logs, and
- Vessel locations in ~15-minute increments from the Siem navigation systems.

The operational and activity logs used local time, which was Australian Eastern Daylight Time (AEDT), UTC+11 until 4 Apr 2021 at 3:00 am, when they changed over to Australian Eastern Standard Time (AEST), UTC+10. Therefore, AEDT is considered local time for the monitoring program. Vessel location data, including and Automated Identification System (AIS) data, as well as other ancillary environmental data and JASCO's recorders use UTC as the time zone. Thus, to avoid potential confusion, all timestamps were converted to UTC.

The *Ocean Onyx* anchoring operation commenced on 11 Feb 2021 and completed on 12 Feb 2021 local time; therefore, 01:00 12 Feb 2021 UTC was considered the start of data with the *Ocean Onyx* moored and in location after all anchor handling was complete. The *Ocean Onyx* departed Artisan-1 on 28 Mar 2021, after commencing disconnect operations on 26 Mar 2021 local time; therefore, 00:00 25 Mar 2021 UTC was considered the end of drilling or rig operations for analysis purposes.

2.2. Vessel Traffic

Regional vessel movement information, including for the project vessels, was obtained from MarineTraffic (www.marinetraffic.com), with data supplied for the time range between 1 Feb 2021 and 5 Apr 2021 in the region. The requested area was 11,003 km^2, with the vertices shown in Table 5.

The supplied data used a one-hour timestamp for vessel locations and all data were derived from satellites, with no terrestrial reporting stations in the vicinity. Figure 3 shows the marine traffic in the project area, derived from vessels broadcasting on the Automated Identification System (AIS), with a map focused on Artisan-1 shown in Figure 4.

Table 5. MarineTraffic data request bounds.

Vertex	Latitude (S)	Longitude (E)	MGA Zone 54 (GDA94)	
			X (m)	*Y* (m)
1	38° 38.71418'	142° 15.17165'	609029.0	5721846.24
2	38° 36.92154'	143° 55.51902'	754698.76	5721846.24
3	39° 17.70699'	143° 57.20532'	754698.76	5646313.77
4	39° 19.54340'	142° 15.89490'	609029.0	5646313.77

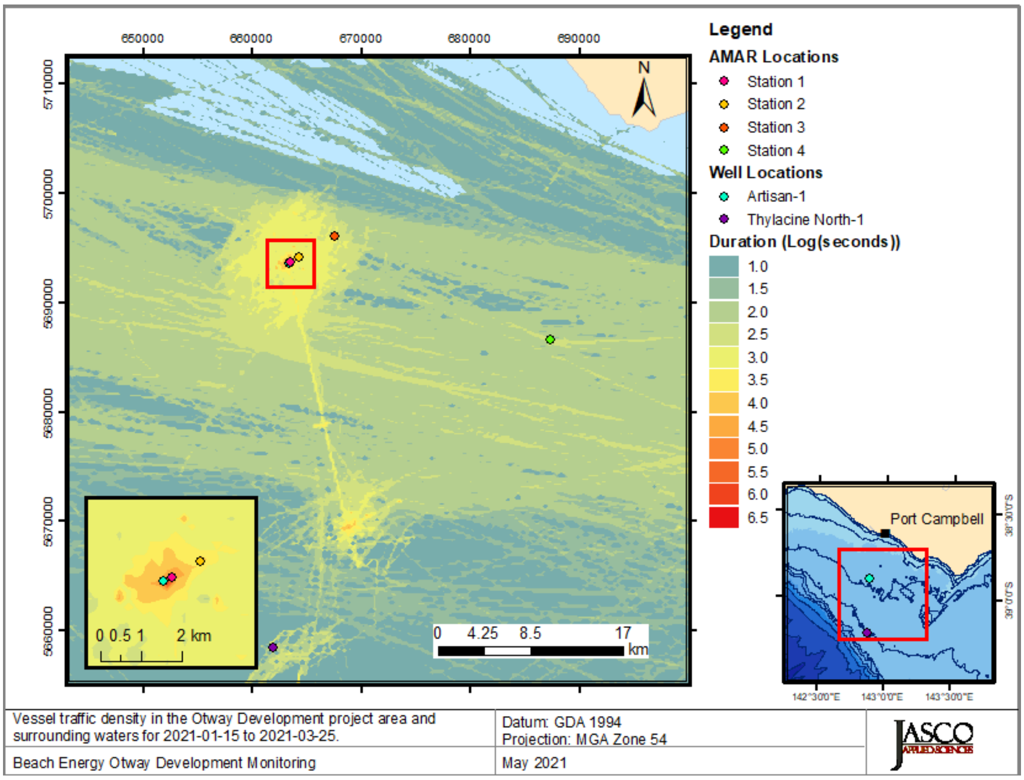


Figure 3. Vessel traffic density within the Development Drilling project area and surrounding waters for 15 Jan to 25 Mar 2021.

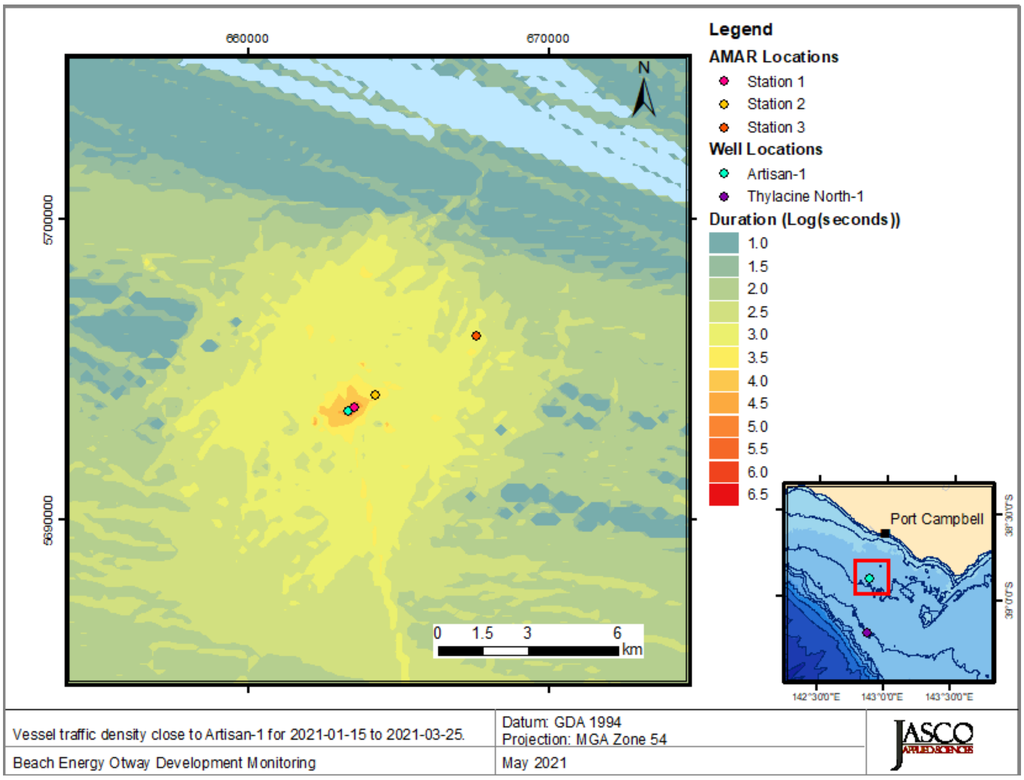


Figure 4. Vessel traffic density near Artisan-1 for 15 Jan to 25 Mar 2021.

2.3. Weather Conditions

Weather conditions at Artisan-1 were quantified through nowcast data provided by MetraWeather (Australia) for the period 00:00 on 1 Feb through until 24:00 6 Apr 2021 (UTC). The data included the following parameters:

- Significant wave height,
- Peak wave period,
- Peak wave direction,
- Significant wave height of swell >8 second period,
- Average wind speed,
- Wind direction, and
- Maximum wind gust speed.

Figure 5 shows the wave and swell weight, and Figure 6 shows the wind and gust speeds.

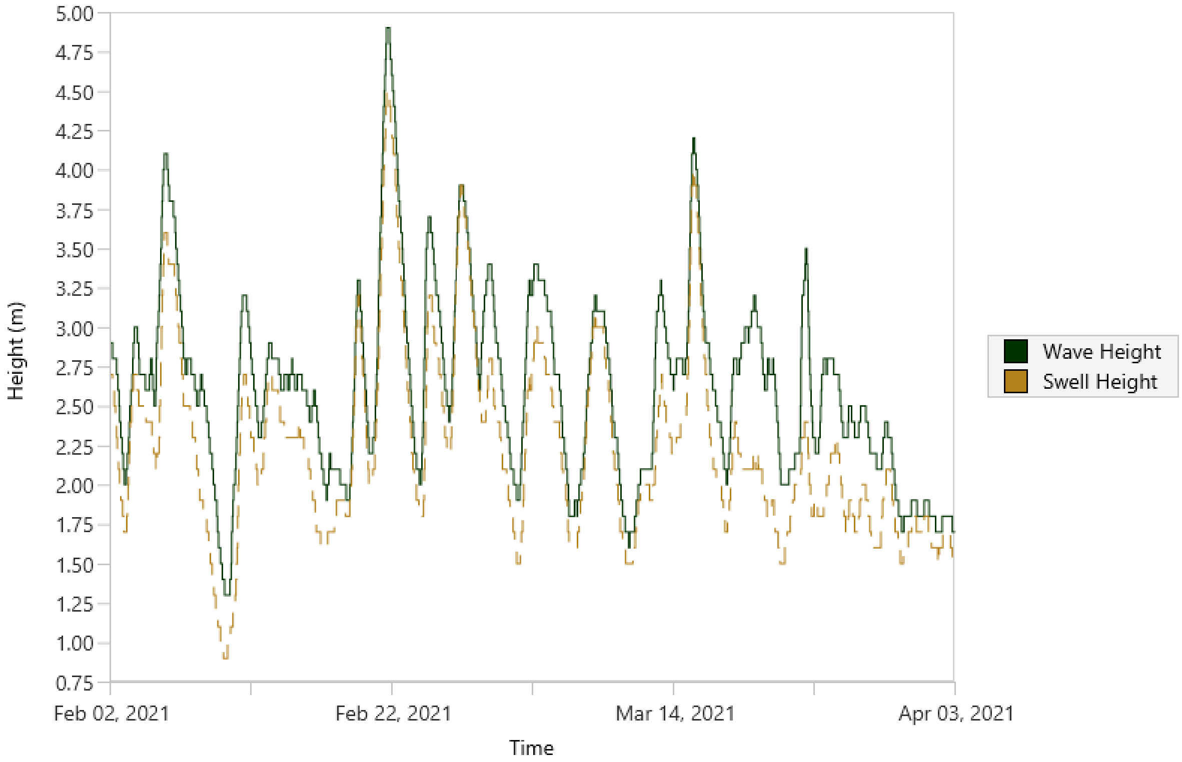


Figure 5. Hourly significant wave height (m) and significant swell height (m), with a period of greater than 8 seconds.

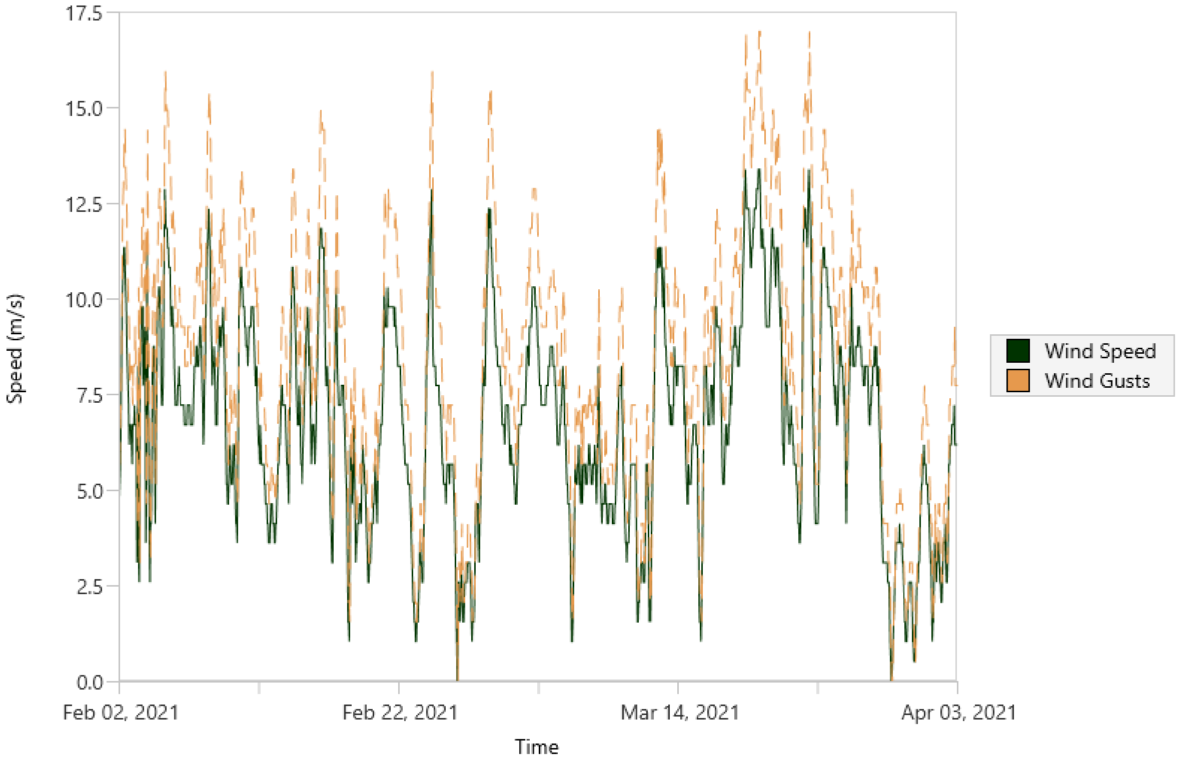


Figure 6. Hourly average wind speed (m/s) and maximum gust speed (m/s).

2.4. Geology

The propagation model used in this study considers a single geologic seabed profile for the Artisan area. The previous work by Koessler et al. (2020) considered two geologic and associated geoacoustic profiles. For deeper areas closer to the continental shelf edge, a profile characterised by well-cemented carbonate caprock (calcarenite) overlying semi-cemented calcarenite was used. Closer to the Artisan area the seabed, located in shallower waters, was characterised by a thin veneer of coarse sand/gravel overlying cemented and semi-cemented carbonate rock. This profile was selected based on a mixture of previous modelling studies (Wood and McPherson 2018) and client supplied geologic reports.

All these sources support a generalised geologic structure within the first 100 m seabed consisting of cemented or semi-cemented calcareous rock (‘calcarenite’) on the continental shelf within Artisan area. Collated information also indicated that there was the potential for a thin layer of coarse sand that could overlay the more cemented calcarenite. This was also indicated by seafloor sediment grab samples from the MARS sediment database (Heap 2009). The seabed environment was considered to be consistent with larger scale geological data and interpretations of the Australian continental shelf environment as summarised by James and Bone (2010), who indicated that the sediments along the continental shelf may be subject to transport and erosion yielding non-uniform distributions of seafloor sediment thickness.

2.5. Specific Source Measurement Operations

2.5.1. MODU Measurements

No operational requirements were requested of the *Ocean Onyx* or attendant support vessels while conducting resupply or standby operations during the drilling program due to the complexity of operationally meeting any requests. Over the course of the monitoring program, the MODU and support vessels engaged in different operational states, with different uncontrollable contributors, such as variable drilling operations, resupply and support operations, weather conditions, and merchant shipping. Operational details were obtained from the provided logs (Section 2.1).

2.5.2. Support Vessel Measurements

Specific operations were defined for the characterisation of the support vessels prior to the *Ocean Onyx* being moored, and while in transit to and from Geelong. For transit measurements, vessels were requested to pass along a defined track line according to ANSI S12.64 (R2014), with the vessel maintaining the straightest track possible and a requested separation from the AMAR of 150 m at the closest point of approach (CPA), with a water depth of 70 m. In deep water vessel noise measurements, it is a requirement for the vessels to be a minimum of either 100 m or one vessel length away from the recorder; in this case the typical vessel length is 91 m. Whilst there are standards for deep water source level measurements, there are none for shallow water environments. Methods to make accurate shallow water measurements of vessel source levels are currently being investigated by JASCO and DW Ship Consult for Transport Canada, with the findings to contribute to standard development (Ainslie et al. 2020); these methods were considered during the design of this study where possible.

The transit measurement track defined at Station 4 is shown in Figure 7, and in increased detail in Figure 8.

For measurements of dynamic positioning (DP), three exercises were defined, with *Exercise Two* completed twice. The three exercises all commenced at a horizontal separation of 150 m from the AMAR:

- *Exercise One*: Vessel to hold station, broadside to AMAR and operate at weather determined power levels for a minimum of 5 minutes.
- *Exercise Two*: Vessel to hold station, broadside to AMAR, then induce maximum reasonable thrust level and move in a perpendicular direction away from the AMAR in the up current direction for two minutes, reset and repeat exercise.
- *Exercise Three*: Vessel to hold station, broadside to AMAR, then using DP, step the vessel to the corners of a 10 × 10 m box using weather determined thruster levels.

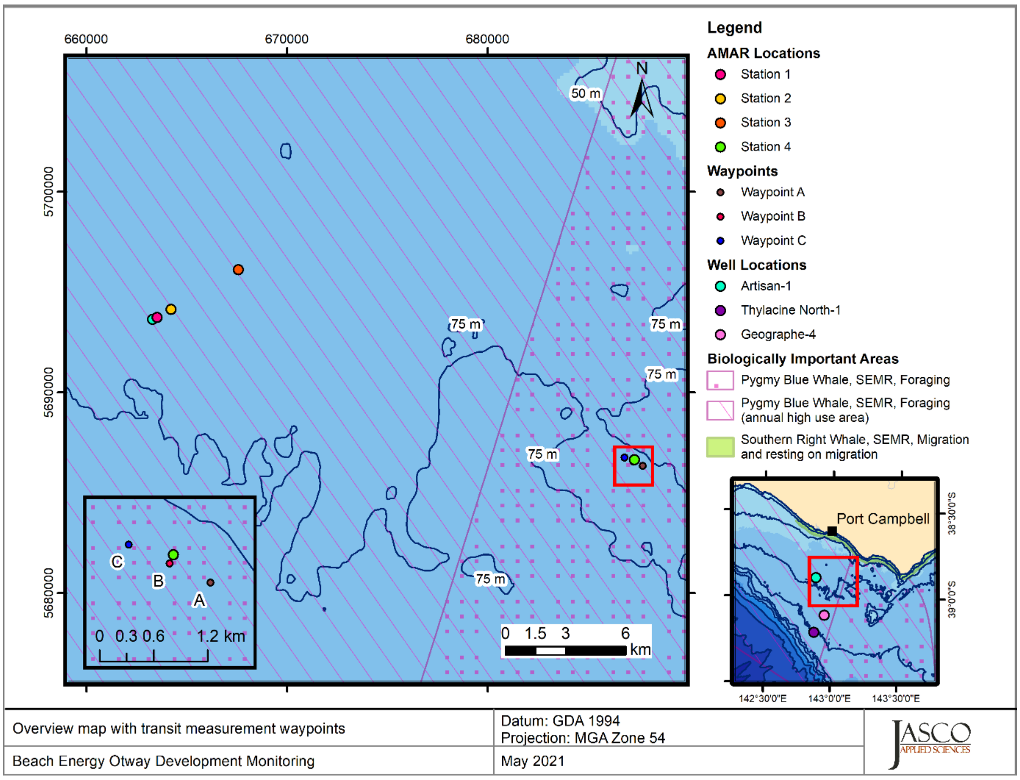


Figure 7. Map showing AMAR locations along with the three waypoints for the measurement track at Station 4 for transit vessels, Waypoints A, B, and C.

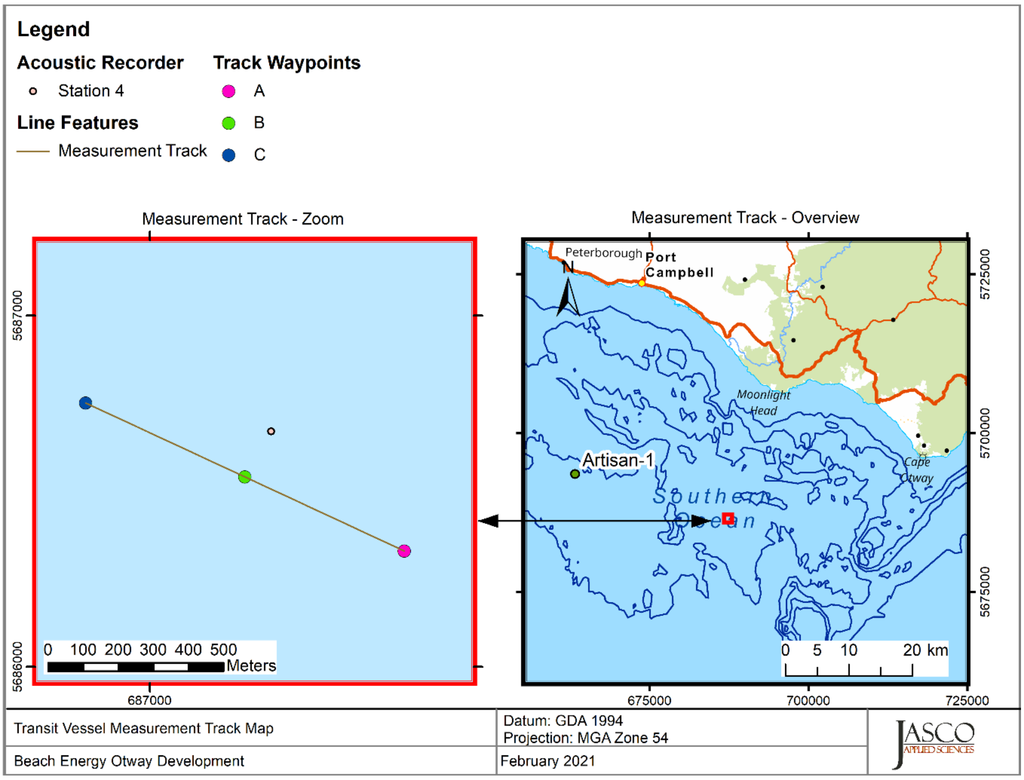


Figure 8. Zoom in of measurement track at Station 4 for transit vessels, as shown in Figure 7.

2.6. Noise Effect Criteria

To assess the potential effects of a sound-producing activity, it is first necessary to establish exposure criteria (thresholds) for which sound levels may be expected to have a negative effect on animals. Whether acoustic exposure levels might injure or disturb marine fauna is an active research topic. Since 2007, several expert groups have developed sound exposure level (SEL) based assessment approaches for evaluating auditory injury, with key works including Southall et al. (2007), Finneran and Jenkins (2012), Popper et al. (2014), United States National Marine Fisheries Service (NMFS 2018) and Southall et al. (2019). The number of studies that investigate the level of behavioural disturbance to marine fauna by anthropogenic sound has also increased substantially.

Two sound level metrics, sound pressure level (SPL), and SEL (Appendix A), are commonly used to evaluate non-impulsive noise and its effects on marine life. In this report, the duration of the SEL accumulation is defined as integrated over a 24 h time period. Appropriate subscripts indicate any applied frequency weighting applied. The acoustic metrics in this report reflect the amended ANSI and ISO standards for acoustic terminology, ANSI S1.1 (S1.1-2013), and ISO 18405:2017 (2017a).

The following thresholds and guidelines for this study were chosen because they represent the best available science, and sound levels presented in literature for fauna with no defined thresholds:

1. Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from the US National Oceanic and Atmospheric Administration (NOAA) Technical Guidance (NMFS 2018) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in marine mammals for non-impulsive sources.
2. Marine mammal behavioural threshold based on the current interim U.S. National Oceanic and Atmospheric Administration (NOAA) (2019) criterion for marine mammals of 120 dB re 1 µPa (SPL; L_p) for non-impulsive sound sources.

The criteria applied in this study to assess possible effects of vessel noise on marine mammals are summarised in Table 6, with frequency weighting explained in Appendix E.

Table 6. Criteria for effects of continuous noise exposure, including vessel noise, for marine mammals: Unweighted sound pressure level (SPL) and 24 h sound exposure level (SEL_{24h}) thresholds.

Hearing group	NOAA (2019)	NMFS (2018)	
	Behaviour	PTS onset thresholds (received level)	TTS onset thresholds (received level)
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2 s)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2 s)
Low-frequency (LF) cetaceans	120	199	179
High-frequency (HF) cetaceans		198	178
Very high-frequency (VHF) cetaceans		173	153
Phocid seals		201	181
Otariid seals		219	199

L_p denotes sound pressure level period and has a reference value of 1 µPa.
L_E denotes cumulative sound exposure over a 24 h period and has a reference value of 1 µPa^{2}s.

3. Marine Acoustic Environment

3.1. Ambient Ocean Soundscape

The ambient acoustic environment, or soundscape, consists of cumulative contributions from abiotic (geophonic), biotic (biophonic), and man-made (anthrophonic) sound sources (Krause 2008). Variation in soundscape characteristics over time and space can act as proxies for geographical, biological, and anthropogenic events occurring within an environment.

In the marine environment, geophonic elements of the soundscape commonly correlate with oceanographic conditions. Increased sea state and wind speed lead to higher sound intensities across frequencies ranging from 500 Hz to 30 kHz, via sound produced by breaking waves, cavitation, surface flow noise, and pressure changes (Knudsen et al. 1948, Wenz 1962) (Figure 9). Rainfall elevates sound levels in the 1–15 kHz frequency range, via surface impacts and bubble entrainment (Heindsmann et al. 1955, Bom 1969, Scrimger et al. 1987). The specific frequency band affected by rainfall depends on rain strength and droplet size. Abiotic acoustic contributions are often unpredictable or irregular (Urick 1983). For example, significant low frequency acoustic energy can be contributed to marine soundscapes by earthquakes and sea ice movement (Urick 1974, Matsumoto et al. 2014). On the other hand, biophonic contributions often feature seasonal and diel activity patterns (Hannay et al. 2013, Erbe et al. 2017). Water movement, or flow noise, is considered to be a pseudo-noise that results from eddies and vortices forming as water flows past an acoustic receiver, and is not considered to be part of a marine soundscape (Strasberg 1979).

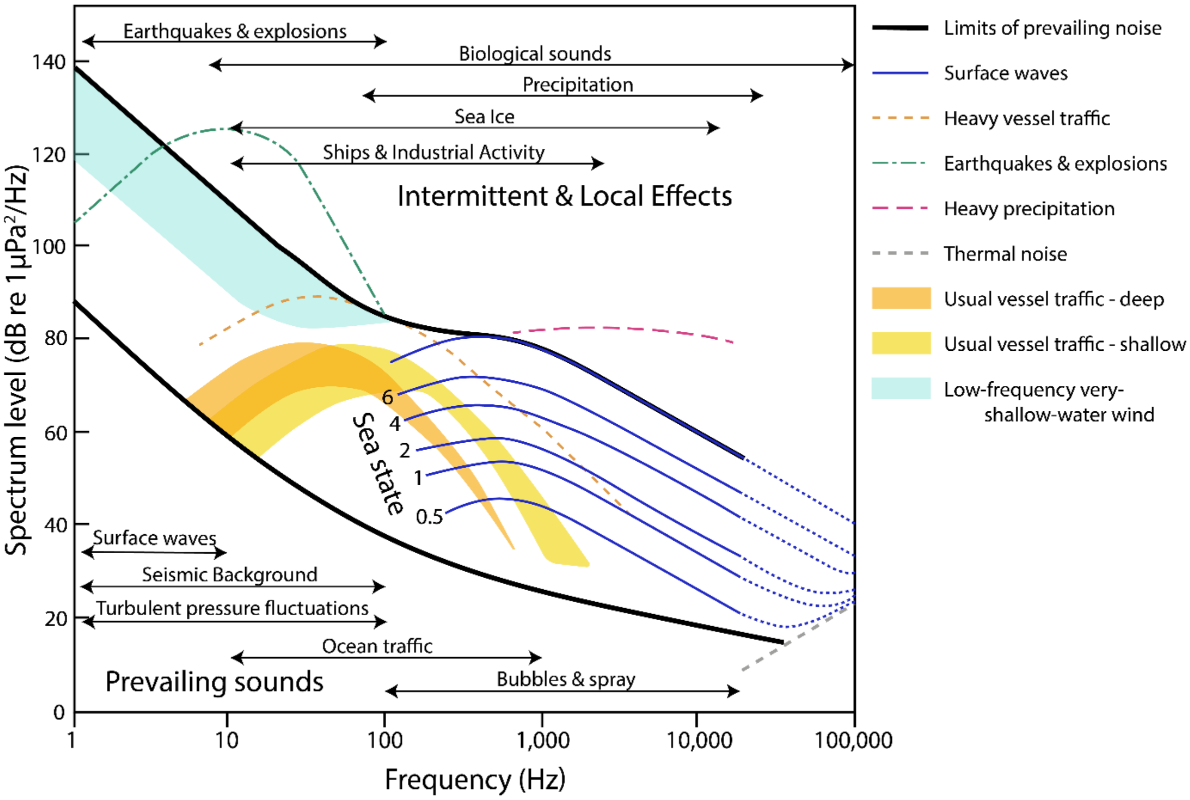


Figure 9. Wenz curves describing pressure spectral density levels of marine ambient sound from weather, wind, geologic activity, and commercial shipping (adapted from NRC 2003, based on Wenz 1962). Thick lines indicate limits of prevailing ambient sound.

3.2. Anthropogenic Contributors to the Soundscape

Anthropogenic (human-generated) sounds are relatively recent additions to soundscapes and, unlike biophonic contributors, often overlap in frequency, space, or time (Cato 1997, van Opzeeland and Boebel 2018). Anthrophonic contributors to global ocean noise include vessel traffic (commercial and recreational) at frequencies mainly in the frequency band 50–500 Hz. This sound can be a by-product of vessel operations, such as engine sound radiating through vessel hulls and cavitating propulsion systems, or it can be a product of active acoustic data collection with seismic surveys, military sonar, and depth sounding as the main contributors.

Marine construction projects involve vessel operations and project specific noise sources that can produce a range of both impulsive and non-impulsive noise. The contribution of anthropogenic sources to the ocean soundscape has increased from the 1950s to 2010, largely due to greater maritime shipping traffic (Ross 1976, Andrew et al. 2011). Oil and gas exploration with seismic airguns, marine pile driving, and oil and gas production platforms elevate sound levels over significant ranges when present (Bailey et al. 2010, Miksis-Olds and Nichols 2016, Delarue et al. 2018).The extent of seismic survey sounds has increased substantially following the expansion of oil and gas exploration into deep water, and seismic sounds have been detected across ocean basins (Nieukirk et al. 2004). Recent trends suggest that global sound levels are leveling off or potentially decreasing in some areas (Andrew et al. 2011, Miksis-Olds and Nichols 2016).

A recent paper examining seasonal fluctuations of ambient sound level in the Pacific Ocean (Ainslie et al. 2021) determined that a 5 dB increase in ambient sound level in the frequency range 63–125 Hz was caused by increases in vessel traffic and vessel size in the second half of the 20th century. A larger (approximate 10 dB) increase at lower frequencies (~16–32 Hz), often attributed incorrectly to shipping, occurs in bands dominated by baleen whale vocalisations. This paper also found that the seasonal dependence in ambient sound level is explained by seasonal changes in average sea surface temperature. This work provides a holistic and valuable examination of long-term trends.

3.3. Soniferous Marine Life

Biophonic contributors to marine soundscapes include tonal and pulsive vocalisations produced by marine mammals, fish, and invertebrates to communicate, orientate, and feed. Seasonal trends in biophonic sounds can act as proxies for behaviours, such as the migration of whales (e.g., Leroy et al. 2016, Gavrilov et al. 2018, Jolliffe et al. 2019). Other sounds of animal origin that contribute to marine soundscapes include by-products of behaviour, such as the snaps produced by snapping shrimp (*Alpheus heterochaelis*) during agonistic or foraging behaviours (Versluis et al. 2000). Snapping shrimp can increase background sound levels by a factor of 10 (20 dB) in the 500 Hz to 20 kHz frequency band (Hildebrand 2009). When a large number of sound-producing animals are present, both voluntary and involuntary sounds can combine to generate choruses where individual sounds cannot be distinguished. Chorusing fish can temporarily elevate the background sound levels by greater than tenfold in the 100 and 2000 Hz frequency band (Cato 1992, Zelick et al. 1999).

Diel trends in choruses can be indicative of time-specific behaviours, such as crepuscular or nocturnal fish activity (McCauley and Cato 2000, D'Spain and Batchelor 2006, McCauley and Cato 2016), with a variety of different species contributing the to the soundscape (Parsons et al. 2016, Parsons et al. 2017).

Many fish species produce sound during the breeding season or when engaged in agonistic behaviours (Amorim 2006). Several species of gadids (cod family), such as Northern cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*), form spawning aggregations that have been detected acoustically (Nordeide and Kjellsby 1999, Hawkins et al. 2002). The acoustic monitoring of fish is hindered by a limited understanding of their acoustic repertoire and behaviour. Nevertheless, the stereotypical nature of acoustic signals produced by some species have led to the development of dedicated acoustic detectors (e.g., cod; see Urazghildiiev and Van Parijs 2016). These detectors allow for a more systematic analysis of acoustic data for fish occurrence. Irrespective of species identity, fish choruses can raise ambient noise levels and therefore influence local soundscapes (Erbe et al. 2015).

The main, best documented, biological contributors to the ocean soundscape are marine mammals. All studied cetacean and pinniped species produce sounds ranging in frequency from ~8 Hz for blue whale (*Balaenoptera musculus*) and fin whale (*B. physalus*) vocalisations to 150 kHz for some porpoise and dolphin vocalisations (Richardson et al. 1995).

Baleen whale sounds can double background sound levels within their frequency bands and persist for extended periods of time (McDonald et al. 2008), such as species off southern Australia, including pygmy blue and southern right whales, that are all notable contributors when present (Cato 1991, McCauley et al. 2001, Gavrilov and McCauley 2013, Erbe et al. 2016, McPherson et al. 2017). For instance, fin whale songs can raise noise levels in the 18–25 Hz band by 15 dB for extended durations (Simon et al. 2010).

Marine mammals, cetaceans in particular, rely almost exclusively on sound for navigating, foraging, breeding, and communicating (Clark 1990, Edds-Walton 1997, Tyack and Clark 2000). Although species differ widely in their vocal behaviour, most can be reasonably expected to produce sounds on a regular basis. Passive acoustic monitoring is therefore increasingly preferred as a cost-effective and efficient survey method. Seasonal and sex- or age-biased differences in sound production, as well as signal frequency, source level, and directionality, all influence the applicability and success rate of acoustic monitoring, thus its effectiveness must be considered separately for each species.

In most cases, baleen whale signals can be reliably identified to the species level, although, seasonal variation in the types of vocalisations produces results in seasonal differences in our ability to detect these species acoustically. For example, the tonal signals produced by blue, fin, and sei (*B. borealis*) whales tend to show lots of similarities in late spring and summer, but they are markedly different from September to April. These issues are considered and discussed on a case-by-case basis.

Knowledge of the acoustic signals of the marine mammals expected in the study area varies across species. These sounds can be split into two broad categories: Tonal signals, including baleen whale moans and delphinid whistles, and echolocation clicks produced by all odontocetes mainly for foraging and navigating. Although the signals of most species have been described to some extent, these descriptions are not always sufficient for reliable, systematic identification, let alone to design automated detectors to process large data sets.

3.4. Changes to Sound as it Travels in the Ocean

A key question in the study of underwater sound is how a sound changes in nature as it propagates from its source to a receiver some distance away. Understanding and modelling sound propagation in the ocean is a complex topic that is the subject of numerous studies. This section provides a descriptive overview of key sound propagation concepts to assist with the results presented in this report. These concepts are integral to interpreting how sounds emitted by a source are transformed into those received some distance away. The sounds are transformed by 1) geometric spreading losses; 2) reflection, scattering, and absorption at the seabed and sea surface; 3) refraction due to changes in sound speed with depth; and 4) absorption by sea water. This section does not address point 3), as sound refraction plays only a minor role in shallow water, such as the Otway Development area.

At one extreme, the echolocation clicks of porpoises at 130 kHz travel only 500 m before becoming inaudible (Au et al. 1999). At the other extreme, sounds from fin whales (20 Hz) and low frequency energy from seismic airguns (5–100 Hz) can be detected thousands of km away under the right conditions (Nieukirk et al. 2012).

Geometric spreading losses: Sound levels from an omnidirectional point source in the water column are reduced with range, a process known as *geometric spreading loss*. As sound leaves the source, each spherical sound wave propagates outward and the sound energy is spread out over this ever-expanding sphere. The farther you are from the source, the lower the sound level you will receive. The received sound pressure levels at a recorder located a distance R (in m) from the source are $20\log_{10}R$ dB lower than the source level (SL) referenced to a standard range of 1 m. However, the sound cannot spread uniformly in all directions forever. Once the waves interact with the sea surface and seabed, the spreading becomes cylindrical rather than spherical and is limited to the cylinder formed by the surface and seabed with a lower range-dependent decay of $10\log_{10}R$ dB. Thus, the water depth is a key factor in predicting spreading losses and thus received sound levels. These spherical and cylindrical spreading factors provide limits for quick approximations of expected levels from a given source. In very shallow waters, sound rapidly attenuates if the water depth is less than a quarter of a wavelength (Urick 1983).

Reflection, scattering, absorption at the sea surface and seabed: If geometric spreading were the only factor governing sound attenuation in water, then at a given distance from a source, sound levels in shallow waters would almost always be higher than those in deep waters. In shallow water, however, the sound interacts with the seabed and sea surface more often than sound travelling in deep waters does, and these interactions reflect, absorb, and scatter the sounds. The sea surface behaves approximately as a pressure release boundary, where incident sound is almost completely reflected with opposite phase. As a result, the sum of the incident and reflected sounds at the sea-surface is zero. At the seabed, many types of interactions can occur depending on the composition of the bottom. Soft silt and clay bottoms absorb sound, sand and gravel bottoms tend to reflect sound like a partially reflective mirror, and some hard yet elastic bottoms, such as limestone, reflect some of the sound while absorbing some of the energy by converting the compressional waves to elastic shear waves.

Absorption by sea water: As sound travels through the ocean, some of the energy is absorbed by molecular relaxation in the seawater, which turn the acoustic energy into heat. The amount of absorption that occurs is quantified by an attenuation coefficient, expressed in units of decibels per kilometre (dB/km). This absorption coefficient depends on the temperature, salinity, pH, and pressure of the water, as well as the sound frequency. In general, the absorption coefficient increases with the square of the frequency, so low frequencies are less affected. The absorption of acoustic wave energy has a noticeable effect (>0.05 dB/km) at frequencies above 1 kHz. For example, at 10 kHz the absorption loss over 10 km distance can exceed 10 dB, as computed according to the formulae of François and Garrison (1982a, b).

4. Methods

4.1. Acoustic Data Acquisition

Underwater sound was recorded with four Autonomous Multichannel Acoustic Recorders (AMARs, JASCO; Figure 10). The AMARs were each fitted with M36 omnidirectional hydrophones (GeoSpectrum Technologies Inc., −164 re 1 V/µPa at 1 kHz sensitivity) and recorded continuously at 24-bit resolution at 64 kHz. Three AMARs stored acoustic data with three SD cards with 512 GB memory each (1.5 TB total), and one AMAR (Station 4) used seven SD-cards with 512 GB memory each (3.5 TB total). Appendix C provides details about the calibration procedure.

The deployment of the AMARs coincided with an inspection trip of the pre-laid anchors at the Artisan 1 drilling location by the Siem *Sapphire*. They were deployed on 3 Feb 2021, for an intended deployment duration of approximately 60 days. The deployment of one of the moorings is shown in Figure 11. The mooring at Station 3 released upon contact with the seafloor, potentially due to the lander striking a rock on the seafloor. It was immediately retrieved, and after sourcing a new weight plate and being re-configured, it was re-deployed on 24 Feb 2021. The retrieval of the moorings was conducted by Beach under guidance from JASCO on 3 Apr 2021.

The AMARs were deployed as part of a JASCO C-lander, with tandem acoustic releases (Figure 10). Each mooring consisted of:

- An AMAR G4 and battery packs,
- A Xeos Apollo Locator Beacon,
- Custom syntactic foam,
- A tandem acoustic release system (EdgeTech), and
- An anchor weight.

The AMAR hydrophones were protected by a hydrophone cage, which was covered with a nylon shroud to minimise noise artifacts from water flow (described in Section 3.1). The AMAR at Station 4 was configured with three hydrophones to allow for directional analysis (Thode et al. 2019).

Figure 10. The four C-Lander bottom moorings with Autonomous Multichannel Acoustic Recorders (AMAR G4s; JASCO) used for the project prior to loading onto the Siem *Sapphire*.

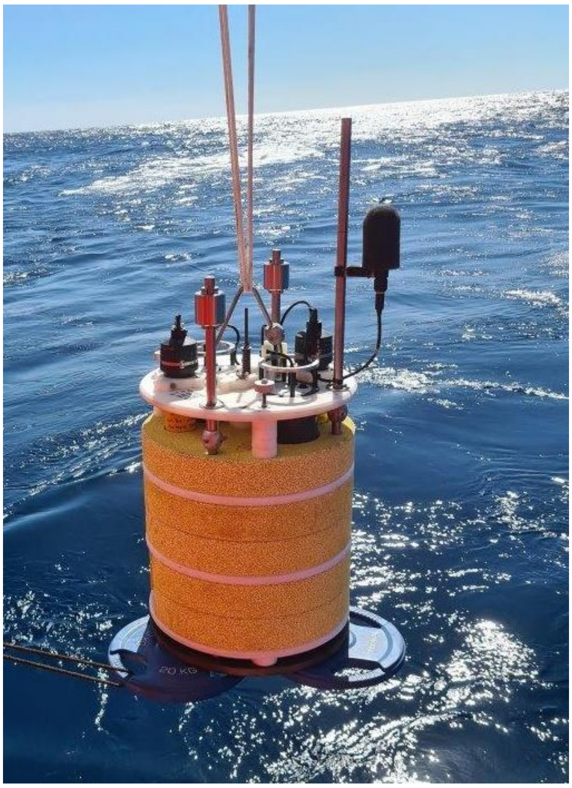


Figure 11. A single hydrophone C-Lander bottom mooring during deployment.

Table 7. Operation period, location, and depth of the Autonomous Multichannel Acoustic Recorders (AMARs) deployed at the Otway Project Area

Station	AMAR	Deployment	Recording duration (days)	Retrieval	Deployment duration (days)	Hydrophone details
1	628	3 Feb 2021	63	3 Apr 2021	58	One M36-V35-900
2	626	3 Feb 2021	63	3 Apr 2021	58	
3	627	24 Feb 2021	42	3 Apr 2021	37	
4	629	3 Feb 2021	63	3 Apr 2021	58	Three M36-V35-900

4.2. Data Analysis

The AMARs collected approximately 10.46 TB of acoustic data during this study, the equivalent of 1 year and 85 days JASCO used a specialised computing platform (PAMlab; JASCO) capable of processing acoustic data hundreds of times faster than real time. The system performed automated analysis of total ocean noise and sounds from vessels, other anthropogenic sources, and marine mammal vocalisations to provide context for the ambient ocean soundscape, anthropogenic contributors, and soniferous marine life (Section 3). Appendix D outlines the stages of the automated analysis.

4.2.1. Total Ocean Sound Levels

The data collected for the project spanned a frequency band between 10 Hz and 32 kHz. The goal of the total ocean sound analysis was to present the expansive data in a manner that documented the underwater sound conditions near Artisan-1 and allowed a comparison over time, along with external factors that change sound levels, such as weather and human activities.

The first stage of the total sound level analysis involves computing the peak sound pressure level and root-mean-square sound pressure level (SPL) for each minute of data collected. This reduced the data to a manageable size without compromising the value for characterising the soundscape (ISO 2017b, Ainslie et al. 2018, Martin et al. 2019). The SPL analysis was performed by averaging 120 fast-Fourier transforms (FFTs) that each include 1 s of data with a 50% overlap and that use the Hann window to reduce spectral leakage. The 1-minute average data were stored as power spectral densities (1 Hz resolution up to 455 Hz and millidecades frequency bands above 455 Hz) and summed over frequency to calculate decidecade band SPL levels. The millidecade band analysis approach is described in Martin et al. (2021). Millidecades are logarithmically spaced frequency bands but have a bandwidth equal to 1/1000th of a decade. The use of millidecades instead of 1 Hz frequency bands reduces the size of the spectral data by a large factor without compromising the use of the data.

Decidecade band levels are very similar to 1/3-octave-band levels. Table B-1 lists the decidecade band frequencies, and Table B-2 lists the decade-band frequencies. The decidecade analysis sums the frequency range from the millidecade bands (representing the frequency range 10 Hz to 32 kHz) in the power spectral density data to a manageable set of 45 bands. The decade bands further summarise the sound levels into four frequency bands for manageability. Detailed descriptions of the acoustic metrics and decidecade analysis can be found in Appendices B.1 and B.2.

In Section 5, the total sound levels are presented as:

- **Band-level plots**: These strip charts show the averaged received sound pressure levels as a function of time within a given frequency band. We show the total sound levels (across the entire recorded bandwidth from 10–32,000 Hz) and the levels in the decade bands of 10–100 (Decade A), 100–1000 (Decade B), 1000–10,000 (Decade C). The 10–100 Hz band is associated with pygmy blue whales, large shipping vessels, flow (or pseudo-noise) and mooring noise, and seismic survey impulses. Sounds within the 100–1000 Hz band are generally associated with the physical environment such as wind and wave conditions but can also include both biological and anthropogenic sources such as minke and humpback whales, fish, nearby vessels, seismic surveys, and pile driving. Sounds above 1000 Hz include high-frequency components of humpback whale sounds, odontocete whistles and echolocation signals, wind- and wave-generated sounds, and sounds from human sources at close range including pile driving, vessels, seismic surveys, and sonars.

- **Long-term Spectral Averages (LTSAs)**: These colour plots show power spectral density levels as a function of time (*x*-axis) and frequency (*y*-axis). The frequency axis uses a logarithmic scale, which provides equal vertical space for each decade increase in frequency and allows the reader to equally see the contributions of low and high-frequency sound sources. The LTSAs are excellent summaries of the temporal and frequency variability in the data.
- **Decidecade box-and-whisker plots**: In these figures, the 'boxes' represent the middle 50% of the range of sound pressure levels measured, so that the bottom of the box is the sound level 25th percentile (L_{25}) of the recorded levels, the bar in the middle of the box is the median (L_{50}), and the top of the box is the level that exceeded 75% of the data (L_{75}). The whiskers indicate the maximum and minimum range of the data.
- **Spectral density level percentiles**: The decidecade box-and-whisker plots are representations of the histogram of each band's sound pressure levels. The power spectral density data has too many frequency bins for a similar presentation. Instead, coloured lines are drawn to represent the L_{eq}, L_5, L_{25}, L_{50}, L_{75}, and L_{95} percentiles of the histograms. Shading is provided underneath these lines to provide an indication of the relative probability distribution. It is common to compare the power spectral densities to the results from Wenz (1962), which documented the variability of ambient spectral levels off the US Pacific coast as a function of frequency of measurements for a range of weather, vessel traffic, and geologic conditions. The Wenz levels are appropriate for approximate comparisons only because the data were collected in deep water, largely before an increase in low-frequency sound levels due to human activities (Andrew et al. 2011).
- **Daily sound exposure levels (SEL; $L_{E,\mathrm{24h}}$)**: The SEL represents the total sound energy received over a 24 h period, computed as the linear sum of all 1-minute values for each day. It has become the standard metric for evaluating the probability of temporary or permanent hearing threshold shift in marine mammals. Long-term exposure to sound impacts an animal more severely if the sounds are within its most sensitive hearing frequency range. Therefore, during SEL analysis, recorded sounds are typically filtered by the animal's auditory frequency weighting function (Appendix E) before integrating to obtain SEL. For this analysis, the 10 Hz and above SEL were computed as well as the SEL weighted by the marine mammal auditory filters (NMFS 2018).

4.2.2. Directional Processing: Maximum Likelihood Beamforming

A maximum likelihood beamformer was applied to direction finding of the Station 4 acoustic data. For random continuous and impulsive signals, such as ship noise, anthropogenic noise, and marine animal vocalisations, the beamforming technique is reduced to Distance of Arrival (DOA) estimation. The sufficient statistic for random signals is the sampled covariance matrix,

$$\boldsymbol{C}(f,t) = \sum_t^{t+T_C} \boldsymbol{x}(f,t)\boldsymbol{x}^+(f,t)\,, \tag{1}$$

computed using N-dimensional DFT spectrums of array outputs, $\boldsymbol{x}(f,t) = [x_1(f,t), \dots, x_N(f,t)]^T$; where $x_n(f,t) = DFT\{x_n(t)\}$ is the short-time discrete Fourier Transform of the output of the *n*th hydrophone, $x_n(t)$. The output of the beamformer can be represented as:

$$P(f,t,\theta,\varepsilon) = \boldsymbol{w}^+(f,\theta,\varepsilon)\boldsymbol{C}(f,t)\boldsymbol{w}(f,\theta,\varepsilon)\,, \tag{2}$$

where $\boldsymbol{w}(f,\theta,\varepsilon) = [w_1(f,\theta,\varepsilon), \dots, w_N(f,\theta,\varepsilon)]^T$ is the N-dimensional vector of weighting coefficients of the array; and symbol "+" denotes transpose and complex conjugation, θ is the azimuth angle and ε is the estimation error. Figure 12 shows an example of the beamformer output in azimuth domain, $P(f,t,\theta,\varepsilon = 0)$. In this figure, colour represents the azimuth. The azimuth and elevation estimates of random signals can be computed for each frequency f and time slice t as:

$$\{\hat{\theta}(f,t), \hat{\varepsilon}(f,t)\} = arg \max_{\theta,\varepsilon} P(f,t,\theta,\varepsilon)\,. \tag{3}$$

An example of the directional information we obtain from this approach is shown in Figure 12. The performance of the beamformer is presented in Urazghildiiev and Hannay (2017). This method is most effective between 50 and 3000 Hz. The direction of true North was obtained using AIS data compared to vessel movements observed in the acoustic data.

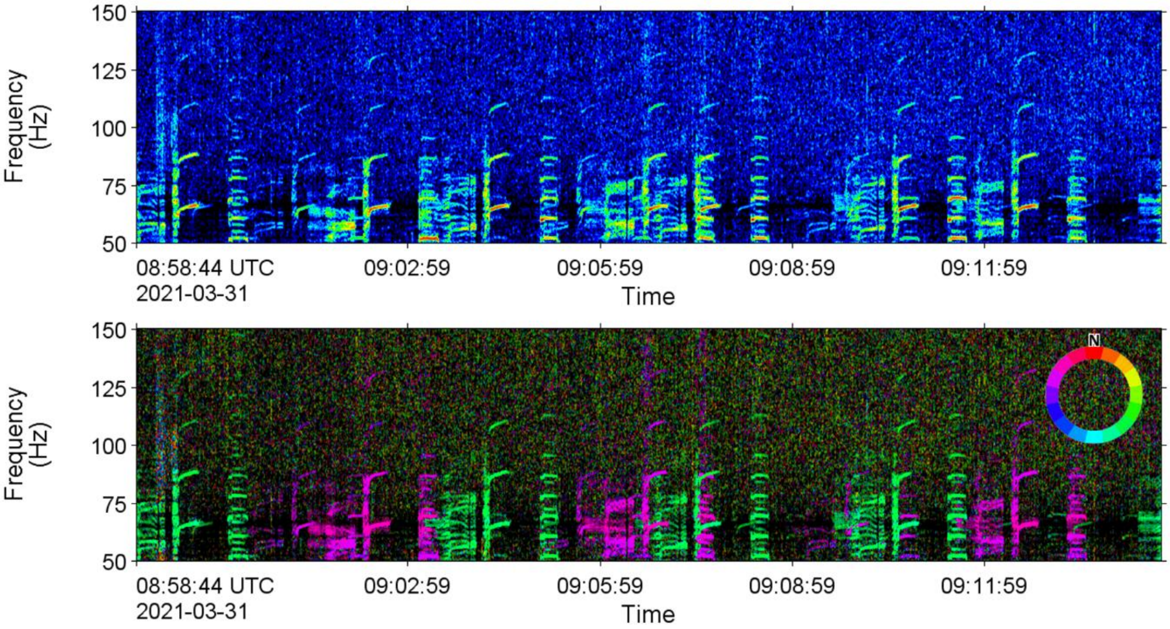


Figure 12. Spectrogram (top) versus directogram (bottom) of same data. In the directogram, colour represents the direction of arrival, with the colour legend shown in the top right corner. In the spectrogram, we cannot tell how many pygmy blue whales are vocalising; however, the directional information allows us to see that there were two animals singing.

4.2.3. Source Level Measurements with ShipSound

4.2.3.1. Overview

JASCO's ShipSound software monitors sound level measurements and AIS broadcasts from passing vessels. For vessel transiting scenarios, it identifies vessels that traverse a predefined transit area and then automatically extracts the corresponding acoustic data for analysis. It uses a vessel's broadcast speed together with a cepstral analysis of the Lloyd mirror pattern to determine the timing and location of closest point of approach (CPA) of the vessel's acoustic centre. For stationary sources, such as MODU or vessels in DP, it processes acoustic data within the specified period for the activity. ShipSound can analyse streaming data from a hydrophone in real time or, as in the case of the Beach Otway recorders, analyse archival hydrophone data downloaded from autonomous recorders. The vessel AIS data were based on Marine Traffic AIS data, vessel measurement logs, as well as client-provided data. AIS data were fed into the ShipSound system for vessel source level analysis. Environmental conditions, such as wind speed, were also recorded for each measurement. Ocean current data can be used to calculate speed through water (STW) from speed over ground (SOG) information received via AIS for each vessel measurement. However, current speed was not available in this project area, so STW was not calculated.

For transiting vessel measurements, the ANSI/ASA S12.64 data window is defined by the period over which the acoustic centre is within ±30° of the CPA. ShipSound can automatically determine the data window. For stationary sources, ShipSound determines the data window based on input specified time. ShipSound processes a single acoustic channel in 1-second periods stepped in 0.5-second intervals (Figure 13). Spectrum measurements are calculated using 1-second fast Fourier transforms, shaded using a Hanning window.

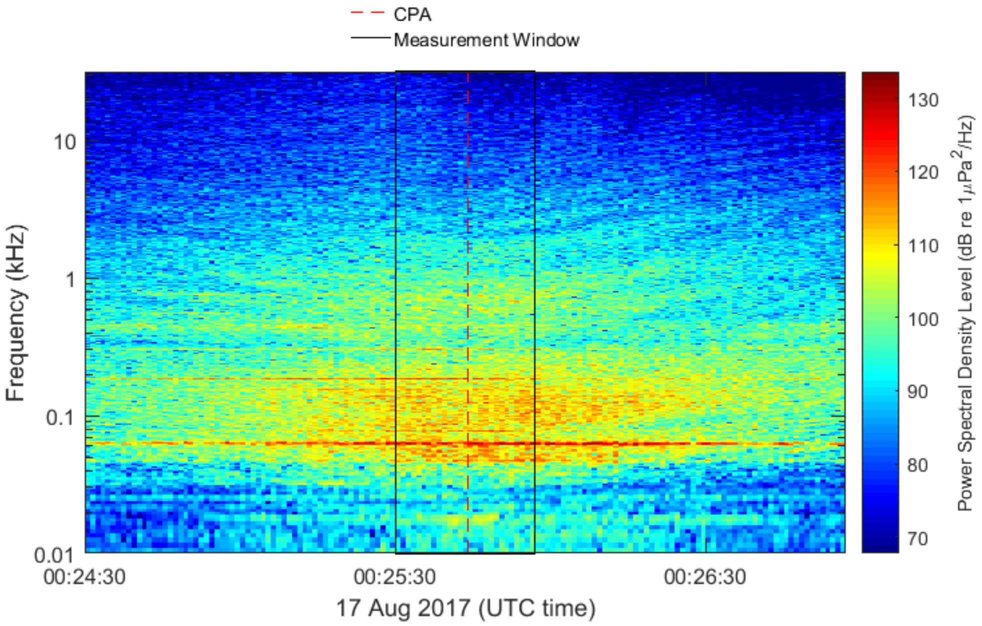


Figure 13. Spectrogram of a single transiting vessel measurement from ShipSound, showing the closest point of approach (CPA) time (dashed red line) and the measurement window (black box) used for calculating vessel source levels. The spectrogram shows the spectrum of the underwater sound pressure recorded on the hydrophone versus time and frequency.

ShipSound calculates two kinds of vessel source levels from the data window: Radiated Noise Level (RNL) and Monopole Source Level (MSL). RNL is equal to the measured sound pressure level, back-propagated according to the distance between a source and the hydrophone. The software applies the ANSI/ASA S12.64 Grade-A method for back-propagation distance: it determines instantaneous vessel range (R) in metres from the measurement hydrophone for each 1-second step within the data window. The RNL back propagation method of 20 x $\mathrm{Log}_{10}(R)$ is applied to the spectra of each step separately. MSL is equal to the measured sound pressure level scaled according to a numerical acoustic propagation loss (PL) model that accounts for the effect of the local environment on sound propagation (i.e., sea-surface reflection, water column refraction and absorption, and bottom loss). Since no single acoustic model is applicable at all sampled ranges and frequencies, a hybrid TL model was used to calculate MSL as follows:

1. At frequencies less than 4 kHz and ranges less than 120 m, PL was calculated using a wavenumber integration model (Hannay et al. 2010, Jensen et al. 2011), which computes reflection coefficients for layered elastic media (Brekhovskikh 1980).
1. At frequencies less than 4 kHz and ranges greater than 240 m, PL was calculated using a wide-angle parabolic equation model (Collins 1993), modified to treat reflection losses for an elastic seabed using a complex-density equivalent fluid approximation (Zhang and Tindle 1995).
2. At frequencies less than 4 kHz and ranges between 120 m and 240 m, PL was calculated from the average of the parabolic equation and wavenumber integration models.
3. At frequencies greater than 4 kHz, PL was calculated using an image-method model (Brekhovskikh and Lysanov 2003), which accounts for surface and seabed reflection coefficients and frequency-dependent absorption (François and Garrison 1982b).

Average TL in each decidecade band was based on the mean propagation factor calculated at 50 frequencies, which were spaced logarithmically between the minimum and maximum band limits. Mean source depth for the MSL calculation was taken to be:

1. For vessel transit, source depth is defined as shaft depth minus 0.7 of the propeller radius. The stern propeller diameter of 4.2 m was used for the calculation.
2. For vessel in DP, since all the thrusters were operating and each are at different depths, the source depth is defined as 0.7 times vessel static draft reported on AIS.
3. For the MODU, the source depth is defined as half the static draft reported on AIS, which gives 11 m of the source depth.

The TL was smoothed by assuming the source depth had a Gaussian distribution, in a manner similar to Wales and Heitmeyer (2002), where the standard deviation was taken to be 30% of the source depth. Additional details regarding the automated source level measurement system are given in Hannay et al. (2016b). ShipSound also calculates background noise in each frequency band. For vessel measurements, ShipSound only accepts measured source band levels if they exceed the background levels by 3 dB or more. ShipSound corrects the band levels if they exceed background levels by 3–10 dB but rejects them if they are less than 3 dB above background. Adjusted and rejected levels are flagged in the database. Figure 14 summarises this approach.

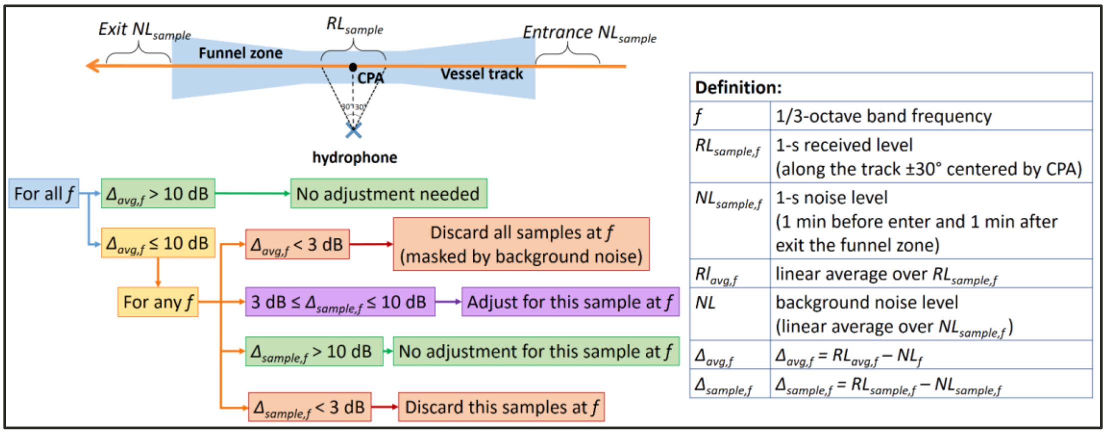


Figure 14. Background noise comparison and adjustment process.

PortListen includes a web-based user interface to access vessel and measurement information. A table view screen lets the user select and view multiple measurements by vessel criteria. This information, including broadband MSL and RNL source levels, can be exported as a spreadsheet. Vessel measurements are summarised in PDFs, presenting vessel and environment information, and the 1/3-octave-band MSL and RNL source levels. A manual quality review of every measurement was performed by an experienced analyst using the web-based interface. An analyst may reject a measurement because it contains interference from other vessels, has high levels of background noise, or if a vessel does not have constant speed and a straight track inside the data window.

MSL was the preferred metric for noise modelling because MSL back-propagation better accounts for the effect of the environment on vessel source levels (e.g., from absorption, surface, and seabed reflections) than RNL back-propagation. Measurements for vessel transits were obtained at different speeds, Ross's classical power law model (Ross 1976) was used to adjust the source levels to a reference speed. The change in source level (SL) to relative changes in speed:

$$\mathrm{SL} - \mathrm{SL}_{\mathrm{ref}} = C_v \times 10 \log_{10}\left(\frac{v}{v_{\mathrm{ref}}}\right). \tag{4}$$

In this equation, SL is the source level at speed v, $\mathrm{SL}_{\mathrm{ref}}$ is the source level at some reference speed v_{ref}, and $\mathrm{C_v}$ = 6, which is a coefficient corresponding to the slope of the curve.

4.2.3.2. MODU

The provided drill logs for the Artisan-1 well were reviewed to identify periods of activity defined as drilling, as this was the activity considered in the modelling study Koessler et al. (2020). Activities associated with mooring operations, cementing, installation of the Blow Out Preventer (BOP), or running casing were not considered. Twenty time periods for drilling were identified, and Long-term Spectral Averages (LSTAs) were created to review the data. From these data, 115 ten-minute time periods were identified as suitable or of interest for processing with ShipSound, listed in Table 8. Of these measurements, 70 were accepted (i.e., passed a manual quality review). Some measurements were rejected by the contamination of nearby vessels in DP (by checking both AIS data and noise spectrum). Source level measurements were matched with drill logs and the source levels were grouped by the drilling activities. The MSL was calculated over three different drilling depth ranges and presented as mean and maximum levels.

Table 8. Details of selected measurement periods for the *Ocean Onyx* mobile offshore drilling unit (MODU) and corresponding drill activities.

Drill activity	Date	Start	End	QC status
Spudded Artisan 1 at 2100 h. Drilled from 94.7 m (seabed) to 115 mMDRT. Pumped 100 bbl PHG sweep and took MWD survey at connection. Survey at 95.62 mMDRT: 0.82 deg inc, 13.97 deg azimuth. *Parameters*: 10–40 rpm, 3–5 kft-lbs torq, 8–10 klbs WOB, 600 gpm, 170 psi SPP	2021 Feb 23	10:05:00	10:15:00	Rejected
		10:25:00	10:35:00	Rejected
		10:55:00	11:05:00	Rejected
		11:00:00	11:10:00	Accepted
		11:25:00	11:35:00	Accepted
		11:45:00	11:55:00	Accepted
Continued drilling 26 × 42" hole from 115 to 171 m (SectionTD). Several small stringers encountered at 140 and 157 m. Pumped 100 bbl PHG sweep and took MWD survey at connection. Survey at 135 mMDRT: 0.5 deg inc. *Parameters*: 60 rpm, 3–5 kft-lb tq, 10 klbs WOB, 800–1,100 gpm, 400–550 psi SPP	2021 Feb 23	13:05:00	13:15:00	Accepted
		13:25:00	13:35:00	Accepted
		13:55:00	14:05:00	Accepted
		14:25:00	14:35:00	Rejected
		14:55:00	15:05:00	Accepted
		15:25:00	15:35:00	Accepted
		15:55:00	16:05:00	Rejected
		16:25:00	16:35:00	Rejected
		16:55:00	17:05:00	Accepted
		17:25:00	17:35:00	Accepted
		17:55:00	18:05:00	Rejected
		18:15:00	18:25:00	Accepted
Drilled 26 × 42” hole from 171 to 171.7 m with seawater at 60 rpm, 2 kft-lbs tq and 8 klbs WOB, 945 gpm with 400 psi.	2021 Feb 23	19:05:00	19:15:00	Accepted
		19:25:00	19:35:00	Rejected
		19:55:00	20:05:00	Rejected
Continued to drill 17.5” hole from 365 to 621 m with S/W and PHG sweeps. Pumped 50 bbls mid stand and spotted 100 bbls on around BHA at connections. Bubble watch in place on surface and ROV in TMS at LPWHH monitoring for shallow gas on sonar. *Parameters*: Flow: 1,100 gpm; Press: 2,240 psi; RPM: 80 surface. Total 201 Torque: 2–5 kft/lbs; WOB: 15–20 kft/lbs; Average ROP: 31 m/h P/U wt: 252 k, S/O 265 k, Rot 260 k.	2021 Feb 26	19:05:00	19:15:00	Rejected
		19:25:00	19:35:00	Accepted
		19:55:00	20:05:00	Accepted
		20:25:00	20:35:00	Accepted
		20:55:00	21:05:00	Accepted
		21:25:00	21:35:00	Accepted
		21:55:00	22:05:00	Accepted
		22:25:00	22:35:00	Accepted
		22:55:00	23:05:00	Rejected

		23:25:00	23:35:00	Accepted
	2021 Feb 27	23:55:00	00:05:00	Accepted
		00:25:00	00:35:00	Accepted
		00:55:00	01:05:00	Accepted
		01:25:00	01:35:00	Accepted
		01:55:00	02:05:00	Accepted
		02:25:00	02:35:00	Accepted
		02:55:00	03:05:00	Accepted
Held JHA for P/U and RIH with the 12 1/4"" BHA. Picked up and RIH with the 12 1/4"" BHA from surface to 50 m. Picked up the SLB motor and RIH from surface to 8.5 m. DSV confirmed that the motor configured with a 0.78 deg bend. Installed a non-ported, plunger type float valve into the motor-DSV on the drill floor and witnessed. Made up the SLB ARC-9 tool onto the motor and picked up the assembly above the RT and installed the 12 1/4"" PDC bit. Continued RIH with the BHA to 50 m.	2021 Mar 4	07:05:00	07:15:00	Rejected
		07:25:00	07:35:00	Rejected
		07:55:00	08:05:00	Rejected
		08:25:00	08:35:00	Rejected
		08:55:00	09:05:00	Rejected
		09:15:00	09:25:00	Accepted
Continued RIH with the 12 1/4"" BHA on 8 1/4"" DC. Picked up and made up 3x singles of 8 1/4"" DC, RIH from 50 to 80 m. Picked up and made up the 8"" Drilling Jar (with 2x 8 1/4"" DC) and continued RIH from 80-107 m. Picked up and made up the Jar Intensifier (with 2 x 8 1/4"" DC) and continued RIH from 107 to 135 m. Weight below the jars (40 klbs). Continued RIH with the 12 1/4"" BHA on 5 7/8"" Spiral HWDP. Made up 3x stand of 5 7/8"" spiral HWDP, RIH from 135 m to 220 mRT. Total string weight 65 klbs.	2021 Mar 4	09:35:00	09:45:00	Accepted
		09:55:00	10:05:00	Accepted
		10:25:00	10:35:00	Accepted
		10:55:00	11:05:00	Accepted
		11:25:00	11:35:00	Accepted
Continued RIH with the 12 1/4"" BHA on 5 7/8"" drill pipe from 220–278 m. Filled string on first stand of drill pipe.	2021 Mar 4	12:20:00	12:30:00	Accepted
		12:40:00	12:50:00	Accepted
PU off bottom 5 m. Staged up pump rate to drill out cement. Drilled out cement from 558 to 563 m. *Parameters*: ROP: 6.7 m/h; Flow: 750 gpm; Rotary: 30 rpm; SPP: 821 psi; WOB: 2–5 klbs; Off Bottom Tq: 1–2 kft-lbs; On Bottom Tq: 2–5 kft-lbs; ECD: 8.77 ppg	2021 Mar 4	16:35:00	16:45:00	Accepted
		16:50:00	17:00:00	Accepted
		17:05:00	17:15:00	Accepted
Continued drilling out cement with the 12 1/4"" BHA from 563 to 565 m. *Parameters*: ROP: 2.7 m/h; Flow 750 gpm; Rotary 30 rpm; SPP 821 psi; WOB-2–5 klbs; Off Bottom Tq 1–2 kft-lbs; On Bottom Tq 2–5 kft-lbs; ECD 8.77ppg	2021 Mar 4	18:15:00	18:25:00	Accepted
		18:30:00	18:40:00	Accepted
		18:45:00	18:55:00	Accepted
Continued to drill hard cement, float Collar and shoe track cement from 565 to 612 m (3 m from shoe) with seawater and 50 bbl PHG sweeps as required. *Parameters*: *ROP*: 13.4 m/h; Flow 800 gpm; Rotary 60 rpm; SPP 1000 psi; WOB 10–12 klbs; Off Bottom Tq 1–2 kft-lbs; On Bottom Tq 2–5 kft-lbs ECD 8.87 ppg; P/U weight 232 klbs; S/O weight 250 klbs; Rot weight 246 klbs	2021 Mar 4	19:05:00	19:15:00	Accepted
		19:25:00	19:35:00	Accepted
		19:55:00	20:05:00	Accepted
		20:25:00	20:35:00	Accepted
		20:55:00	21:05:00	Rejected
		21:25:00	21:35:00	Rejected
		21:55:00	22:05:00	Rejected
		22:25:00	22:35:00	Rejected
Drilled 12 1/4"" hole from 647 to 711 m. *Parameters*: Flow: 800 gpm; Press: 1,640 psi; RPM: 51 surface. 137 bit Torque: 1–3 kft/lbs; WOB: 4–5 kft/lbs; Average ROP: 21.3 m/h; P/U wt: 240 k, S/O 255 k, Rot 250 k. ESD: 10.1 ppg; ECD: 10.57 ppg	2021 Mar 5	10:05:00	10:15:00	Rejected
		10:25:00	10:35:00	Rejected
		10:55:00	11:05:00	Rejected
		11:25:00	11:35:00	Rejected
		11:55:00	12:05:00	Rejected
		12:25:00	12:35:00	Rejected

Drilled 12 1/4"" hole from 711 to 804 m. Parameters: Flow: 1002 gpm; Press: 2365 psi; RPM: 98 surface. 205 bit; Torque: 1–10 kft/lbs; WOB: 2–5 klbs; Average ROP: 46.5 m/h; P/U wt: 244 klbs, S/O 260 klbs, Rot 253 klbs. ESD: 10.18 ppg, ECD: 10.63 ppg	2021 Mar 5	13:05:00	13:15:00	Rejected
		13:25:00	13:35:00	Rejected
		13:55:00	14:05:00	Rejected
		14:25:00	14:35:00	Rejected
		14:45:00	14:55:00	Rejected
Drilled 12 1/4"" hole from 804 to 869 m. *Parameters*: *Flow*: 991 gpm; Press: 2390 psi; RPM: 99 surface. 206 bit; Torque: 2–5 kft/lbs; WOB: 2–5 kft/lbs; Average ROP: 18.57 m/h; P/U wt: 250 klbs, S/O 270 klbs, Rot 265 klbs. ESD: 10.2 ppg, ECD: 10.47 ppg	2021 Mar 5	15:35:00	15:45:00	Rejected
		15:55:00	16:05:00	Rejected
		16:25:00	16:35:00	Rejected
		16:55:00	17:05:00	Rejected
		17:25:00	17:35:00	Rejected
		17:55:00	18:05:00	Rejected
		18:25:00	18:35:00	Rejected
		18:45:00	18:55:00	Rejected
Drilled 12–1/4"" hole from 1,000 to 1,001 m. *Parameters*: Flow: 800 gpm; SPP: 2,650–2,800 psi; RPM: 79 surface/176 bit; Tq: Off 2 kft-lbs/On 5–15 kft-lbs. WOB: 5–20 klbs; Average ROP: 1 m/h; ESD: 10.11 ppg, ECD: 10.4 ppg; Slow drilling due to hard stringer. Boosted riser with 325 gpm at 75 psi.	2021 Mar 6	12:05:00	12:15:00	Accepted
		12:25:00	12:35:00	Accepted
		12:45:00	12:55:00	Accepted
Drilled ahead 12–1/4"" hole from 1,006 to 1014 m. *Parameters*: Flow: 900 gpm; SPP: 2,210 psi; RPM: 60 surface/170 bit; Tq: Off 1–2 kft-lbs/On 1–10 kft-lbs; WOB: 1–5 klbs P/U wt: 260 klbs, S/O wt: 280 klbs, Rot: 275 klbs; Average ROP: 8 m/h; ESD: 10.14 ppg, ECD: 10.52 ppg	2021 Mar 7	12:05:00	12:15:00	Accepted
		12:25:00	12:35:00	Accepted
		12:45:00	12:55:00	Accepted
Drilled ahead 12–1/4"" hole from 1,146 to 1,164 m. *Parameters*: Flow: 920 gpm; SPP: 2,330 psi; RPM: 100–120 surface/197–217 bit; Tq: Off 1–2 kft-lbs/On 1–10 kft-lbs; WOB: 1–5 klbs P/U wt: 266 klbs, S/O wt: 288 klbs, Rot: 285 klbs. Average ROP: 24 m/h. ESD: 10.39 ppg, ECD: 10.68 ppg	2021 Mar 7	18:20:00	18:30:00	Accepted
		18:40:00	18:50:00	Accepted
Drilled ahead 12–1/4"" hole from 1,433 to 1,545 m. *Parameters*: Flow: 1,000 gpm; Boost Pump: 250 gpm; SPP: 3,000 psi; RPM: 120 surface/217 bit; Tq: Off 1–2 kft-lbs/On 5–10 kft-lbs; WOB: 5–15 klbs P/U wt: 300 klbs, S/O wt: 325 klbs, Rot: 315 klbs; Average ROP: 18.6 m/h; ESD: 11.18 ppg, ECD: 11.37 ppg; Offline: Displaced the Boost line and flushed the MGS utilising the boost pump-total of 20 strokes pumped (10 bbls). At 1,510 m MW over the shakers recorded at 10.7 ppg (ESD-10.88 ppg). Ceased centrifuging and weighted up the mud with additions of barite. MW at 1543 m recorded at 11.1 ppg.	2021 Mar 8	13:05:00	13:15:00	Accepted
		13:25:00	13:35:00	Accepted
		14:25:00	14:35:00	Accepted
		14:55:00	15:05:00	Accepted
		15:25:00	15:35:00	Accepted
		15:55:00	16:05:00	Accepted
		16:25:00	16:35:00	Accepted
		16:55:00	17:05:00	Accepted
		17:25:00	17:35:00	Accepted
		17:55:00	18:05:00	Accepted
		18:25:00	18:35:00	Accepted
		18:45:00	18:55:00	Accepted
Continued to drill 12–1/4” hole from 1,623 to 1,655 m. *Parameters*: Flow: 805 gpm; SPP: 2,135 psi; RPM: 120 surface/206 bit; Tq: Off 1–2 kft-lbs/On 4–15 kft-lbs; WOB: 5–15 klbs; P/U wt: 310 klbs, S/O wt: 330 klbs, Rot: 325 klbs; Average ROP: 11m/h including connections; ESD: 11.13 ppg; ECD: 11.39 ppg	2021 Mar 9	08:45:00	08:55:00	Rejected
		09:10:00	09:20:00	Rejected
		09:40:00	09:50:00	Accepted
		10:10:00	10:20:00	Accepted
		10:40:00	10:50:00	Accepted

		11:10:00	11:20:00	Accepted
		11:35:00	11:45:00	Accepted
Continued to drill 12–1/4” hole from 1,830 to 1,851 m. *Parameters*: Flow: 920 gpm; SPP: 2,750 psi; RPM: 100 surface/198 bit; Tq: Off 1–2 kft-lbs/On 3–10 kft-lbs.; WOB: 10–20 klbs; P/U wt: 320 klbs, S/O wt: 345 klbs, Rot: 325 klbs; Average ROP: 19.3 m/h including connections. ECD: 11.40 ppg; ROP controlled to max 30 m/h for flow rate, mud rheology and surface equipment.	2021 Mar 10	01:35:00	01:45:00	Accepted
		01:55:00	02:05:00	Accepted
		02:25:00	02:35:00	Accepted
		02:45:00	02:55:00	Accepted

4.2.3.3. Vessels

ShipSound was used to process a total of 4 vessel DP measurements collected from Station 2, five vessel transit measurements collected from Station 2, and 16 vessel transit measurements collected from Station 4. All these measurements were accepted measurements. Details of the measurements were shown in Table 9. The classical power law model of Ross (1976) was used to calculate source levels to a referenced speed (Section 4.2.3.1), with the speed scaling coefficients C_v = 6 proposed by Ross (1976).

Table 9. Vessel measurements collected from Stations 2 and 4.

MMSI	Vessel	Activity	Speed (kn)	CPA time	CPA distance (m)	QC status
Station 2						
257544000	SIEM *SAPPHIRE*	DP	0.6	2021 Feb 4 01:23:00	162.3	Accepted
257544000	SIEM *SAPPHIRE*	DP	0.6	2021 Feb 4 01:38:30	183.9	Accepted
257544000	SIEM *SAPPHIRE*	DP	0.6	2021 Feb 4 01:47:30	182.6	Accepted
257544000	SIEM *SAPPHIRE*	DP	0.8	2021 Feb 4 02:00:00	185.6	Accepted
257544000	SIEM *SAPPHIRE*	Transit	8	2021 Feb 4 02:32:48	189.4	Accepted
257544000	SIEM *SAPPHIRE*	Transit	6.9	2021 Feb 4 08:10:52	165.6	Accepted
257544000	SIEM *SAPPHIRE*	Transit	7.7	2021 Feb 4 08:29:14	165.5	Accepted
257544000	SIEM *SAPPHIRE*	Transit	6.5	2021 Feb 4 08:45:40	184.6	Accepted
257544000	SIEM *SAPPHIRE*	Transit	7.9	2021 Feb 4 09:01:22	160.7	Accepted
Station 4						
257544000	SIEM *SAPPHIRE*	Transit	9.3	2021 Feb 5 15:02:57	187.6	Accepted
257662000	SIEM *AQUAMARINE*	Transit	9.3	2021 Feb 15 02:33:00	147.7	Accepted
257544000	SIEM *SAPPHIRE*	Transit	6.3	2021 Feb 15 04:19:19	128.9	Accepted
257709000	SIEM *TOPAZ*	Transit	8.8	2021 Feb 17 06:50:05	121.5	Accepted
257709000	SIEM *TOPAZ*	Transit	10.4	2021 Feb 20 08:38:36	118.2	Accepted
257709000	SIEM *TOPAZ*	Transit	10	2021 Feb 23 17:11:01	113.8	Accepted
257662000	SIEM *AQUAMARINE*	Transit	14.7	2021 Feb 25 10:35:02	133.4	Accepted
257662000	SIEM *AQUAMARINE*	Transit	10.1	2021 Feb 27 18:45:40	118.9	Accepted
257544000	SIEM *SAPPHIRE*	Transit	9.9	2021 Mar 1 05:41:49	108.7	Accepted
257544000	SIEM *SAPPHIRE*	Transit	8.6	2021 Mar 3 21:48:03	120.6	Accepted
257662000	SIEM *AQUAMARINE*	Transit	8.2	2021 Mar 8 05:01:58	120.1	Accepted
257662000	SIEM *AQUAMARINE*	Transit	9.4	2021 Mar 10 21:56:02	35.3	Accepted
257709000	SIEM *TOPAZ*	Transit	6.6	2021 Mar 13 00:22:58	118.7	Accepted
257544000	SIEM *SAPPHIRE*	Transit	8.7	2021 Mar17 12:14:59	124.8	Accepted
257662000	SIEM *AQUAMARINE*	Transit	10.1	2021 Mar 21 06:29:56	144.5	Accepted
257662000	SIEM *AQUAMARINE*	Transit	11.1	2021 Mar 23 09:51:01	131.0	Accepted

4.2.4. Fit Equations

For each minute of data at each station, the analysis provided the range and received sound levels, with the metric of interest being SPL. To be able to understand the trends of the change in sound levels with range, and to interpolate the sound levels in between the measurement locations, it is required to obtain equations which represent the measurement data. The data were fit using linear models from 'R' (R Core Team 2020) of the form:

$$\text{model} = lm(\text{SPL} \sim \log(range) + range)\,. \tag{5}$$

The tilde (~) is used to separate the left- and right-hand sides in a model formula. The models provide the following values that fit the data:

- An intercept,
- Coefficients multiplied by log10(range), and
- Range.

The coefficient of log10(range) may be interpreted as the average geometric spreading for the environment. The coefficient of range may be interpreted as an additional loss term that models the effects of reflection and scattering when the sound interacts with the surface and seabed. This simple model formulation is valid when:

- There are no systematic changes to the geometric spreading–i.e., it is not valid very close to the Ocean Onyx and associated vessel movements within the 500 m zone where DP is required,
- The seabed geoacoustic properties are approximately constant, and
- The water depth does not significantly vary.

The models were used to predict the most likely data values for ranges of 20 to 6000 m, as well as the 90% prediction interval. The top of the prediction interval corresponds to the value that is greater than 95% of the measured data. The distance to 95% of the measured data is not the same as the $R_{95\%}$ range determined through modelling.

The coefficient of determination (r2) was used to assess the validity of the fit, with fits where r2 was less than 0.85 being flagged as suspect.

The per-minute SPL at each station was influenced by both the operations centred on the Ocean Onyx and sound sources close to each station. To create a model which focuses on understanding the trends of the change in sound level with range in relation to activities closes to Station 1, the data was split into three different sets. The data was therefore presented in the following ways:

- All per-minute SPL data from Station 1–3 while the Ocean Onyx was operational (01:00 12 Feb through until 00:00 25 Mar)
- Per-minute SPL data for per-minute SPL at Station 1 between 130 and 150 dB re 1µPa, thereby excluding periods when high noise levels, likely due to a close support vessel, or support vessels operating at high thrust levels which might skew the fit.
- Per-minute SPL data for per-minute SPL at Station 1 over 150 dB re 1µPa, to examine the trends in change in sound level with range for notably loud period at Station 1.
- The low-frequency weighted per-minute SPL can be adjusted by $10*\log_{10}(T)$, where T is 1440 (the number of minutes in 24 h) to determine the daily SEL for each of the three data sets.

4.2.5. Vessel Noise Detection

Outside of the specific individual vessel analysis requirements, vessels are detected in two steps (Martin 2013):

1. Detect constant, narrowband tones produced by a vessel's propulsion system and other rotating machinery (Arveson and Vendittis 2000). These sounds are also referred to as tonals. We detect the tonals as lines in a 0.125 Hz resolution spectrogram of the data (8 s of data, Hann window, 2 s advance).
2. Assess the SPL for each minute in the 40–315 Hz shipping frequency band, which commonly contains most sound energy produced by mid-sized to large vessels. Background estimates of the shipping band SPL and system-weighted SPL are then compared to their mean values over a 12 h window, centred on the current time.

Vessel detections are defined by the following criterion (Figure 15):

1. SPL in the shipping band (40–315 Hz) is at least 3 dB above the 12 h mean for the shipping band for at least 5 min.
2. AND at least three shipping tonals (0.125 Hz bandwidth) are present for at least 1 min per 5 min window. Tonals are difficult to detect during turns and near the closest points of approach (CPA) due to Lloyds' mirror and Doppler effects.
3. AND SPL in the shipping band is within 12 dB of the system weighted SPL.

The duration where these constraints are valid is identified as a period with shipping present. A 10 min shoulder period before and after the detection period is also included in the shipping period. The shipping period is searched for the highest 1 min SPL in the vessel detection band, which is then identified as the CPA time. This algorithm is designed to find detectable shipping, meaning situations where the vessel noise can be distinguished from the background. It does not identify cases of two vessels moving together or cases of continuous noise from stationary platforms, such as oil and gas drilling and dynamic positioning operations. Those situations are easily identified from tools such as the daily SEL and long-term spectral average figures.

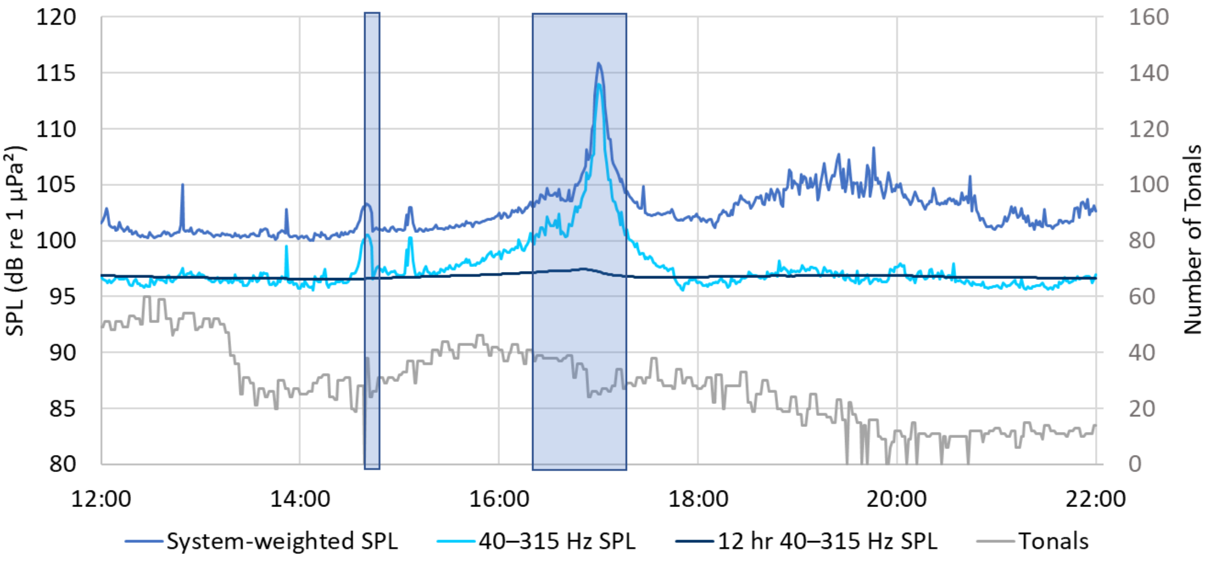


Figure 15. Example of broadband and 40–315 Hz band sound pressure level (SPL), as well as the number of tonals detected per minute as a vessel approached a recorder, stopped, and then departed. The shaded area is the period of shipping detection. Fewer tonals are detected at the vessel's closest point of approach (CPA) at 17:00 because of masking by broadband cavitation noise and due to Doppler shift, that affects the tone frequencies.

4.2.6. Seismic Survey Event Detection

Seismic pulse sequences were looked for using correlated spectrogram contours. The processing calculated spectrograms using a 300 s long window with 4 Hz frequency resolution and a 0.05 s time resolution (Reisz window). All frequency bins were normalised by their medians over window the 300 s window. The detection threshold was set to three times the median value at each frequency. If pulses were found, contours were created by joining the time-frequency bins above threshold in the 7–1000 Hz band using a 5 × 5 bin kernel. Contours 0.2–6 s in duration with a bandwidth of at least 60 Hz are then further analysed.

The process is used to create an “event” time series by summing the normalised value of the frequency bins in each time step that contained detected contours. The event time series is auto correlated to look for repeated events. The correlated data space was normalised by its median, and a detection threshold of 3 was applied. Peaks larger than their two nearest neighbours can be identified, and the list of peaks searched for entries with a set repetition interval. The allowed spacing between the minimum and maximum time peaks was 4.8–65 s, which captures the normal range of seismic pulse periods. If at least six regularly spaced peaks occur, the original event time series is searched for all peaks that match the repetition period within a tolerance of 0.25 s. The duration of the 90% SPL window of each peak can be determined from the originally sampled time series, and pulses more than three second long were rejected.

Despite the flexibility of the detection process, no impulses were detected, and thus no results are presented for seismic survey impulses.

4.2.7. Marine Mammal Detection Overview

We used a combination of automated detector-classifiers (referred to as automated detectors) and manual review by experienced analysts to determine the presence of sounds produced by marine mammals in the acoustic data. First, a suite of automated detectors was applied to the full data set (Appendices D.1 and D.2). Second, a subset (0.5%) of acoustic data was selected for manual analysis of marine mammal acoustic occurrence. The subset was selected based on automated detector results via our Automatic Data Selection for Validation (ADSV) algorithm (Kowarski et al. 2021) (Appendix D.3). Third, manual analysis results were compared to automated detector results to determine automated detector performance (Appendix D.4). Finally, hourly marine mammal occurrence plots were created that incorporated both manual and automated detections as well as automated detector performance metrics to provide a reliable representation of marine mammal presence in the acoustic data (Section 5.7). These marine mammal analysis steps are summarised here and described in detail in Appendix D.

4.2.7.1. Automated Click Detection

Odontocete clicks are high-frequency impulses ranging from 5 to over 150 kHz (Au et al. 1999, Møhl et al. 2000). We applied an automated click detector to the acoustic data to identify clicks from sperm whales and delphinids. This automated detector is based on zero-crossings in the acoustic time series. Zero-crossings are the rapid oscillations of a click’s pressure waveform above and below the signal’s normal level (e.g., Figure D-1). Zero-crossing-based features of automatically detected events are then compared to templates of known clicks for classification (see Appendix D.1 for details).

4.2.7.2. Automated Tonal Signal Detection

Tonal signals are narrowband, often frequency-modulated, signals produced by many species across a range of taxa (e.g., baleen whale moans and delphinids whistles). They range predominantly between 15 Hz and 20 kHz (Steiner 1981, Berchok et al. 2006, Risch et al. 2007). The automated tonal signal detector identified continuous contours of elevated energy and classified them against a library of marine mammal signals (see Appendix D.2 for details).

4.2.7.3. Evaluating Automated Detector Performance

JASCO's suite of automated detectors are developed, trained, and tested to be as reliable and broadly applicable as possible. However, the performance of marine mammal automated detectors varies across acoustic environments (e.g., Hodge et al. 2015, Širović et al. 2015, Erbs et al. 2017, Delarue et al. 2018). Therefore, automated detector results must always be supplemented by some level of manual review to evaluate automated detector performance. Here, we manually analysed a subset of 5 min acoustic files for the presence/absence of marine mammal acoustic signals via spectrogram review in JASCO's PAMlab software. A subset (0.5%) of acoustic data from each station was selected via ADSV for manual review (Appendix D.3).

To determine the performance of the automated detectors at each station per 5 min acoustic file, the automated and manual results (excluding files where an analyst indicated uncertainty in species occurrence) were fed into an algorithm that calculates precision (*P*), recall (*R*), and Matthew's Correlation Coefficient (*MCC*) (see Appendix D.4 for formulas). *P* represents the proportion of files with detections that are true positives. A *P* value of 0.90 means that 90% of the files with automated detections truly contain the targeted signal, but it does not indicate whether all files containing acoustic signals from the species were identified. *R* represents the proportion of files containing the signal of interest that were identified by the automated detector. An *R* value of 0.90 means that 90% of files known to contain a target signal had automated detections, but it says nothing about how many files with automated detections were incorrect. An MCC is a combined measure of *P* and *R*, where an MCC of 1.00 indicates perfect performance–all events were correctly detected. The algorithm determines a per file automated detector threshold (the number of automated detections per file at and above which automated detections were considered valid) that maximizes the MCC.

The acoustic occurrence of each species (both automated and manual results) was plotted using JASCO's Ark software as time series showing presence/absence by hour over each day of the recording period. Automated detector performance metrics are provided alongside these figures and should be considered wen interpreting results.

4.3. Modelling Validation

In order to validate the modelled predictions presented in Koessler et al. (2020), the calculated Monopole Source Levels (MSLs), which were computed from measured data using the method outlined in Section 4.2.3, were used to update the acoustic model inputs for the scenarios from Koessler et al. (2020). This process yielded new ranges to thresholds based on in-situ measured data. Only the scenarios for Artisan (i.e., Scenario 5 – 8 in Koessler et al. (2020)) were consider for a validation exercise.

The following process was implemented for updating the inputs to the acoustic model.

1. Update the sound speed profile to use predictions from the Global Ice Ocean Prediction System (GIOPS) forecasting system for the period when the data was acquired. Determine and median profile to best represent potential propagation conditions over the February 2021 – March 2021 periods.
2. Update the decidecade MSLs and MSL source depth based on the results of the ShipSound analysis presented in Section 5.5.
3. Re-run all propagation modelling, gridding and radii calculations as detailed in Koessler et al. (2020) with these updated input parameters for all scenarios.

During this process, the data fit plots discussed in Section 4.2.4 and presented Section 5.3 were reviewed in the context of results from previous modelled scenarios and newly acquired MSLs to infer the appropriateness of the seabed selection for the Artisan development area and its effect on the distances to thresholds. Further detail can be found in Section 6.2.

5. Results

5.1. Soundscape Characterisation

Long-term spectra averages, power spectral density, and decidecade band box plots are shown in Figure 16 for all stations during the period the *Ocean Onyx* was moored (01:00 12 Feb through 00:00 25 Mar 2021), with the decade band percentile levels presented in Table 10.

The same plots are presented for two examples of operational activity at the *Ocean Onyx* (Table 8), Figure 17, from 5 Mar 2021, which included resupply and drilling operations, and Figure 18, from 26 Feb 2021, for a drilling operations with support vessels further from the *Ocean Onyx*.

5.1.1. Spectrograms and Statistical Analysis

The spectrogram and band-level plots for all stations (Figure 16) provide an overview of the sound variability in time and frequency presenting an overview of presence and level of contribution from different sources. Short-term events appear as vertical stripes on the spectrograms and spikes on the band level plots. Long-term events affect (increasing or decreasing accordingly) the band level over the event period and appear in the spectrograms as horizontal bands of colour.

The most prominent feature to note is the decrease in sound level with distance from the drill rig. Stations 1 and 2, located 336 m and 1132 m from the platform respectively, demonstrate elevated sound levels across all frequencies, but particularly at frequencies under approximately 2000 Hz. This is consistent with the bands most typically impacted by seismic and pressure fluctuations, as well as vessel noise, as can be seen in the Wenz curves of Figure 9. At these two stations, the L_{50} and above, as well as the L_{mean} percentiles exceed the upper limit of the Wenz curve across all frequencies. At Stations 3 and 4, located 5 km and 25 km from the platform respectively, the sound levels are much reduced. Station 3 still receives some sound energy emitted from the platform and associated operations, whereas these contributions are not notable within Station 4's soundscape, as can be seen in the two right side panels of Figure 16. The soundscape of these two stations is more influenced by vessel traffic, apparent by the 'ripples' in the L_{mean} percentiles between 40 and approximately 100 Hz, which are due to narrowband tones produced by vessel propulsion systems.

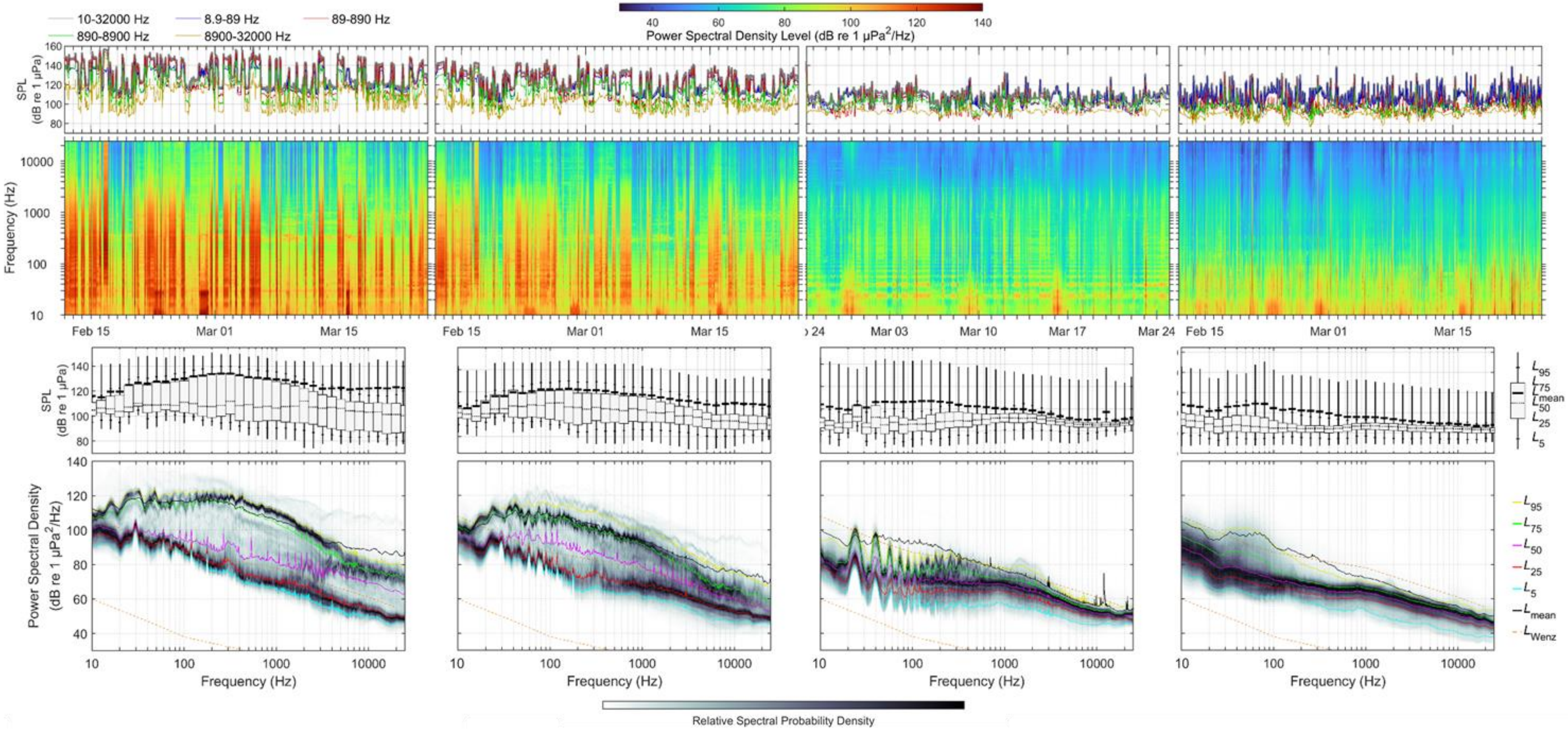


Figure 16. *Entire Ocean Onyx moored period*: (Top row) In-band sound pressure level (SPL) and spectrogram (or long-term spectral average; LTSA) of underwater sound, (bottom row) percentiles and mean of decidecade sound pressure level (SPL) and percentiles and probability density (grayscale) of 1-min power spectral density levels, by station compared to the Wenz curve limits (coloured lines) of prevailing noise (Wenz 1962), for 01:00 12 Feb through until 00:00 25 Mar, for Stations 1, 2 and 4, or from 12:00 24 Feb for Station 3.

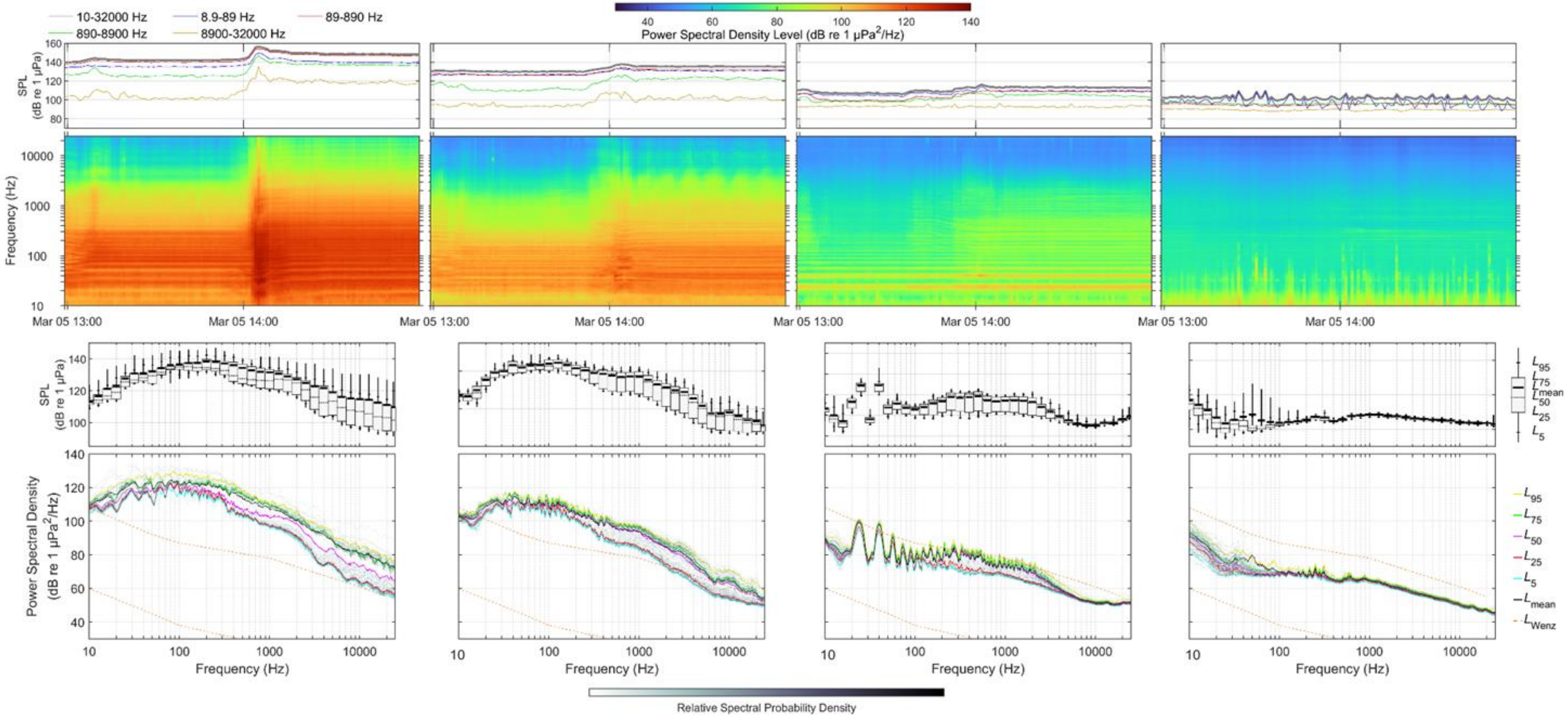


Figure 17. *Drilling and vessel operation 5 Mar 2021*: (Top row) In-band sound pressure level (SPL) and spectrogram (or long-term spectral average; LTSA) of underwater sound, (bottom row) percentiles and mean of decidecade sound pressure level (SPL) and percentiles and probability density (grayscale) of 1-min power spectral density levels, by station for a drilling period on 5 Mar 2021 (Table 8) which included resupply and support vessels, compared to the Wenz curve limits (coloured lines) of prevailing noise (Wenz 1962).

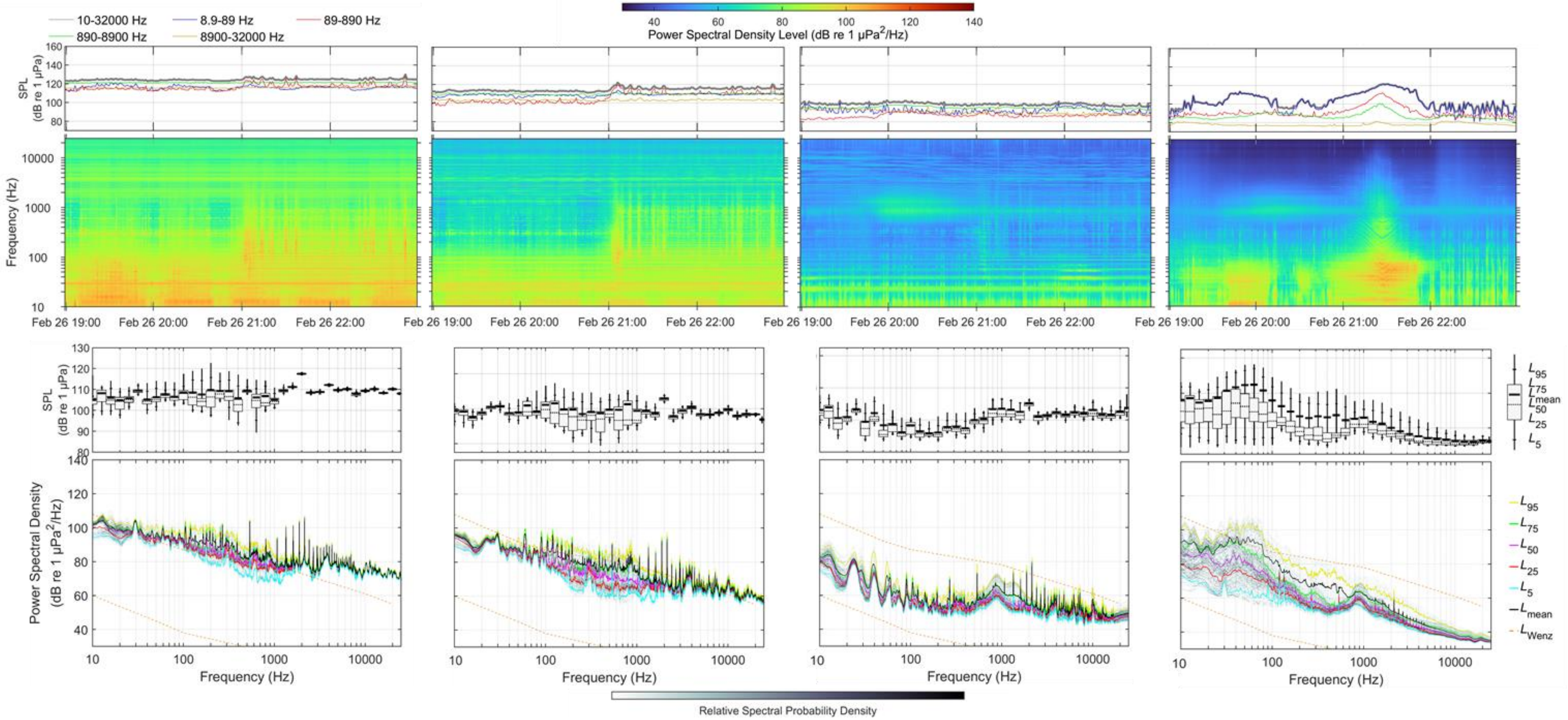


Figure 18. *Drilling operations 26 Feb 2021*: (Top row) In-band sound pressure level (SPL) and spectrogram (or long-term spectral average; LTSA) of underwater sound, (bottom row) percentiles and mean of decidecade sound pressure level (SPL) and percentiles and probability density (grayscale) of 1-min power spectral density levels, by station for a drilling period on 5 Mar 2021 compared to the Wenz curve limits (coloured lines) of prevailing noise (Wenz 1962).

Table 10. Statistical a0nalysis of sound levels while *Ocean Onyx* was moored, 01:00 12 Feb through until 00:00 25 Mar 2021, for Stations 1, 2, and 4, or from 12:00 24 Feb 2021 for Station 3. SPL units: dB re 1 µPa.

Sound level statistic	Station	Sound level				
		10–32000 Hz	8.9–89 Hz	89–890 Hz	890–8900 Hz	8900–32000 Hz
Minimum	1	107.6	105.1	102.2	92.5	85.5
	2	101.1	98.5	92.6	83.1	82.2
	3	91.9	83.5	80.1	82.6	84.4
	4	86.6	79.3	80.2	80.9	77.2
L_5	1	112.9	110.7	106.7	98.1	90.7
	2	107	105.1	98.4	94.5	89.5
	3	97.5	89.4	87.6	91.5	89
	4	96.3	88.4	87.3	86.4	82
L_{25}	1	117.1	114.2	110.6	103.7	94.3
	2	112	109.1	104.1	101.9	93.5
	3	102.1	94.4	94.1	96.8	92
	4	101.1	95.5	92.6	92.6	87.7
L_{50}	1	124.6	118.3	119.7	119.3	109.6
	2	121.3	116.2	117.4	110.7	99.5
	3	106.4	101.3	99.2	100.2	93.7
	4	104.5	101.8	95.9	96.2	90.9
L_{75}	1	143.8	135.4	142.4	132.6	117.2
	2	132.1	127.8	129.5	119.9	105.8
	3	111.3	107.8	105.7	103.5	95
	4	110.1	109.2	99.1	98.7	93.1
L_{95}	1	149	139.4	147.8	139.8	124.3
	2	141.3	133.6	138.9	130.2	114.1
	3	115.8	111.8	111.3	110.2	98.8
	4	120.7	120	109.8	102	98.2
Maximum	1	159	155	156.5	152.6	151.3
	2	158.6	154.2	156.2	147.9	139.3
	3	153.4	150	150.4	139.8	137.4
	4	153.6	153.1	145.1	138.6	128.6
Mean	1	144	135.5	142.3	135.7	129.6
	2	133.4	127.5	131.3	123.6	116
	3	117.8	114	114.8	106.8	99.9
	4	118.3	117	111.7	103.2	95.1

5.1.2. Frequency Weighted Sound Exposure Levels

The perception of underwater sound depends on the hearing sensitivity of the receiving animal in the frequency bands of the sound. Hearing sensitivity in animals, however, varies over the frequency band of their hearing (the hearing curve (audiogram) usually resembling a U-shaped form). The frequency range of hearing and hearing sensitivity differ between species, resulting in the fact that different species will perceive underwater sound differently. Auditory (frequency) weighting functions (Appendix E) are applied to account for this difference as they reflect an animal's ability to hear a sound, emphasising the frequency band of best sensitivity over frequencies animals do not hear well. Figure 19 shows the difference between perceived ambient noise by low-, mid- and high frequency cetaceans. Similar to the figures in Section 5.1.1, Figure 19 demonstrates the decrease in sound levels with distance from the drilling platform. Station 4 is more exposed to general shipping traffic within the shipping lanes when compared to Station 3 (Figure 3), and thus its daily SEL were more variable, being less influenced or driven by activity close to the *Ocean Onyx* more by the frequency of shipping traffic. The low-frequency cetacean weighted daily SEL for all stations, along with the thresholds for PTS and TTS (Section 2.6) are shown in Figure 20.

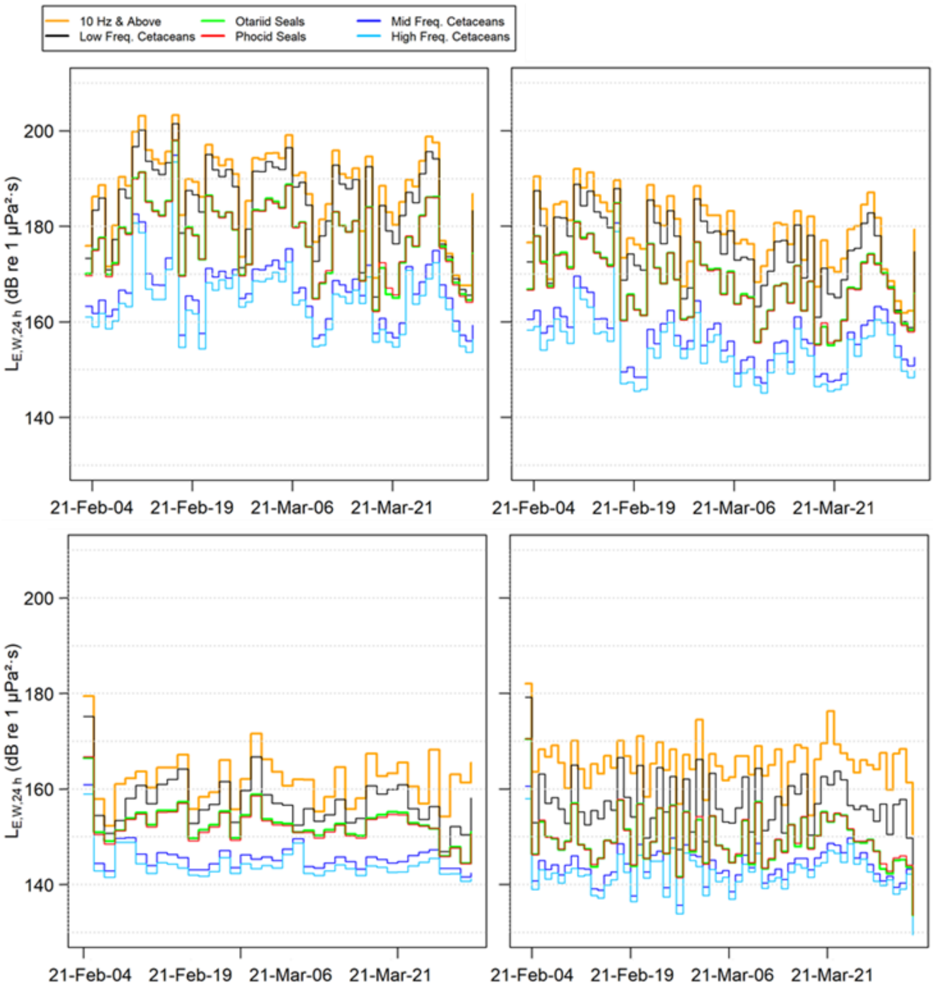


Figure 19. Auditory frequency weighted ambient noise (10 Hz and above) over the measurement period shown as daily sound exposure levels (SEL) (NMFS 2018). (Top left to right) Stations 1 and 2 and (bottom left to right) Stations 3 and 4. Locations are provided in Table 4.

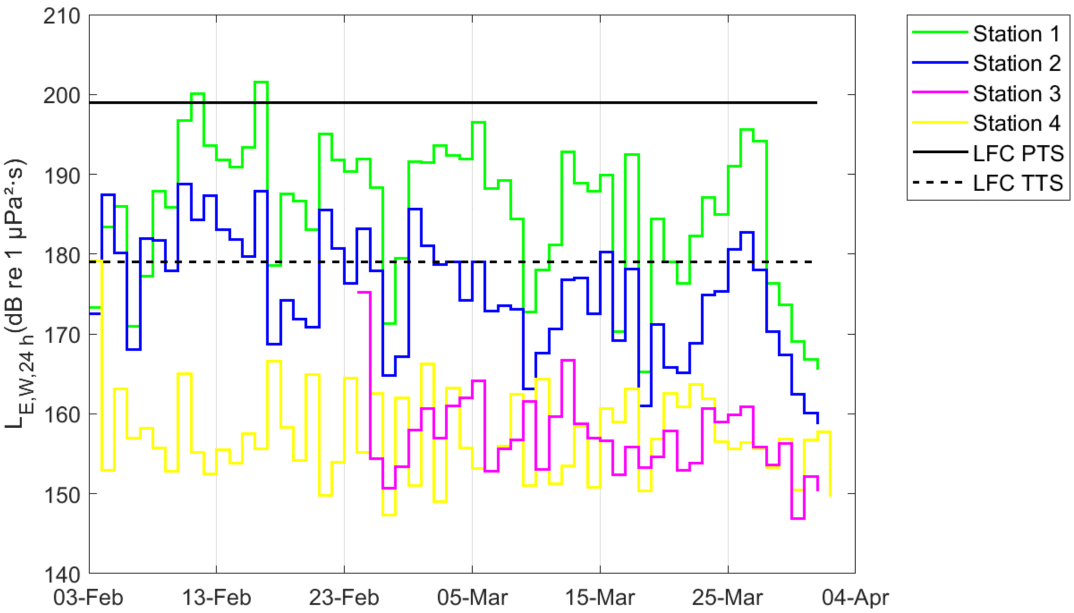


Figure 20. Daily low-frequency cetacean (LFC) weighted sound exposure levels (SEL) (NMFS 2018) at each station (composite created from Figure 19, station locations provided in Table 4), including thresholds for permanent threshold shift (PTS) and temporary threshold shift (TTS) (Table 6).

5.2. Environmental Correlations

The environmental conditions during the drilling period, specifically the wave height and wind speed, were compared to sound pressure levels during the drilling period in the 20 Hz, 80 Hz, 630 Hz, 3150 Hz, and 125000 Hz decidecade bands in the correlograms in Figure 21. Correlograms offer two ways to visualise correlations between two variables: the upper right panels show the scatter plot between each variable pair, and the bottom left show the strength of the correlation both by amount of the circle filled and depth of the colour. Blue represents a positive correlation, and red a negative. The four panels show Stations 1 to 4, respectively. The impact of wind and wave conditions on underwater soundscape is generally above 100 Hz, as shown in Figure 9 (Wenz 1962).

Stations 1 and 2, at 336 and 1132 m from the drill rig respectively, show very little correlation of sound level at any band with wind or wave conditions. At these stations, the soundscape was dominated by drilling operations. As the distance to the station increases, i.e., for Stations 3 and 4 at 5 and 25 km, the wind speeds and wave heights have a positive correlation with sound levels, although the relationship with wind speed is much stronger than that for wave height.

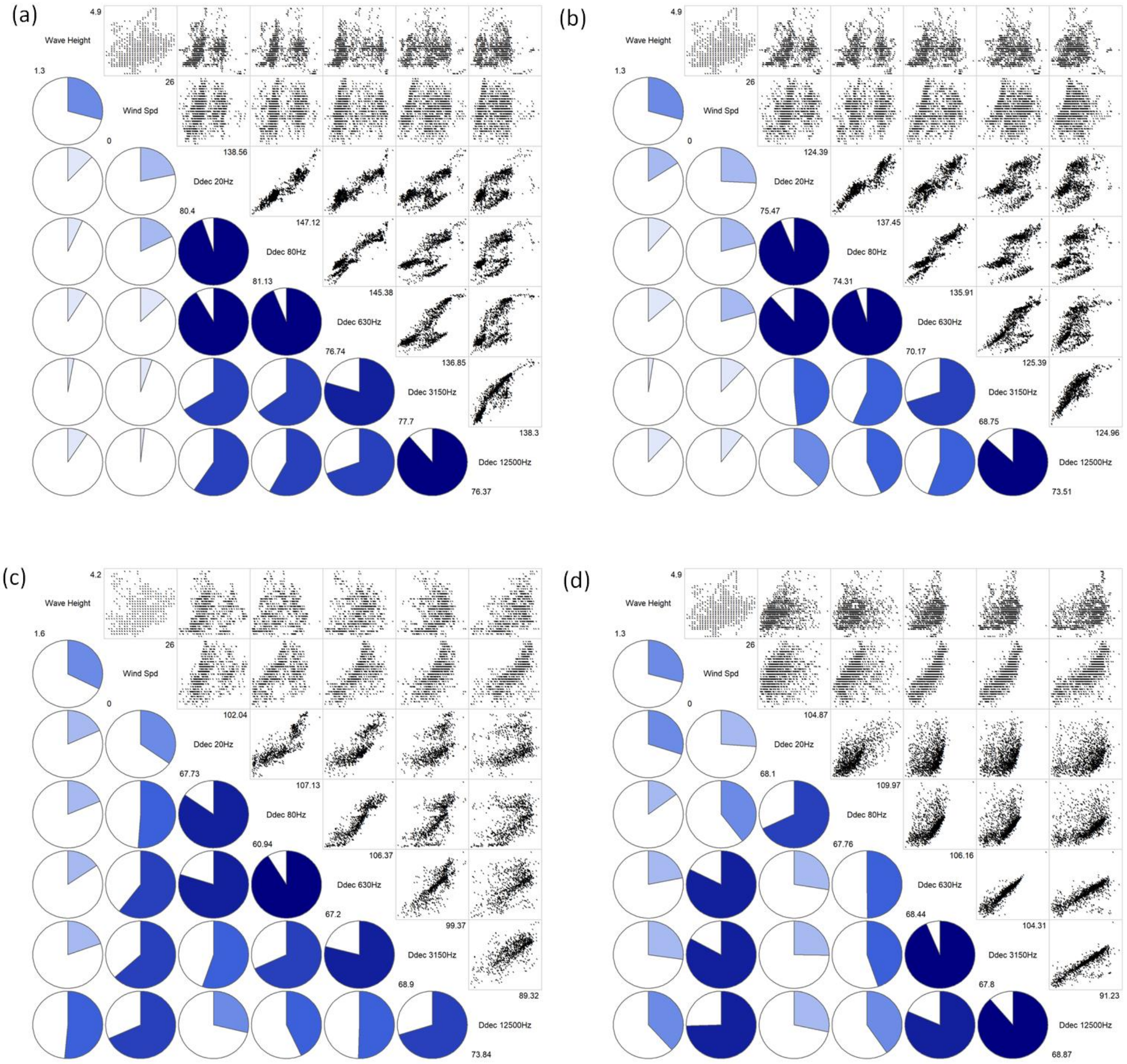


Figure 21. Correlogram comparing weather conditions to sound levels in five specified decidecade bands for (a) Station 1 at 300 m; (b) Station 2 at 1 km; (c) Station 3 at 5 km; and (d) Station 4 channel 1 at 25 km.

5.3. Data Fits

The per-minute SPL data from Station 1–3 while the Ocean Onyx was moored (01:00 12 Feb through until 00:00 25 Mar 2021) was analysed according to the methods detailed in Section 4.2.4, with the results presented in Figures 22 and 23. These fits were used to gain an understanding of the propagation loss environment, and to complete the validation analysis (Section 4.3), as discussed in Section 6.2.

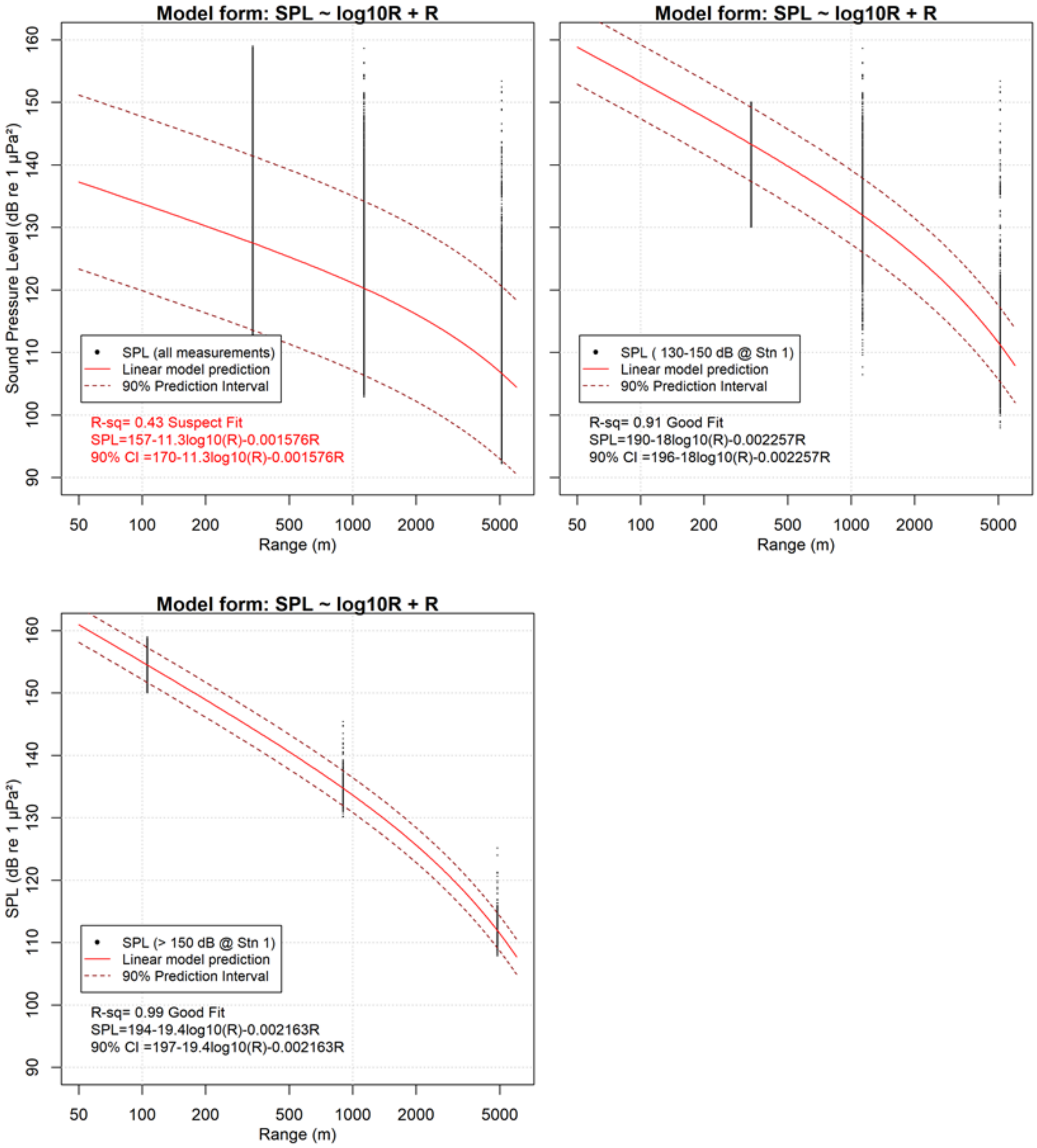


Figure 22. Per-minute sound pressure level (SPL) plotted against range for Stations 1–3, for the entire period the *Ocean Onyx* is present (top-left), levels at Station 1 between 130 and 150 dB re 1µPa (top-right), and levels at Station 1 above 150 dB re 1µPa (bottom-left).

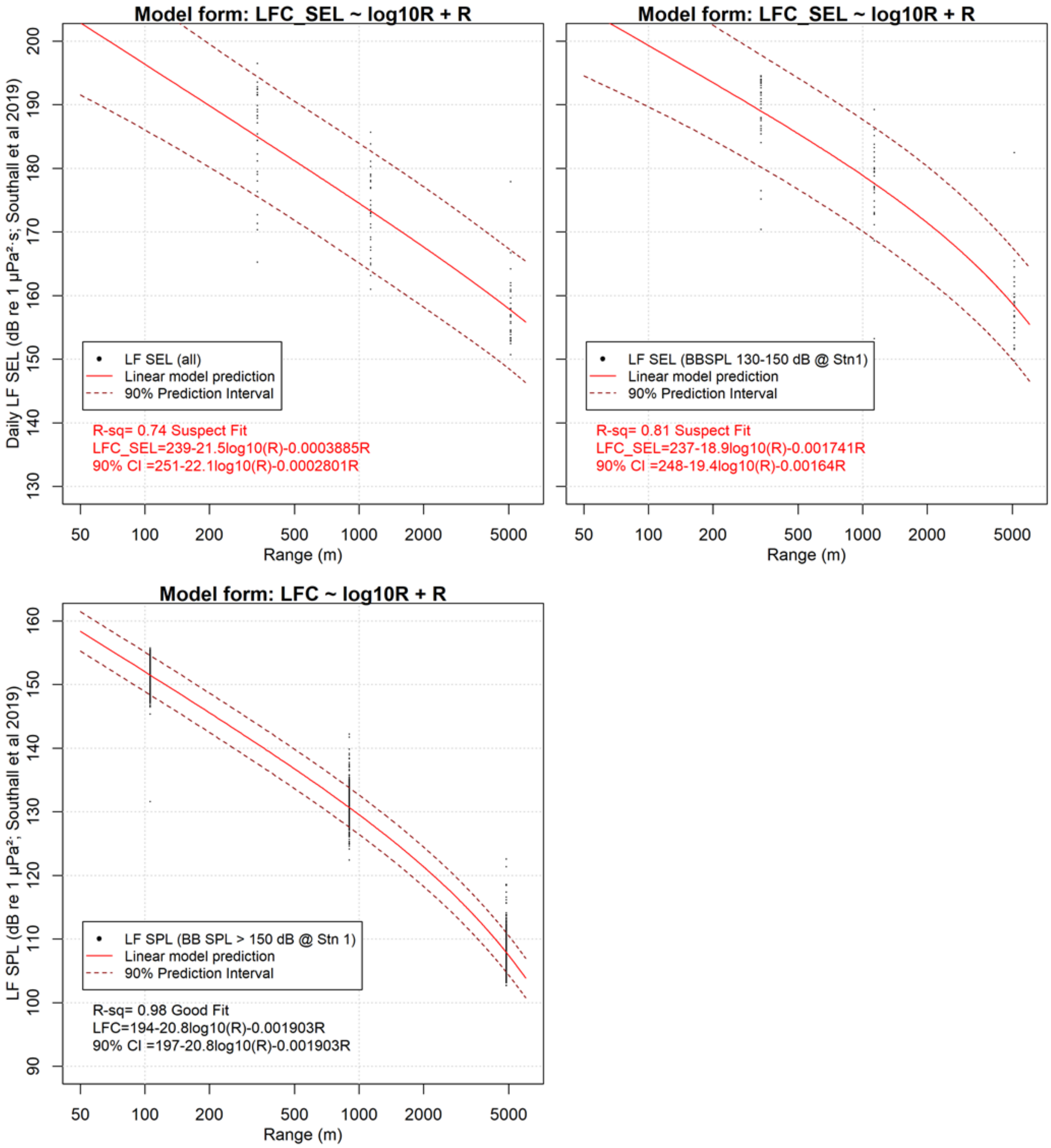


Figure 23. Daily low-frequency cetacean weighted sound exposure level (SEL) (calculated from frequency weighted per-minute sound pressure level (SPL)) plotted against range for Stations 1–3, for the entire period the *Ocean Onyx* is present (top-left), levels at Station 1 between 130 and 150 dB re 1µPa (top-right), and levels at Station 1 above 150 dB re 1µPa (bottom-left).

5.4. Drilling Operations

A detailed analysis was undertaken on two file snippets from Station 1, focused on correlating the acoustic signals to the drilling logs, and providing details on some of the signals observed in the acoustic data.

5.4.1. Snippet 1

A snippet of data from Station 1 for 22 Feb 2021 from 14:14:37 was examined to look for alignment between the acoustic data and the drilling logs to provide a detailed insight into the noise producing sources. The drilling log for this period stated:

> Continued drilling 26" x 42" hole from 115m to 171m (SectionTD). Several small stringers encountered at 140m and 157m. Pumped 100bbl PHG sweep and took MWD survey at connection. Survey @ 135mMDRT: 0.5deg inc.
>
> Parameters: 60rpm, 3-5kft-lb tq, 10klbs WOB, 800-1,100gpm, 400-550psi SPP

The spectrogram of the entire wav file is shown in Figure 24, with a shorter timescale and more focused frequency range shown in Figure 25, both showing components above 10 Hz only. In this data, drilling tonals with a spacing of 155 Hz were identified (Figure 26), and the analysis of the very low frequency tonals (Figure 27) clearly shows a 1 Hz tonal, which aligns with the 60 rpm drilling speed in the logs. A steady state pump operating at centre frequencies of 2992 Hz and 3062 Hz, with a strong correlation to high frequency harmonics (Figure 28). In this snippet there were three unstable narrowband noise sources present which are likely due to the drilling operations. This is considered likely due to their harmonic spacing under varying loads of operations. Tonals indicate that something, potentially the drill bit or the main aperture rod, is rotating between 52 and 74 RPM. This appears unrelated to the steady state pumps, which are likely high pressure pumps that fluctuate very little over time or load. During this recording, a vessel was also present although it did not appear to be operating under DP.

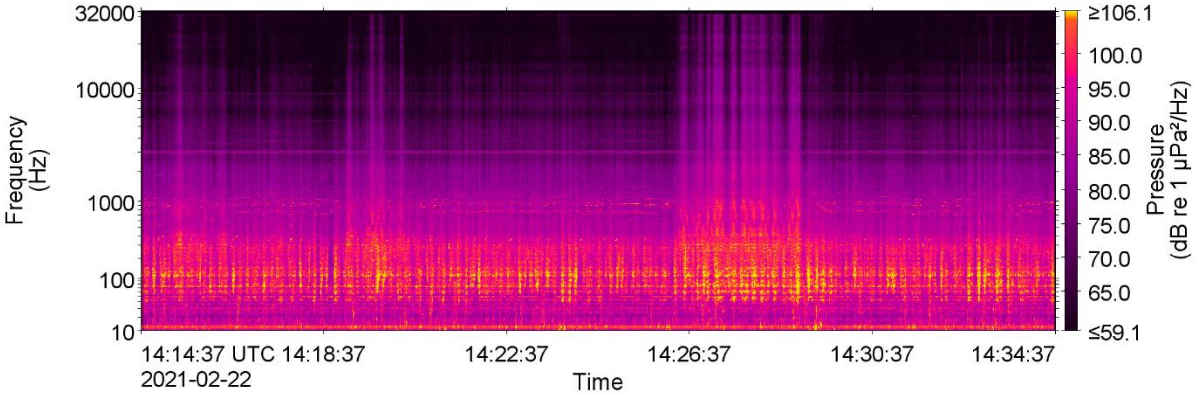


Figure 24. Spectrogram of 20 minutes of drilling operations on 22 Feb 2021 from 14:14:37 at Station 1(0.2 Hz frequency resolution, 1 s time window, 0.5 s time step, Hamming window).

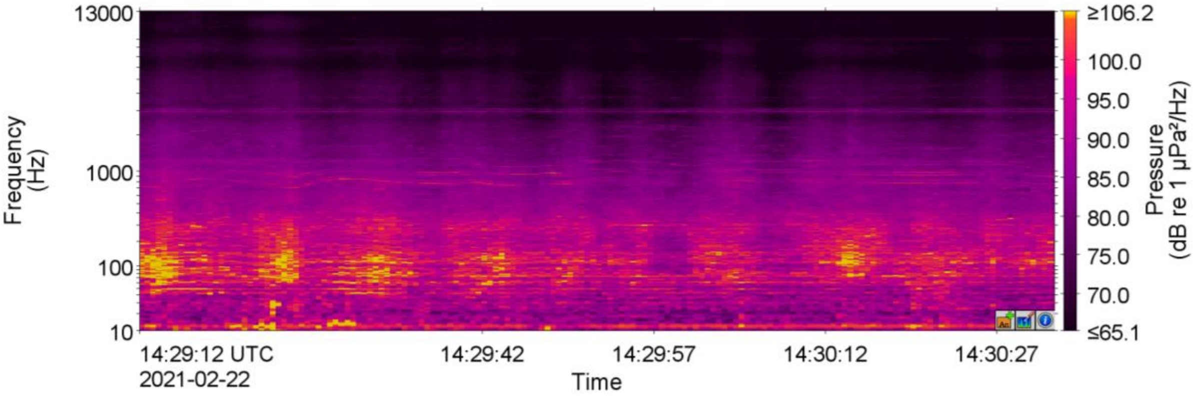


Figure 25. Spectrogram of 80 s minutes of drilling operations on 22 Feb 2021 from 14:29:12 at Station 1(0.2 Hz frequency resolution, 1 s time window, 0.5 s time step, Hamming window).

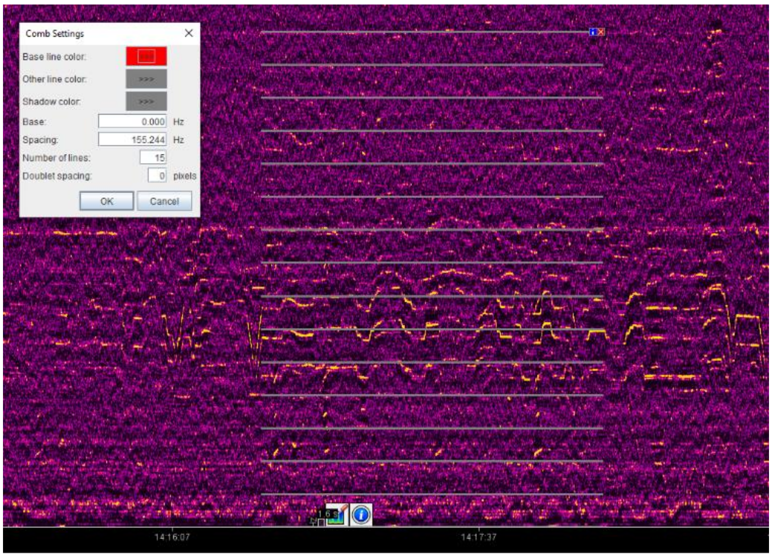

Comb Settings
Base line color: >>>
Other line color: >>>
Shadow color: >>>
Base: 0.000 Hz
Spacing: 155.244 Hz
Number of lines: 15
Doublet spacing: 0 pixels

Figure 26. Drilling tonals, spaced at 155 Hz

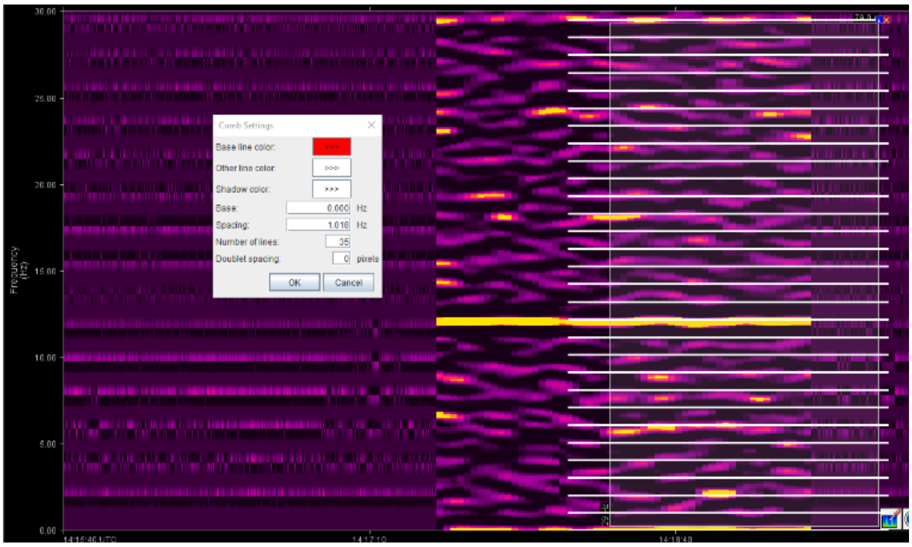
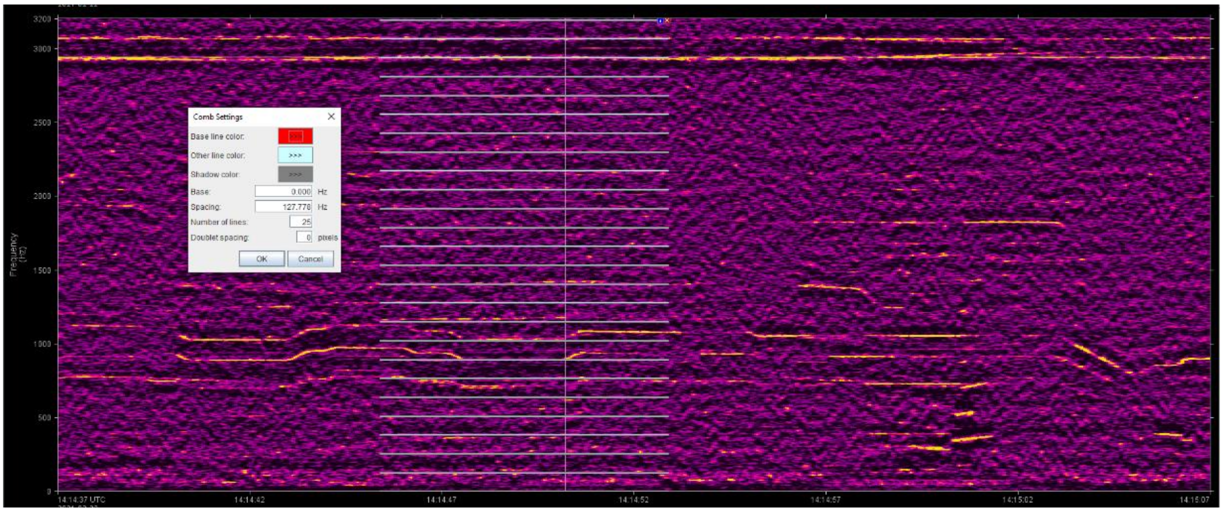

Comb Settings
Base line color: >>>
Other line color: >>>
Shadow color: >>>
Base: 0.000 Hz
Spacing: 1.016 Hz
Number of lines: 35
Doublet spacing: 0 pixels

Figure 27. Very low frequency tonal analysis correlates with 60 rpm drilling speed


Comb Settings

Base line color: >>>

Other line color: >>>

Shadow color: >>>

Base: 0.000 Hz

Spacing: 127.778 Hz

Number of lines: 25

Doublet spacing: 0 pixels

Figure 28. Example of correlation between harmonics and load on main pump with centre frequencies of 2992 and 3062 Hz. The example also shows the diesel generators with engine firings rates fluctuating between 149 and 152 Hz while under hotel load from *Ocean Onyx*.

5.4.2. Snippet 2

A snippet of data from Station 1 for 08 Mar 2021 from 18:14:40 was examined to look for alignment between the acoustic data and the drilling logs to provide a detailed insight into the noise producing sources. The drilling log for this period stated:

> Drilled ahead 12-1/4" hole from 1,433m to 1,545m.
> Parameters:
> Flow: 1,000gpm, Boost Pump-250gpm, SPP: 3,000psi, RPM: 120 surface/217 bit
> Tq: Off 1-2kft-lbs/On 5-10kft-lbs. WOB: 5-15klbs P/U wt: 300klbs, S/O wt: 325klbs, Rot: 315klbs. Average ROP: 18.6m/hr
> ESD: 11.18ppg, ECD: 11.37ppg
> Offline: Displaced the Boost line and flushed the MGS utilising the boost pump
> - total of 20 strokes pumped (10bbls).
> At 1,510m MW over the shakers recorded at 10.7ppg (ESD-10.88ppg).
> Ceased centrifuging and weighted up the mud with additions of barite. MW at 1543m recorded at 11.1ppg.

The spectrogram of the entire wav file is shown in Figure 29, with a shorter timescale and more focused frequency range shown in Figure 30, both showing components above 10 Hz only. In this snippet there is no secondary source, such as a support vessel, present, just the *Ocean Onyx*. The narrowband tonals below 200 Hz indicate that the revolutions-per-minute fluctuate between 178 and 220 rpm, this aligns with data pins 9, 13 and 16 in Figure 31, along with various higher frequency harmonics. A second low-frequency rotating source, with a speed of 120.6 rpm was detected, Figure 32, and it demonstrates no apparent relationship between the 1.63:1 reduction ratio present in the low frequency spectrum to the other source. These frequencies align with information provided in the drill logs.

The data indicates various generator (diesel gensets and pumps) running in multiple configurations. All appear to be running in a steady-state fashion with varying loads, apparent through the fluctuations in frequency. Two distinct gensets are noted in particular as running hotel load, as they are more stable than the others which are likely being used for the *Ocean Onyx* drilling operations, and thus having changing requirements which changes their load. The tone at 3 kHz which is consistent without fluctuation, shown clearly in Figure 34, is probably a high-pressure pump which does not fluctuate with power draw, as no banding (harmonics) are observed, the motor is not a pole motor.

Figure 35 shows three distinct gensets (one tonal each) with accompanying cylinder firing rates throughout the spectrogram. These appear related to *Ocean Onyx* drilling operations as there are no secondary contacts on spectrogram (such as vessels) and the tonals fluctuate with power draw over time.

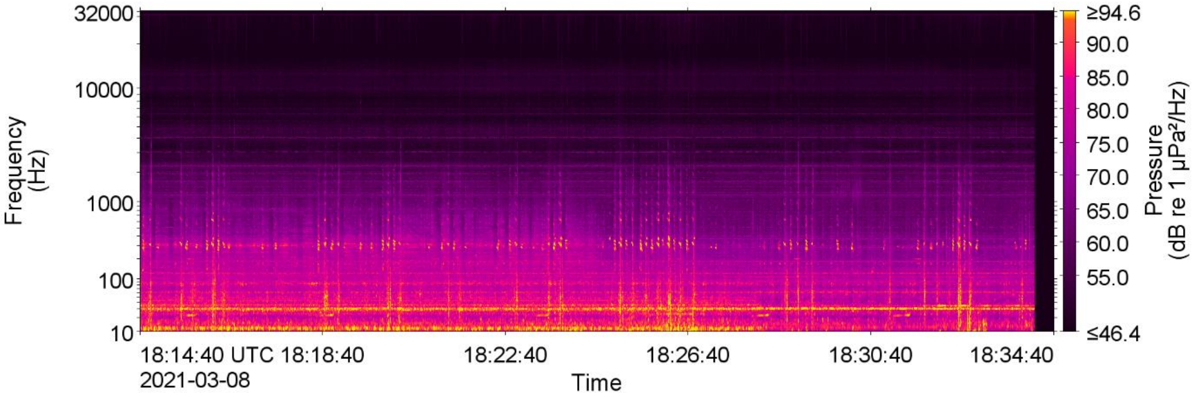


Figure 29. Spectrogram of 20 minutes of drilling operations on 08 Mar 2021 from 18:14:40 at Station 1(0.2 Hz frequency resolution, 1 s time window, 0.5 s time step, Hamming window).

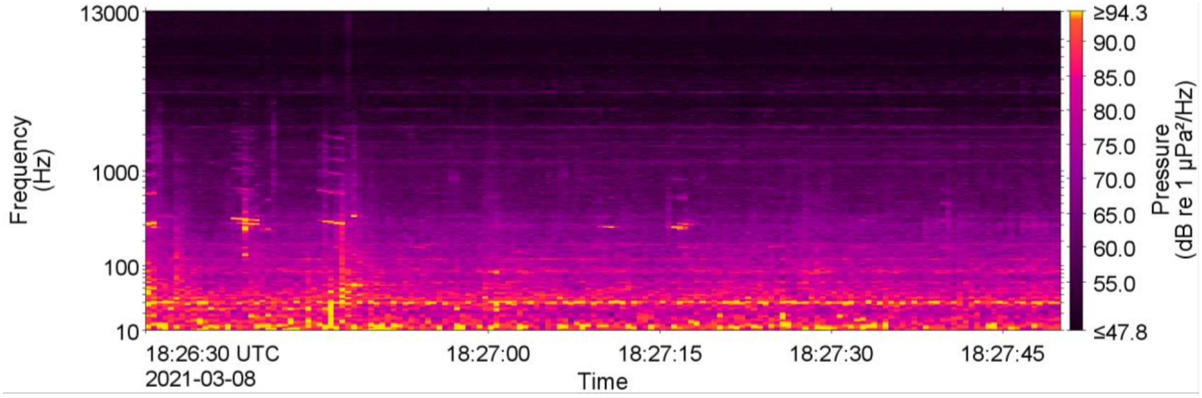
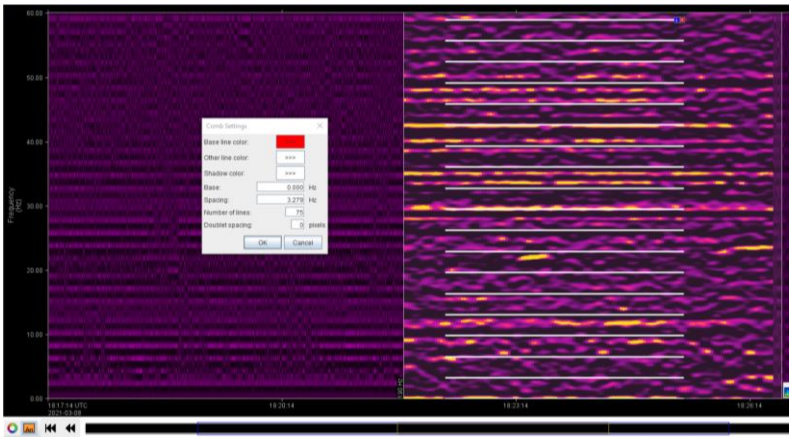
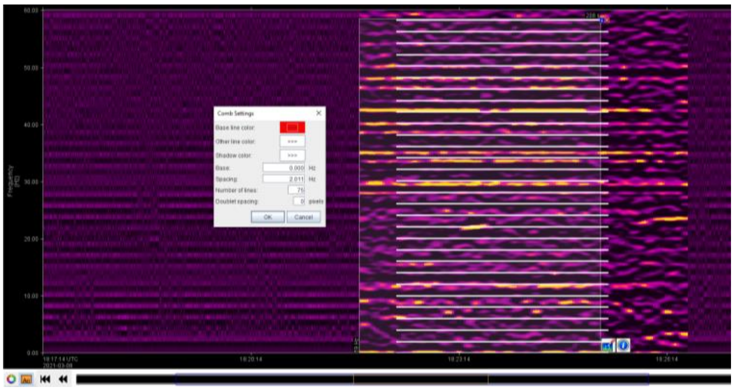


Figure 30. Spectrogram of 80 s of drilling operations on 08 Mar 2021 from 18:26:30 at Station 1(0.2 Hz frequency resolution, 1 s time window, 0.5 s time step, Hamming window).



Base line color:
Other line color: >>>
Shadow color: >>>
Base: 0.000 Hz
Spacing: 3.279 Hz
Number of lines: 75
Doublet spacing: 0 pixels

Figure 31. Low frequency analysis – rotating source contribution from first source.



Comb Settings

Base line color:

Other line color: >>>

Shadow color: >>>

Base: 0.000 Hz

Spacing: 2.011 Hz

Number of lines: 75

Doublet spacing: 0 pixels

OK Cancel

Figure 32. Low frequency analysis – rotating source contribution from second source rotating at 120.6 rpm.

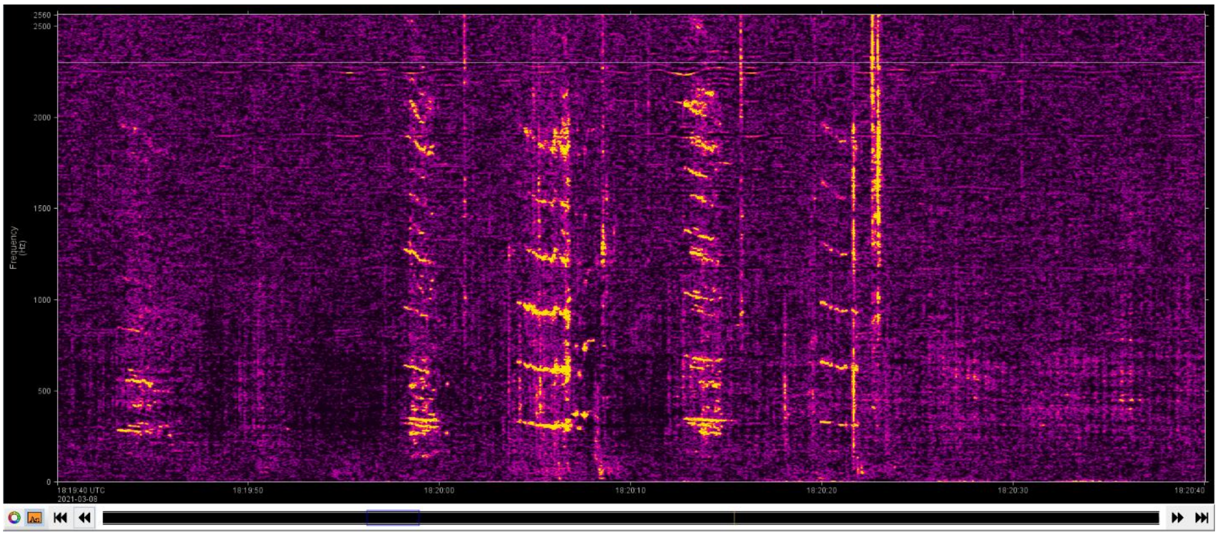
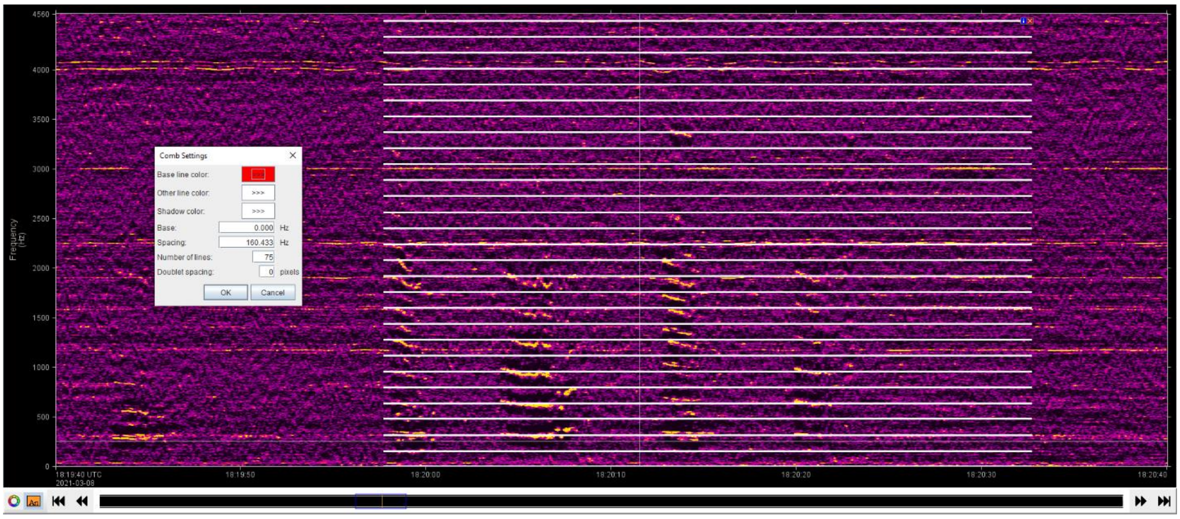


Figure 33. Transient noise from Mobile Offshore Drilling Unit (MODU) due to sea state or other movement on the anchored position (spectrogram normalised across transients).



Comb Settings

Base line color:

Other line color: >>>

Shadow color: >>>

Base: 0.000 Hz

Spacing: 160.433 Hz

Number of lines: 75

Doublet spacing: 0 pixels

OK Cancel

Figure 34. Generator analysis showing hotel load tonals.

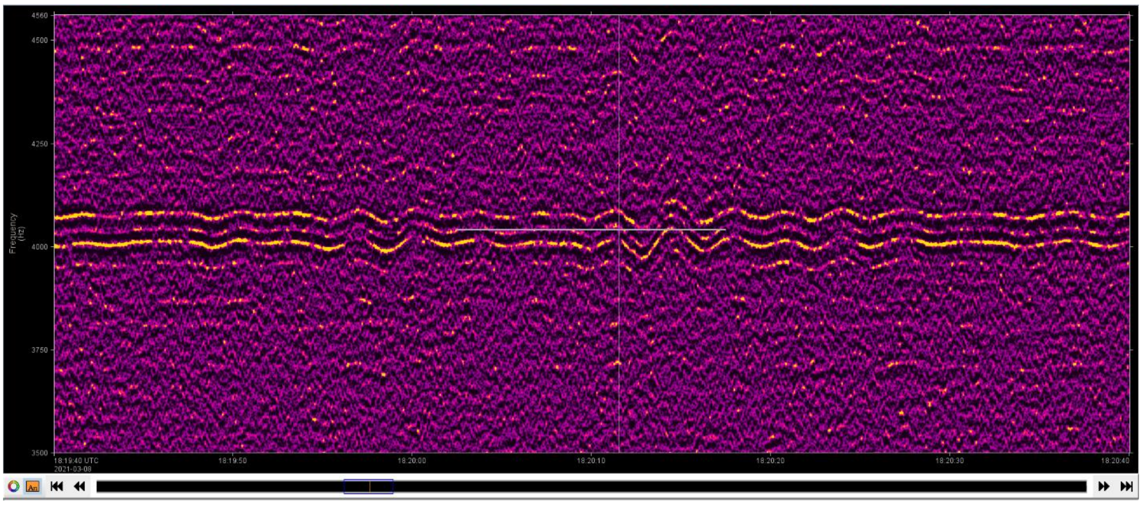


Figure 35. Three distinct gensets with accompanying cylinder firing rates throughout the spectrogram. These appear related to MODU operations as there are no secondary contacts on spectrogram and the tonals fluctuate with power draw.

5.5. Source Levels

ShipSound was used to determine the source levels for the *Ocean Onyx* and support vessels under dynamic positioning and during transits using the methods detailed in Section 4.2.3 and the operations described in Section 2.5. The following sections detail the Monopole Source Levels for each of these sources.

5.5.1. MODU

Following the method detailed in Section 4.2.3.2 and the periods specified in Table 8, the mean and maximum MSL for the *Ocean Onyx* was determined for three drilling depth ranges (Figure 36). The mean MSL is more representative of typical levels for each drilling depth and therefore suitable for comparison to the levels used in Koessler et al. (2020). Three example ShipSound reports are provided in Appendix G.1, and a spectrogram of drilling activities extracted from the ShipSound report included in Appendix G.1.2 is shown in Figure 37.

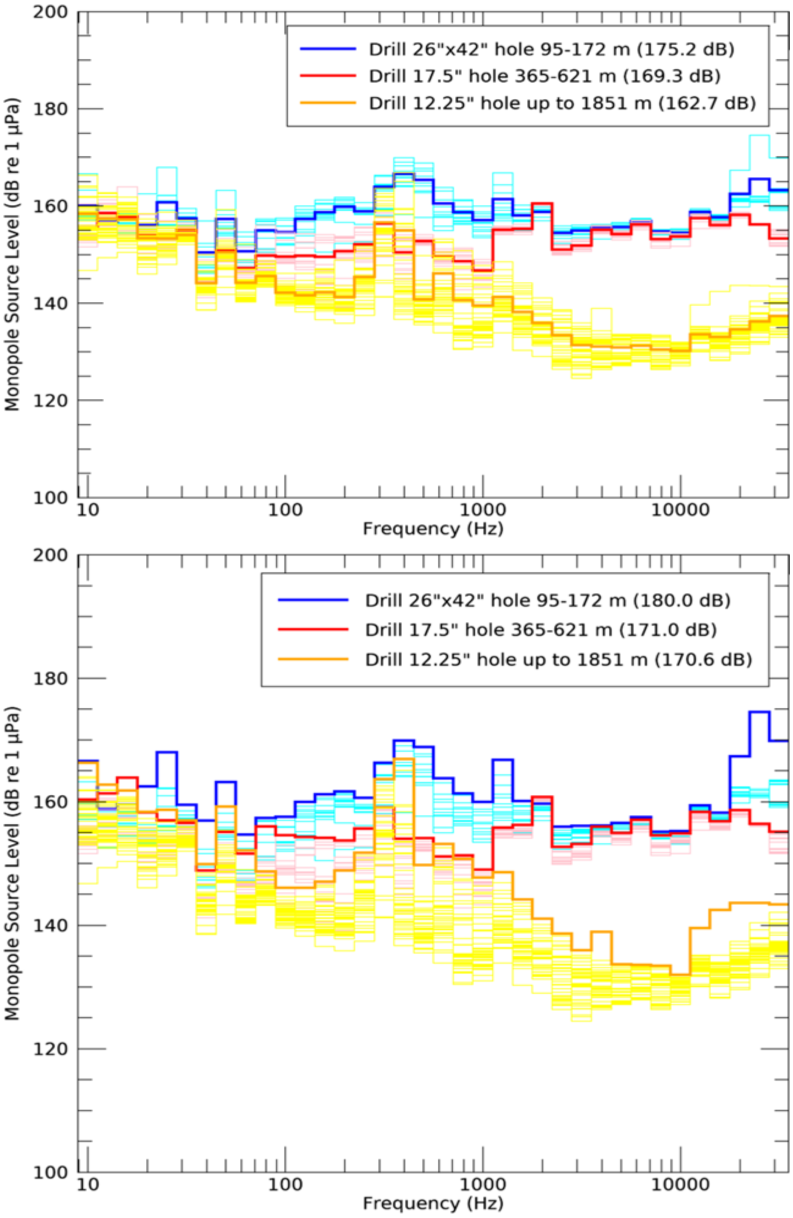


Figure 36. Monopole Source Level (MSL) and spectra for *Ocean Onyx* Mobile Offshore Drilling Unit (MODU) from Station 1 ShipSound processing, averaged over a ShipSound measurements over three different drilling depths, mean (top) and maximum (bottom).

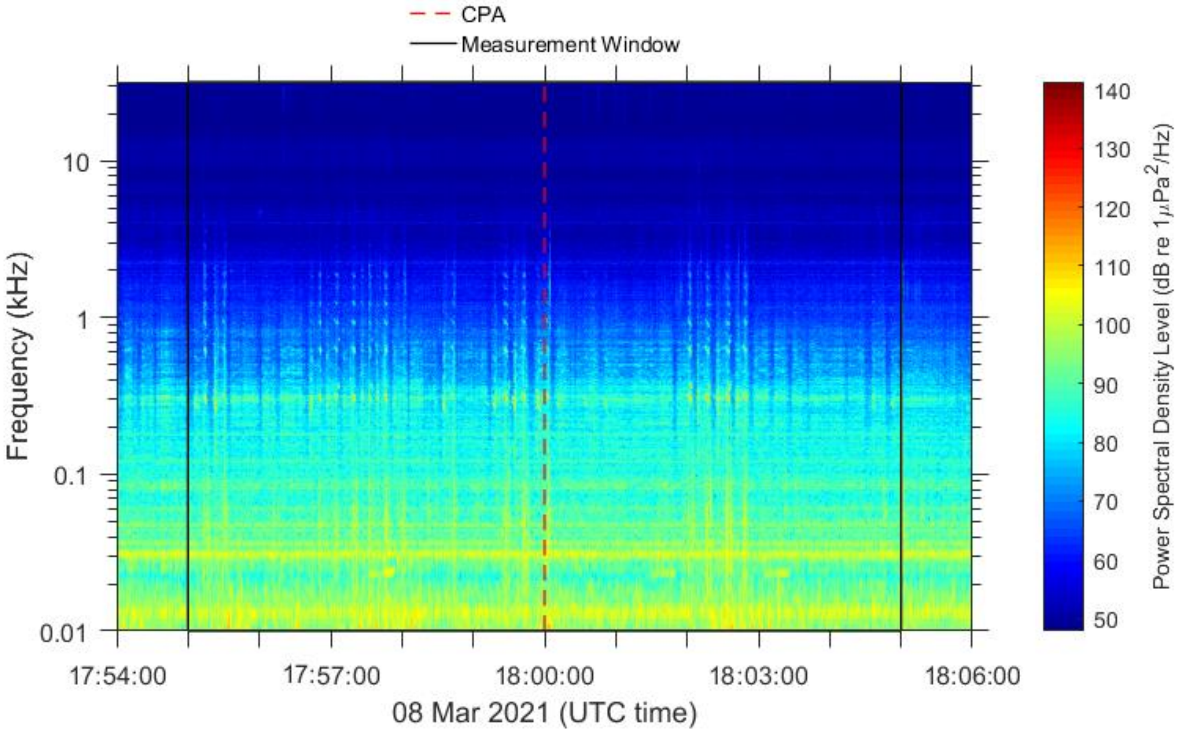


Figure 37. Spectrogram from ShipSound report included in Appendix G.1.2, with a calculated Monopole Source Level (MSL) of 159.6 dB re 1µPa m.

Table 11. *Ocean Onyx* monopole source levels (MSLs) from Figure 36.

Measurement	Monopole source level (dB re 1 µPa m)	
	Mean	Maximum
Drilling 26”x42” hole from 95–172 m	175.2	180.0
Drilling 17.5” hole from 365–621 m	169.3	171.0
Drilling 12.25” hole up to 1851 m	162.7	170.6

5.5.2. Vessels under Dynamic Positioning

Following the method detailed in Section 4.2.3 for vessels under dynamic positioning, the mean MSL was determined to be 193.9 dB re 1 µPa (Figure 38). The mean representative of typical levels from the trials of dynamic positioning is therefore suitable for comparison to the levels used in Koessler et al. (2020). One example ShipSound report is provided in Appendix G.2.

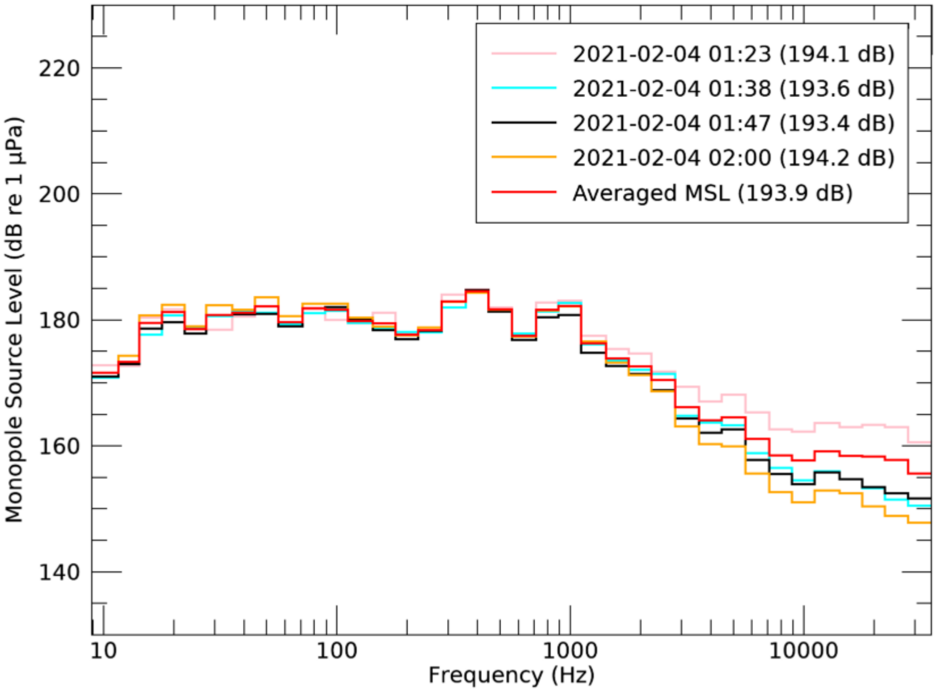


Figure 38. Monopole Source Level (MSL) and spectra for Siem *Sapphire* in dynamic positioning (DP) from Station 2 ShipSound processing. The MSL was averaged over all ShipSound measurements.

5.5.3. Vessels during Transit

Following the method detailed in Section 4.2.3 for vessels under transit, the mean MSL was determined for each vessel, the Siem *Sapphire* under transit at both 7 and 9 kn (Figures 39 and 40), and the Siem *Aquamarine* and *Topaz* at 9 kn (Figures 41 and 42). The two transit speeds are therefore suitable for comparison to the levels used in Koessler et al. (2020). One example ShipSound report is provided in Appendix G.3.

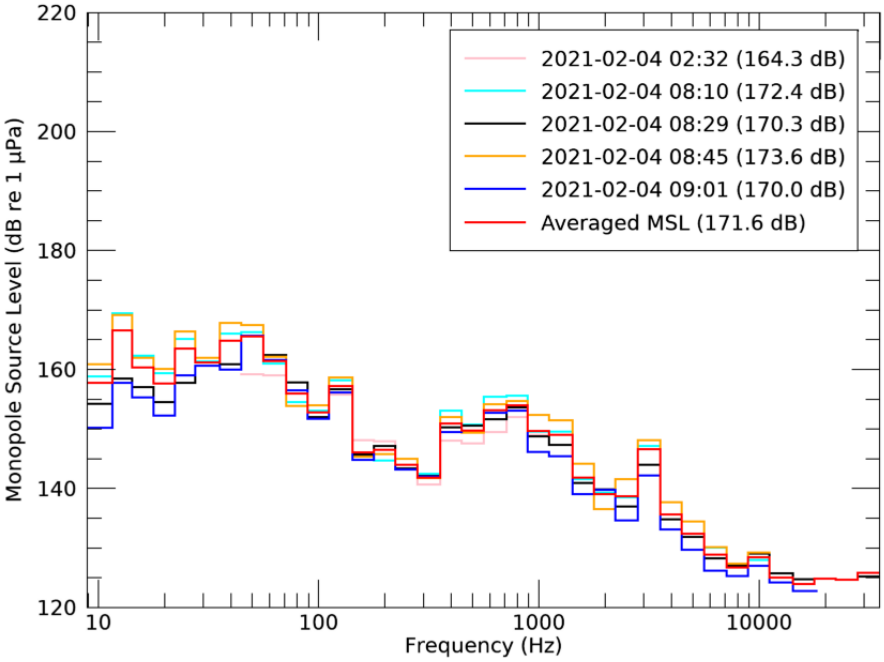


Figure 39. Monopole Source Level (MSL) and spectra for Siem *Sapphire* from Station 2 ShipSound processing. The MSL was converted to 7 kn and averaged over a few ShipSound measurements.

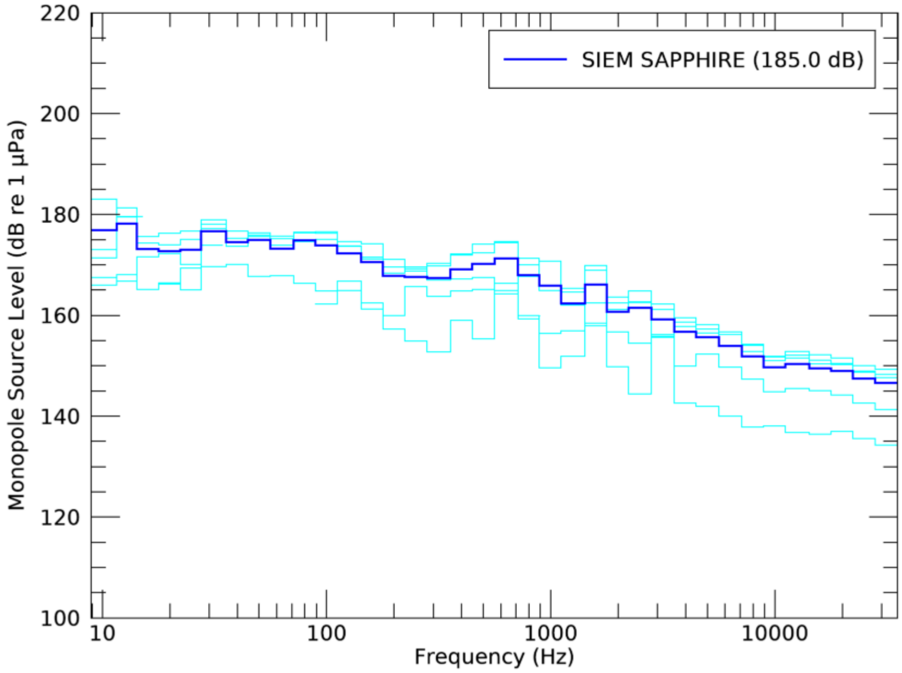


Figure 40. Monopole Source Level (MSL) and spectra for Siem *Sapphire* from Station 4 ShipSound processing. The MSL was converted to 9 kn and averaged over a few ShipSound measurements.

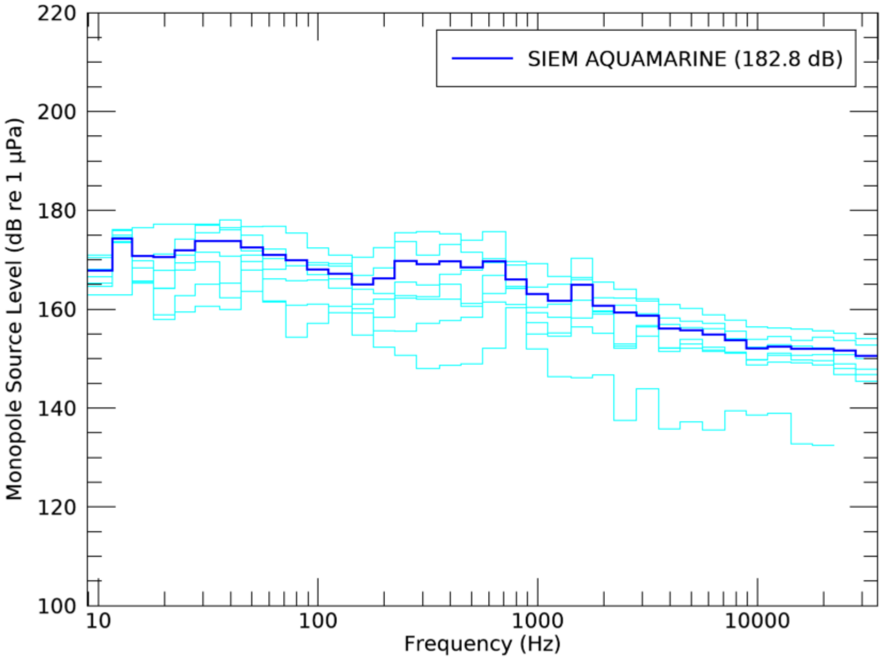


Figure 41. Monopole Source Level (MSL) and spectra for Siem *Aquamarine* from Station 4 ShipSound processing. The MSL was converted to 9 kn and averaged over a few ShipSound measurements.

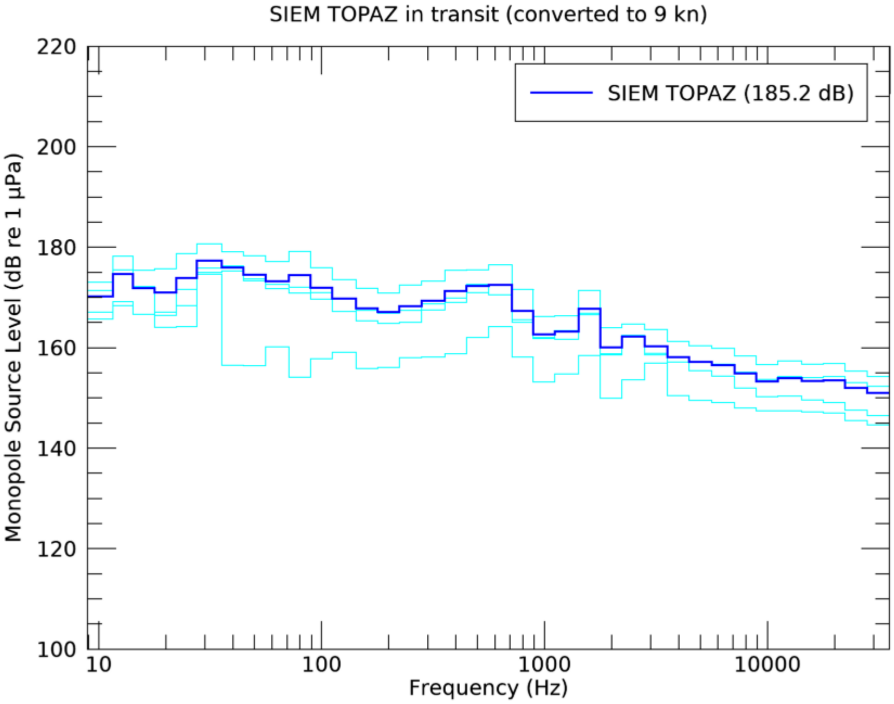


Figure 42. Monopole Source Level (MSL) for Siem *Topaz* from Station 4 ShipSound processing. The MSL was converted to 9 kn and averaged over a few ShipSound measurements.

5.6. Vessel Detections

Vessels were detected throughout the entire recording period using the automated detection algorithm described in Section 4.2.2. Results are shown for the two stations farthest from the *Ocean Onyx*, Stations 3 and 4 (Figure 43). Figure 44 shows an example of a large container vessel passing with a Lloyd’s mirror pattern, and the map of the pass is shown in Figure 45, along with less defined contributions from vessel operations at the *Ocean Onyx* to the north-west (purple) between 100 and 1000 Hz. A spectrogram of a closer vessel pass and associated map are shown in Figures 46 and 47.

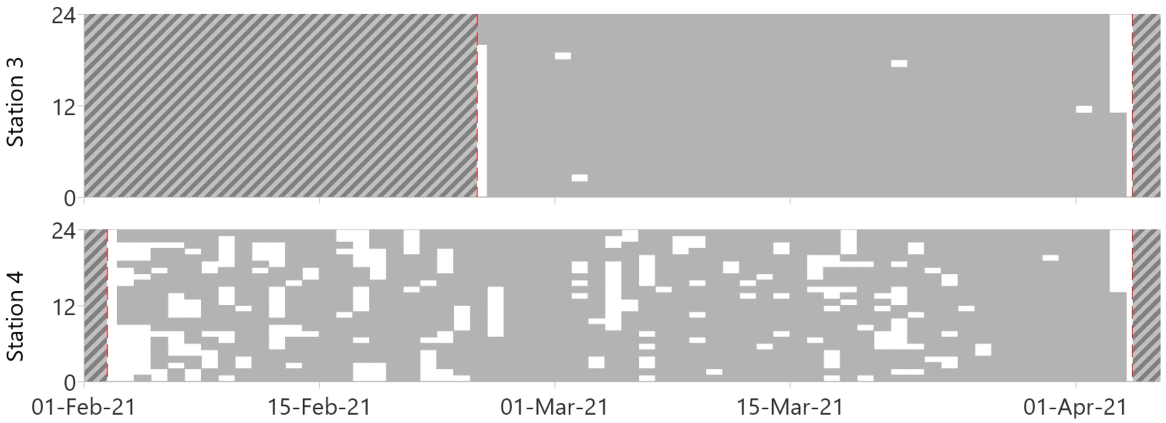


Figure 43. Vessel detections each hour (vertical axis) compared to date (horizontal axis) over the entire recording period at Stations 3 and 4. Vertical dashed lines (red) indicate AMAR deployment and retrieval dates.

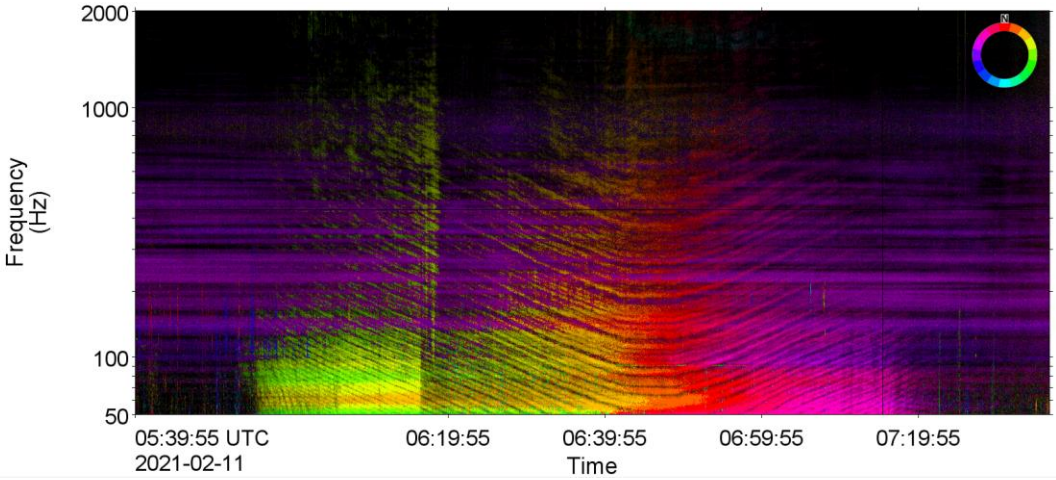


Figure 44. Example of a 334 m long container ship (*E.R. Tokyo*) travelling at 16 kn passing within 5.9 km north of Station 4 from east to west (green/yellow through to purple) that illustrates the Lloyd’s mirror, or bathtub pattern over 2 h, with less defined contributions from vessel operations at the *Ocean Onyx* to the north-west (purple) between 100 and 1000 Hz. This pattern is caused by constructive and destructive interference between direct and reflected paths of sound (0.4 Hz frequency resolution, 2 s time window, 0.5 s time step, Hamming window, normalised across time).

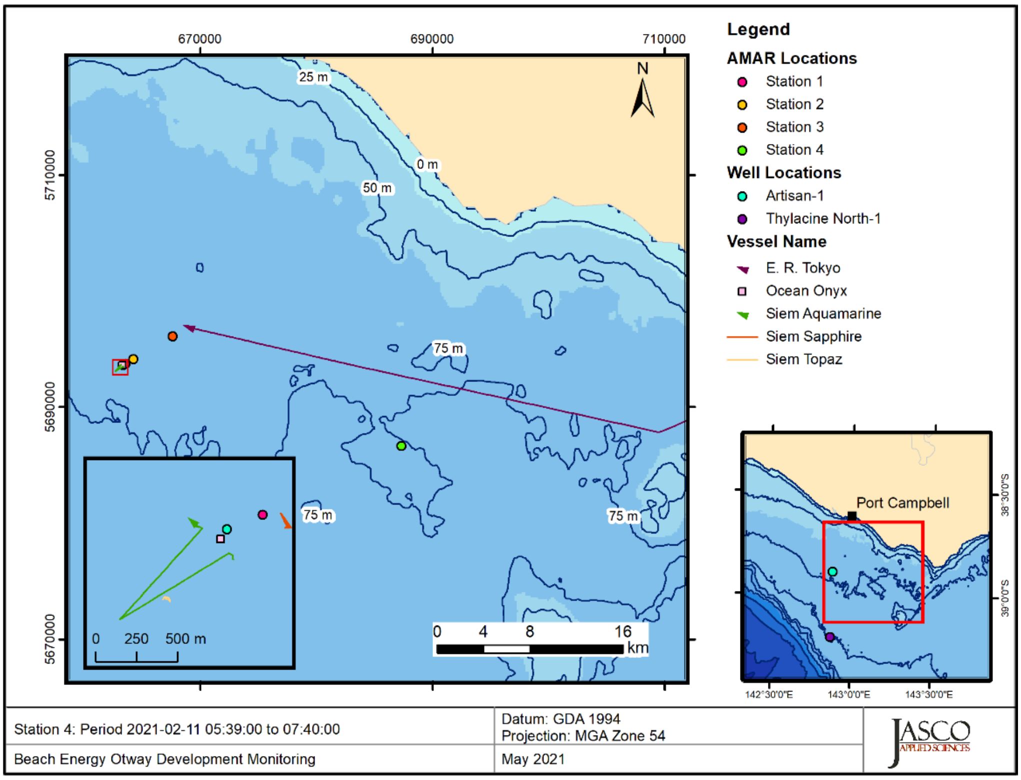


Figure 45. Map of automatic identification system (AIS) reported vessel locations for the spectrogram shown in Figure 44.

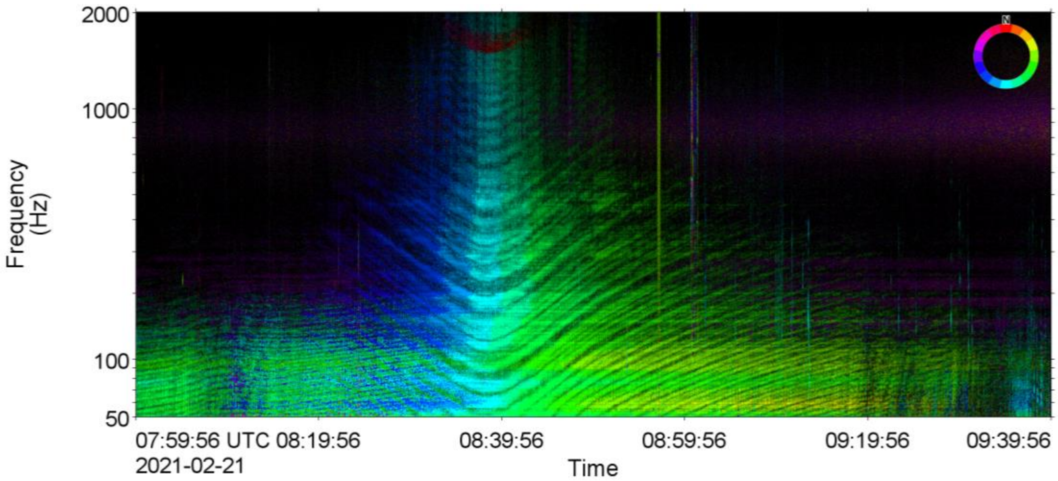


Figure 46. Example of a 200 m long vehicle carrier (*Tombarra*) travelling at 13 kn passing within 2.6 km south of Station 4 from east to west (green/yellow through to purple) that illustrates the Lloyd's mirror, or bathtub pattern over 2 h, with less defined contributions from vessel operations at the *Ocean Onyx* to the north-west (purple) between 100 and 1000 Hz. This pattern is caused by constructive and destructive interference between direct and reflected paths of sound (0.4 Hz frequency resolution, 2 s time window, 0.5 s time step, Hamming window, normalised across time).

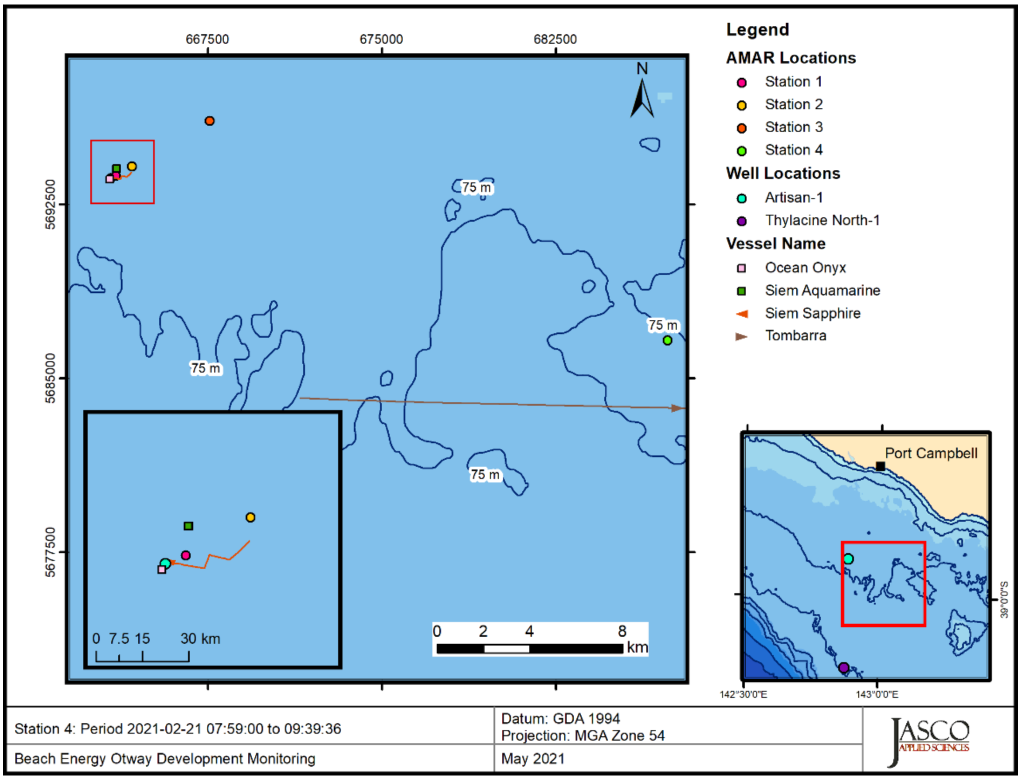


Figure 47. Map of automatic identification system (AIS) reported vessel locations for the spectrogram shown in Figure 46.

5.7. Marine Mammals

The acoustic presence of marine mammals was identified automatically by JASCO's detectors (Section 4.2.7.3) and validated via the manual review of 0.5% of the data, which represents 312 of the 5 min sound files, or 26 h worth of data. Acoustic signals of pygmy blue whales and dolphins were identified and vocalisations of other mysticetes, such as humpback and southern right whales, were not detected by the detectors (D.2), or observed during the 0.5% manual review.

5.7.1. Dolphins

Dolphins produce both impulsive (click) and tonal (whistle) sounds that show less species-level specificity than other marine mammal signals and are therefore more difficult to distinguish acoustically. Due to the directionality of impulsive clicks and the associated degradation of their spectral features when recorded at increasing angles away from the longitudinal axis of the vocalising animal, delphinid clicks cannot be confidently assigned to individual species. Furthermore, because the audible frequency of the acoustic data only reached 32 kHz, much of the energy from dolphin clicks (which can reach over 150 kHz) was not captured. Because of the overlap in spectral features of tonal signals from different dolphin species (Steiner 1981) and the expected but unquantified variability of these signals around the few described vocalisation types, we were unable to distinguish dolphin whistles by species.

The dolphin clicks and whistles observed in the data (Figure 48) were likely produced by short-beaked common dolphins (*Delphinus delphis*), and/or bottlenose dolphins (*Tursiops sp.*) (Bilgmann et al. 2007, Bilgmann et al. 2014, Charlton-Robb et al. 2015). These signals were observed at all stations throughout the recording period with detections highest at Station 4 and through the month of March at Stations 1, 2, and 3 (Figures 49 and 50). It was apparent that dolphin clicks occurred more at night than during the day, particularly at Stations 1–3 (Figure 49).

A third vocalisation type believed to be produced by dolphin calves was also observed in March at Station 3 alongside whistles (Figure 51). These lower frequency patterns of ‘chirps’ and ‘quacks’ have previously been attributed by JASCO analysts to young bottlenose dolphins.

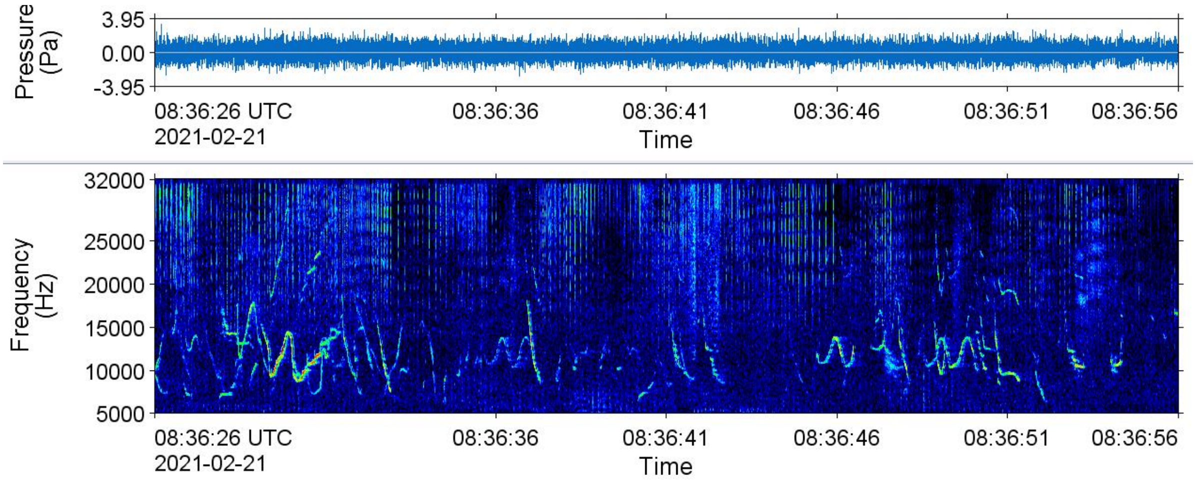


Figure 48. Spectrogram of dolphin clicks and whistles recorded on 21 Feb 2021 at Station 4 (64 Hz frequency resolution, 0.01 s time window, 0.005 s time step, Hamming window, normalised across time). The window length is 30 s.

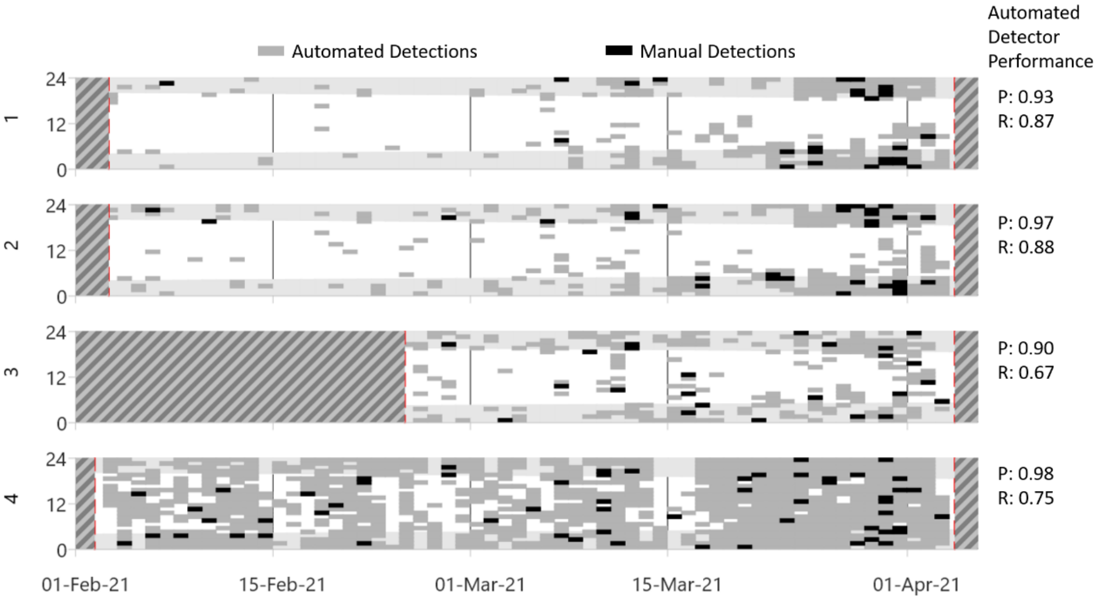


Figure 49. Daily and hourly occurrence of dolphin click detections recorded at Stations 1–4 (top – bottom) with automated detector performance metrics included along right side. The grey areas indicate hours of darkness from sunset to sunrise (Ocean Time Series Group 2009). Hashed areas indicate when there was no acoustic data and red dashed lines indicate the start and end of recordings. Automated detector results are for the dolphin click train detector.

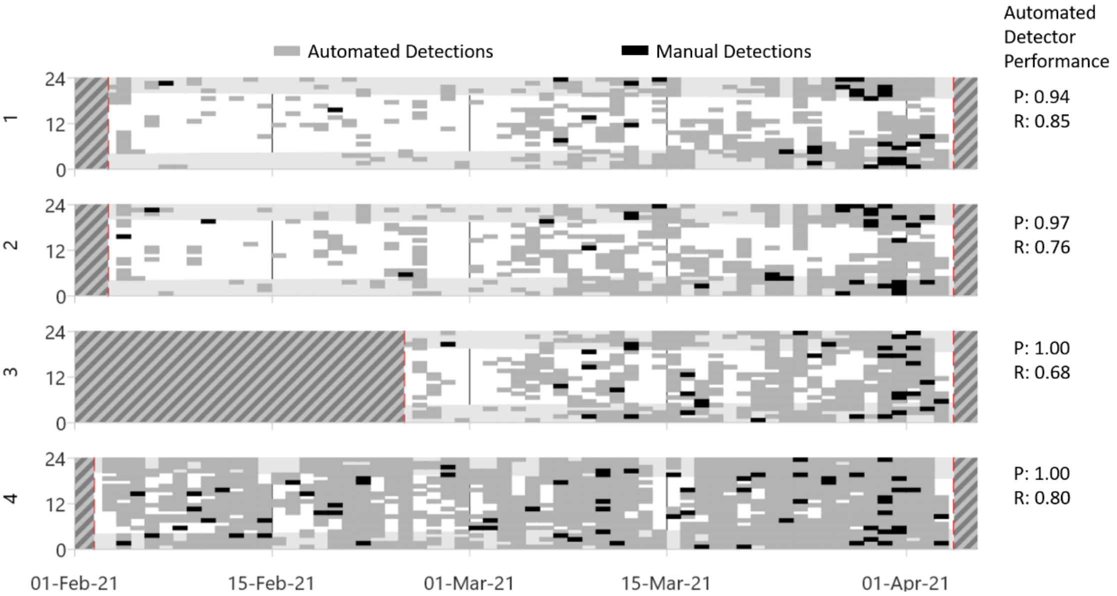


Figure 50. Daily and hourly occurrence of dolphin whistle detections recorded at Stations 1–4 (top – bottom) with automated detector performance metrics included along right side. The grey areas indicate hours of darkness from sunset to sunrise (Ocean Time Series Group 2009). Hashed areas indicate when there was no acoustic data and red dashed lines indicate the start and end of recordings. Automated detector results are for the WhistleHigh detector.

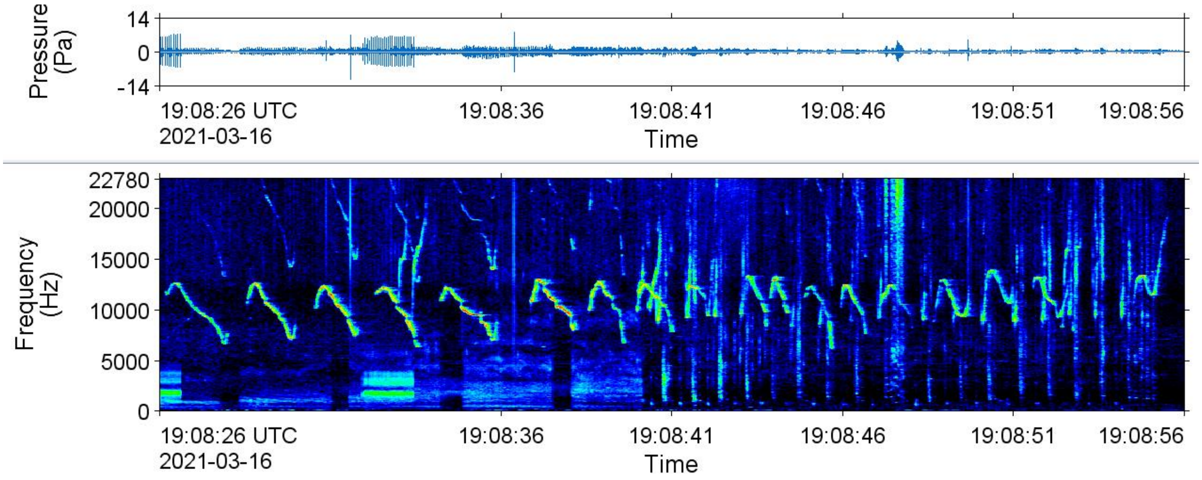


Figure 51. Spectrogram of dolphin whistles (above 5000 Hz) and sounds from young dolphins (majority present under 5000 Hz) recorded on 16 Mar 2021 at Station 3 (2 Hz frequency resolution, 0.125 s time window, 0.03125 s time step, Hamming window, normalised across time). The window length is 30 s.

5.7.2. Pygmy Blue Whales

Songs of pygmy blue whales (*Balaenoptera musculus brevicauda*; Figures 52 and 53) were detected sporadically through February and the first half of March. By the end of March, the signals were present in almost every hour of recording (Figure 54). This pattern of occurrence was reflected across all recording stations (Figure 54). In addition to the songs containing A, B, and C notes (Figures 52 and 53) (McDonald et al. 2006, Gavrilov and McCauley 2013, McCauley et al. 2018) that were the most common blue whale vocalisation in the data, blue whale D calls (Figure 55) (Recalde-Salas et al. 2014) were also present at the end of March and into April.

At Station 4, the direction of the blue whale acoustic signals relative to the recorder position was observed. An example of this is provided in Figure 52, where one blue whale is singing to the northwest, and one is singing to the southeast. Similarly, in Figure 55, the blue whale is calling from south of the recorder. When manually analysing blue whales at Station 4, an annotation was created for every direction of calling animals and the direction saved with the annotation. Figure 56 summarises these blue whale directional results from manual analysis. Blue whales occurred in all directions relative to Station 4, and there were 1–3 individuals confirmed vocalising at a time (Figure 56). Early in the recording, there is an apparent trend in the animals being more to the east and, later in the recording, being more to the west. However, the data were too sparse to confirm anything about animal movements.

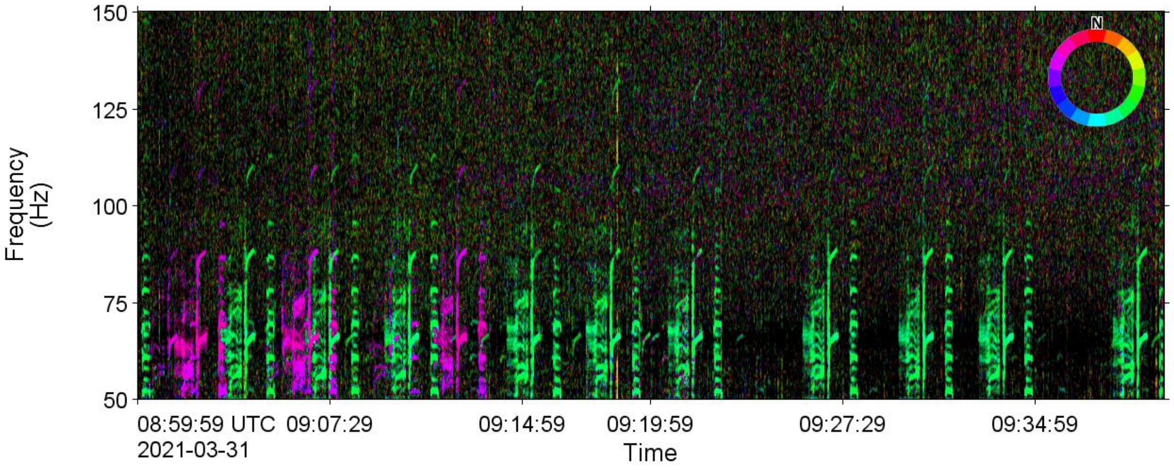


Figure 52. Directogram of pygmy blue whale songs recorded on 31 Mar 2021 at Station 4 (UTC) (0.4 Hz frequency resolution, 2 s time window, 0.5 s time step, Hamming window, normalised across time). Displaying ~40 min of data. One blue whale is singing to the northwest of Station 4 (pink) and one is singing to the southeast of Station 4 (green).

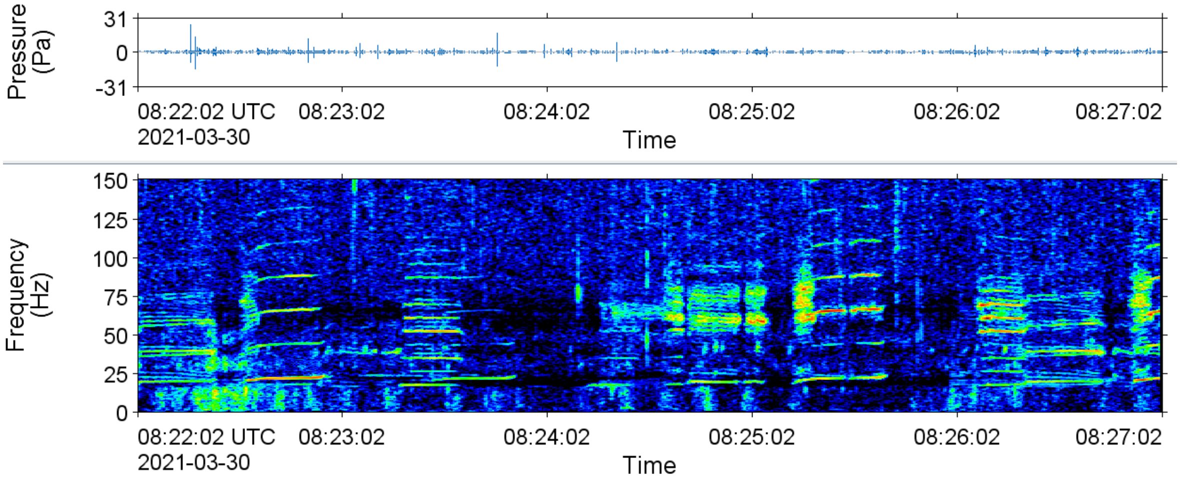


Figure 53. Spectrogram of pygmy blue whale songs recorded on 30 Mar 2021 at Station 3 (UTC) (0.4 Hz frequency resolution, 2 s time window, 0.5 s time step, Hamming window, normalised across time). Displaying 5 min of data.

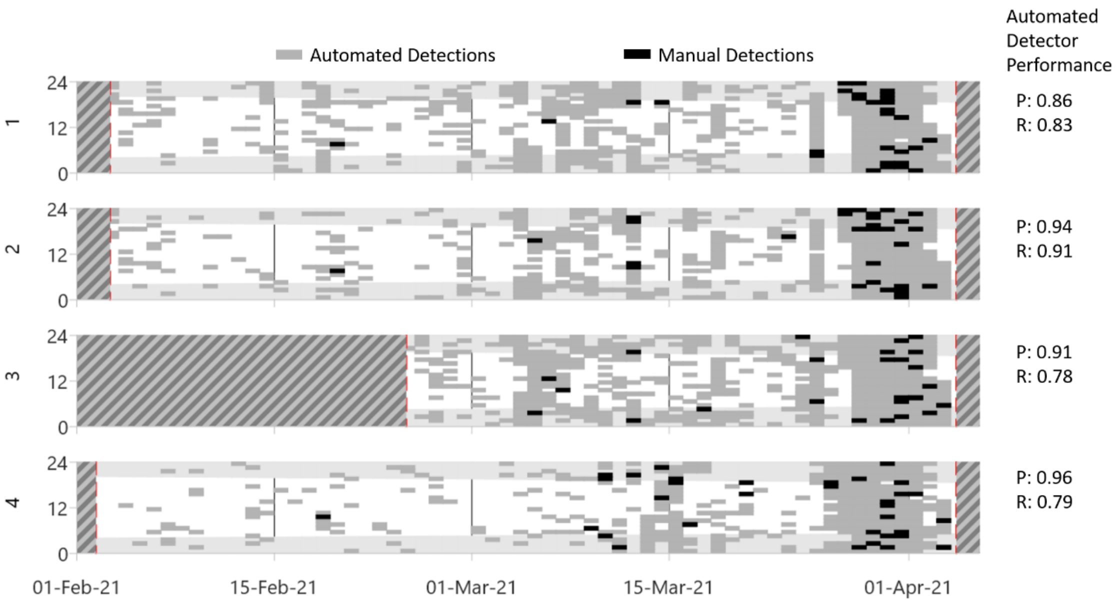


Figure 54. Daily and hourly occurrence of pygmy blue whale vocalisations recorded at Stations 1–4 (top – bottom) with automated detector performance metrics included along right side. The grey areas indicate hours of darkness from sunset to sunrise (Ocean Time Series Group 2009). Hashed areas indicate when there was no acoustic data and red dashed lines indicate the start and end of recordings. Automated detector results are for the AUS_BW_BH20 detector.

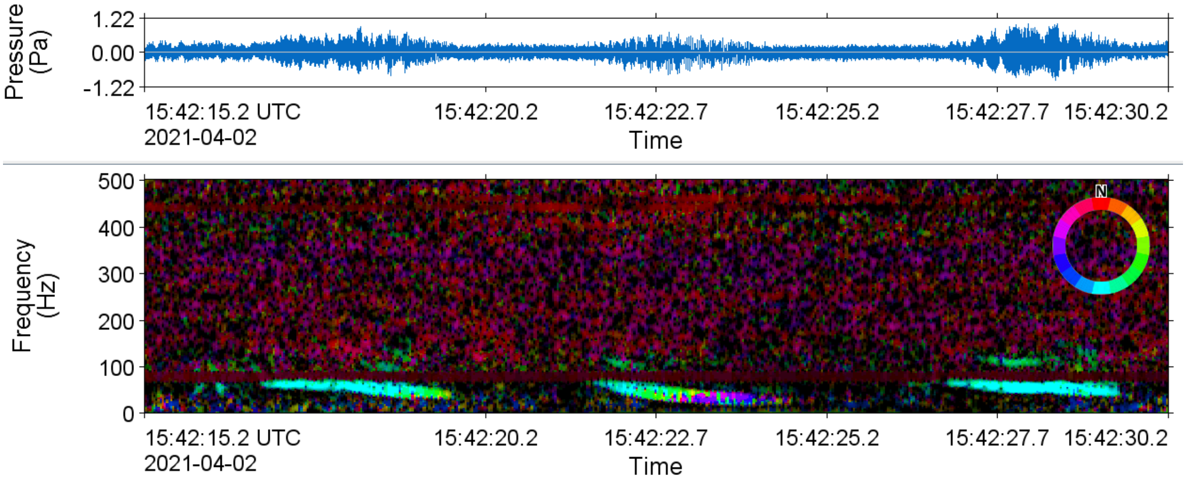


Figure 55. Directogram of pygmy blue D calls recorded on 2 Apr 2021 at Station 4 (UTC) (2 Hz frequency resolution, 0.125 s time window, 0.03125 s time step, Hamming window, normalised across time). Displaying 16 s of data. The blue whale is vocalising to the south of Station 4 (teal). In the second call, the frequencies fall below those which can be accurately determined with the hydrophone spacing using, with the colour of the signal changing from teal to purple and navy blue.

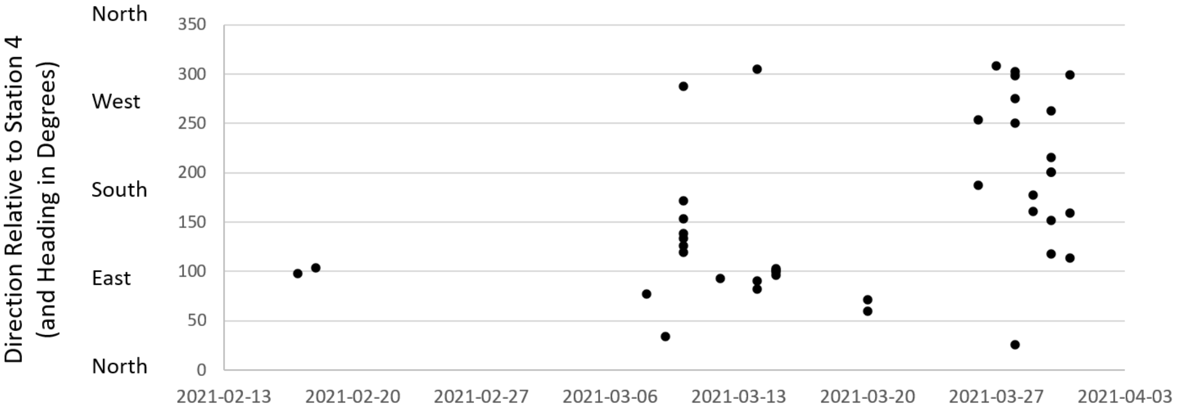


Figure 56. Plot of direction of blue whale vocalisations relative to Station 4 over the recording period where each point is a calculated from a manual annotation created during the 0.5% manual validation analysis (one annotation per direction per 5 min file analysed).

5.7.3. Other Potential Biological Sounds

Occasionally during manual analysis, pulses ranging from ~750 to 1250 Hz (Figure 57) were observed that may have been produced by fish. Alternatively, these signals could be a result of some anthropogenic activity, noises from which were noted through much of the data during manual review, particularly at Stations 1 and 2. Fish chorusing activity was apparent in the LTSAs, in particular at Station 4, with examples provided in Figures 58–60.

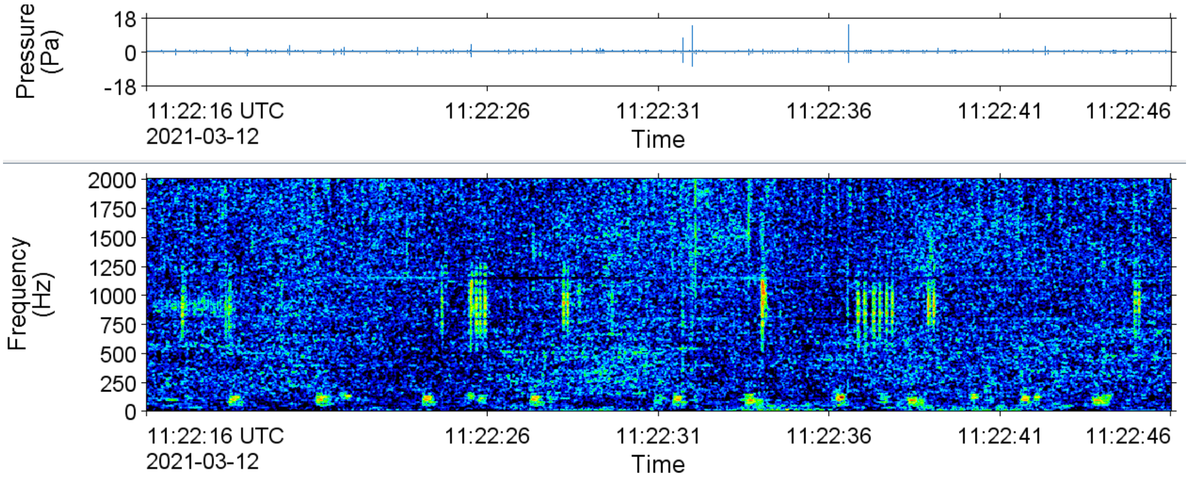


Figure 57. Spectrogram of unknown signals potentially produced by fish (pulses at 500–1250 Hz) recorded on 12 Mar 2021 at Station 3 (UTC) (2 Hz frequency resolution, 0.125 s time window, 0.03125 s time step, Hamming window, normalised across time). Displaying 30 s of data.

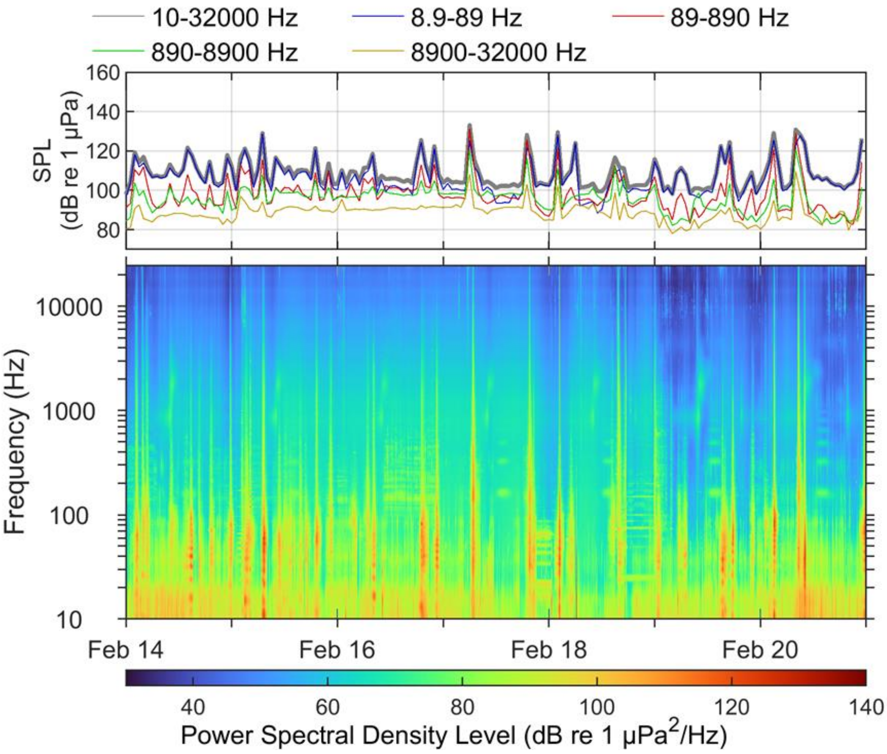


Figure 58. In-band sound pressure level (SPL) and spectrogram (or long-term spectral average; LTSA) of underwater sound for one week of data at Station 4, showing daily fish chorus's between 700 and 2000 kHz, and between 150 and 450 Hz, more obvious after 17 Feb 2021.

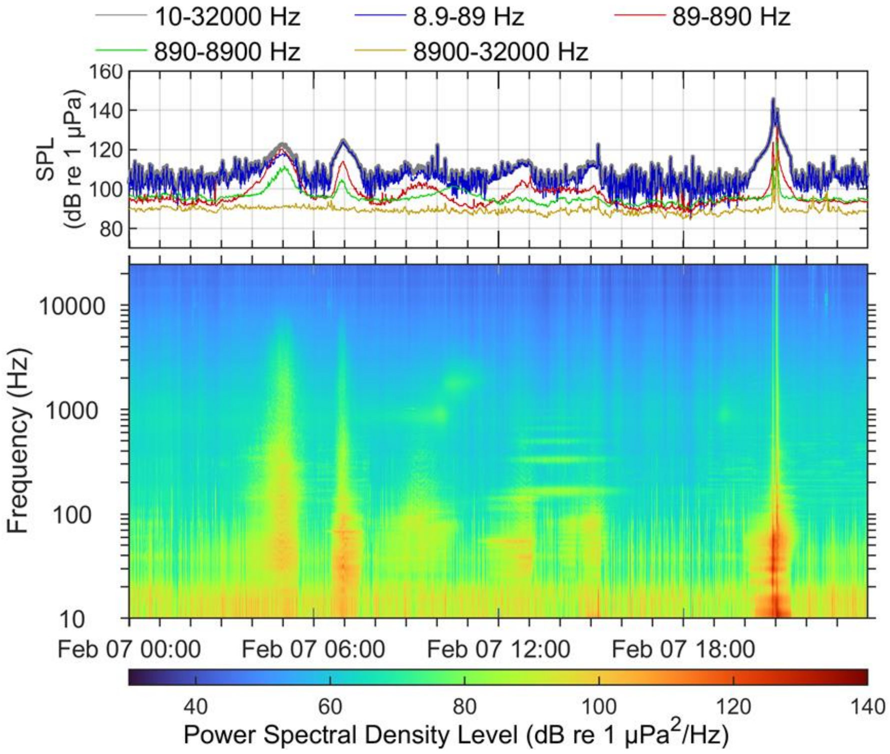


Figure 59. In-band sound pressure level (SPL) and spectrogram (or long-term spectral average; LTSA) of underwater sound for one day of data at Station 4, showing the daily fish chorus between 700 and 2000 kHz, and between 150 and 450 Hz, apparent in Figure 58, and six vessel transits.

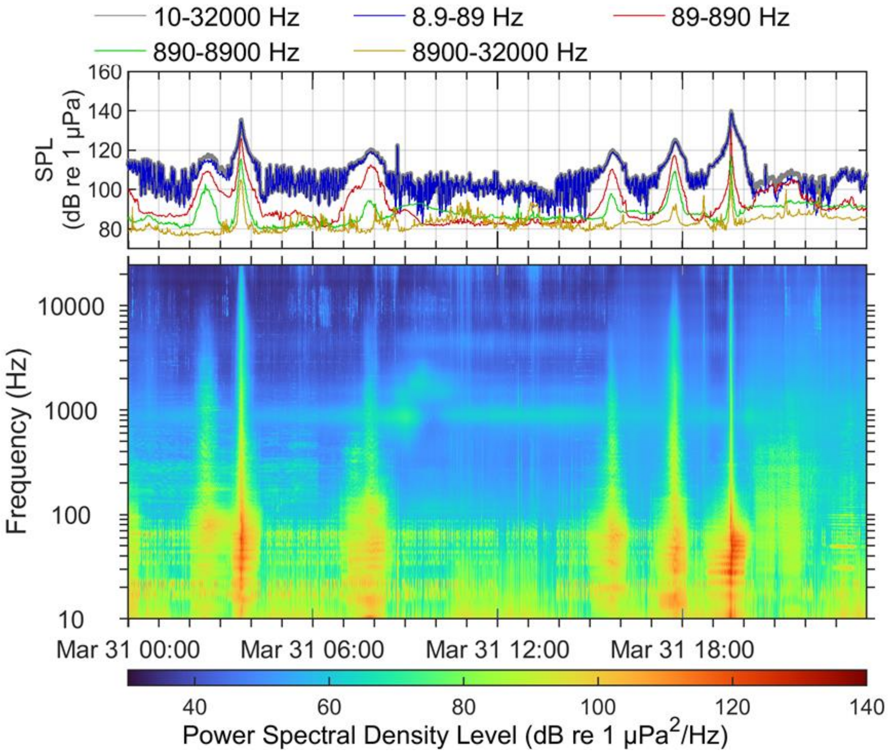


Figure 60. In-band sound pressure level (SPL) and spectrogram (or long-term spectral average; LTSA) of underwater sound for one day of data at Station 4, showing the daily fish chorus between 700 and 2000 kHz, lasting almost the entire day, along with six vessel transits.

6. Validation Analysis

Table 12 presents the four scenarios that need to be considered to validate the pre-measurement modelling presented in Koessler et al. (2020) for the Artisan-1. The scenarios are described in Table 12, with the modelling site locations and descriptions provided in Table 13.

Table 12. Description of modelling scenarios for the Artisan-1 development area from Koessler et al. (2020)

Well	Scenario number	Description	Associated modelled sites
Artisan-1	5	MODU, normal drilling operations	4
	6	OSV standby, independent of MODU, for 24 h	6
	7	MODU with OSV during resupply operations (including 4 hours alongside the MODU)	4, 5 and 6
	8	MODU with OSV standby (combination of Scenarios 5 and 6)	4 and 6

Table 13. Location details for the validation modelled sites.

Well	Site	Source	Latitude (S)	Longitude (E)	MGA Zone 54 (GDA94)		Water depth (m)
					X (m)	*Y* (m)	
Artisan-1	4	MODU	38° 53' 27.4106"	142° 52' 58.4450"	663300	5693640	71.5
	5	OSV	38° 53' 27.4021"	142° 53' 01.0962"	663364	5693639	71.6
	6	OSV standby	38° 53' 26.1553"	142° 54'21.4165"	665300	5693637	70.2

6.1. Source Level Comparison

The modelled source levels used in Koessler et al. (2020) are shown in Figures 61–63 alongside MSLs from the measurement program.

The mean estimated source levels for the vessels under transit used in the modelling study, which were derived based on the scaling of the power level, were similar to the MSL determined through the measurement study, which varied significantly with vessel speed (between 171.6 and 185.2 dB re µPa m). The trend of decreased MSL with speed follow those from studies on commercial shipping and ferries (MacGillivray et al. 2019). The measured MSL under dynamic positioning was different to that used in Koessler et al. (2020), in part due to the vessel power levels applied, but also because the approach used to estimate sound levels under dynamic positioning is based upon vessels under transit and is an approximation based on the Maximum Continuous Rating (MCR). Limited measurements of vessels under dynamic positioning using standardised measurement approaches are reported in literature, and there are significant differences between the thruster models and specifications, depths, and vessel dynamic positioning systems which control thruster operations. Therefore, this characterisation is a valuable contribution to understanding the MSLs for systems installed in anchor handling vessels.

The mean MSLs for the *Ocean Onyx* Figure 63 decrease as the drilling depth increases. The estimate of the *Ocean Onyx* source level spectrum was based on the Transocean *Polar Pioneer*, a similarly sized MODU. The *Polar Pioneer* was measured by JASCO while anchored and drilling, and had a broadband (10 Hz to 35 kHz) source level of 170.1 dB re 1 µPa m (Austin et al. 2018), although the source level used in the modelling was 178.7 dB re 1 µPa m. The mean maximum MSL from the measurement program was 175.2 re 1 µPa m, associated with shallowest drilling depths.

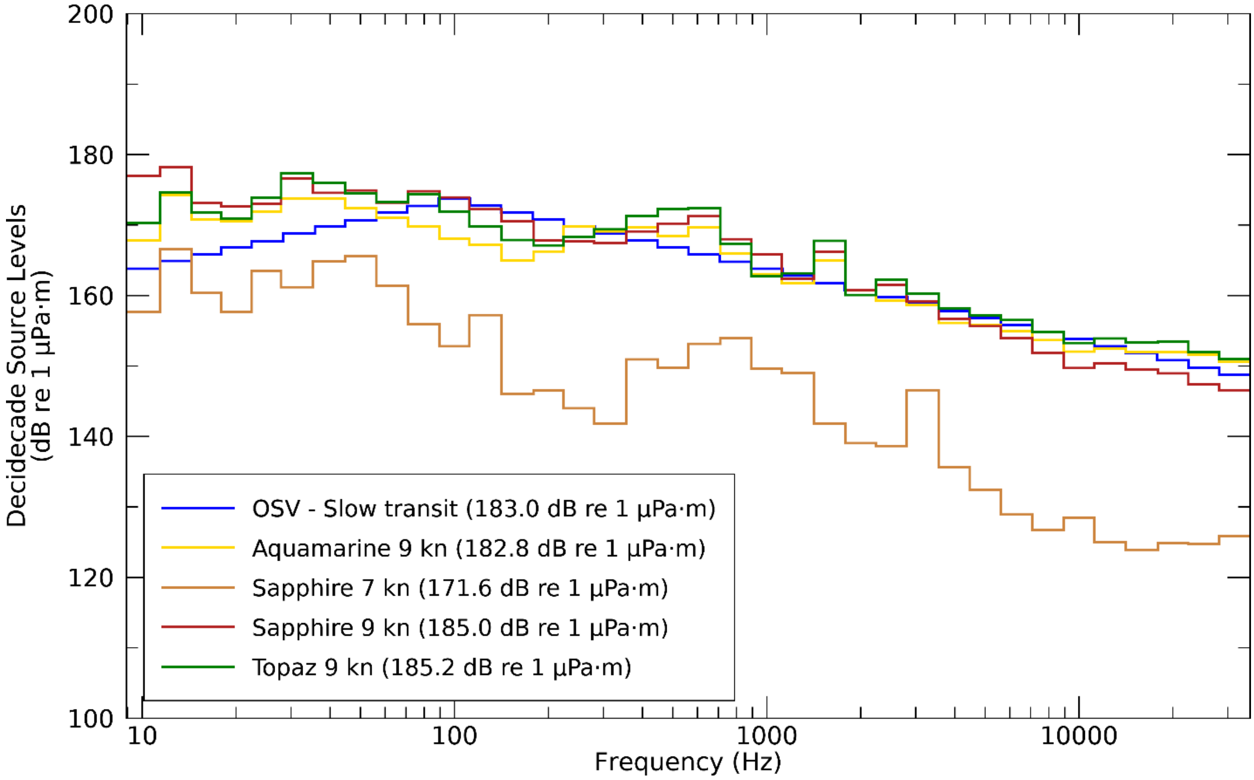


Figure 61. *Offshore Support Vessel (OSV)*: Decidecade source level spectra of the modelled OSV, slow transit (15% MCR) and Monopole source levels (MSLs) determined through the measurement program.

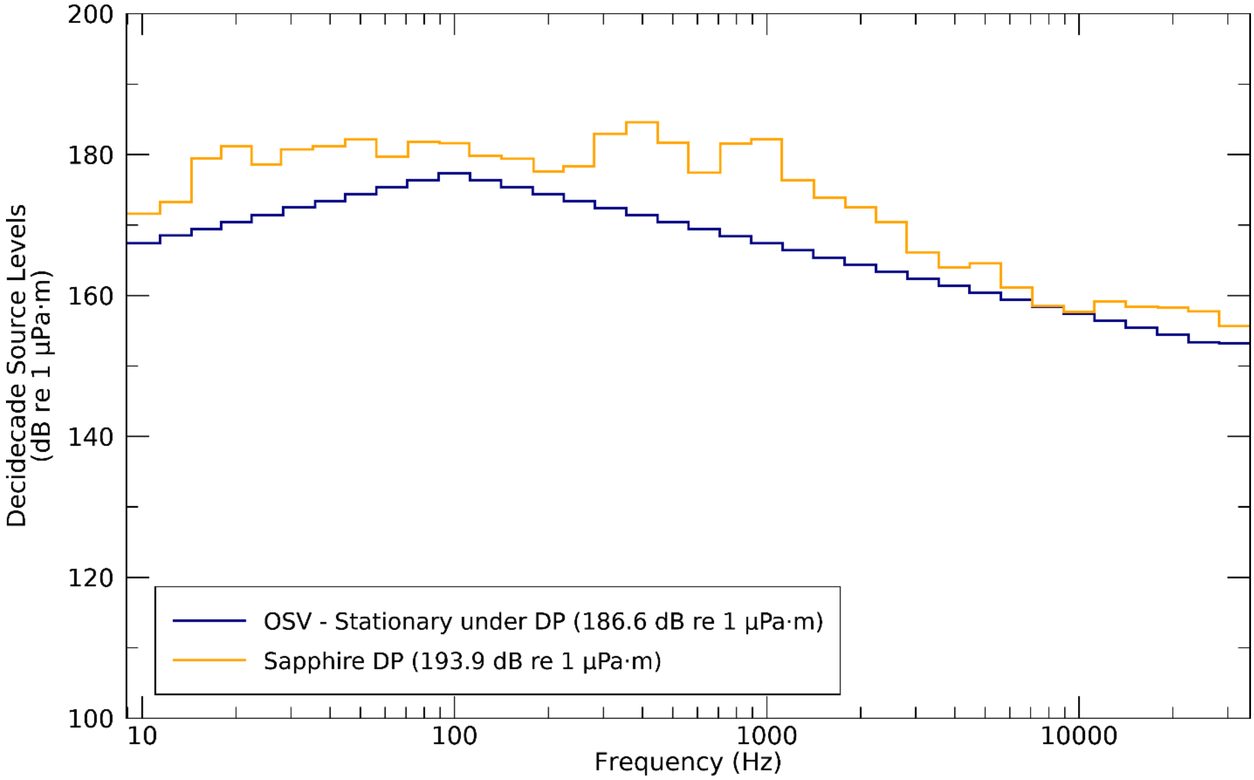


Figure 62. *Offshore Support Vessel (OSV)*: Decidecade source level spectra of the modelled DP (20% MCR) and MSLs determined through the measurement program.

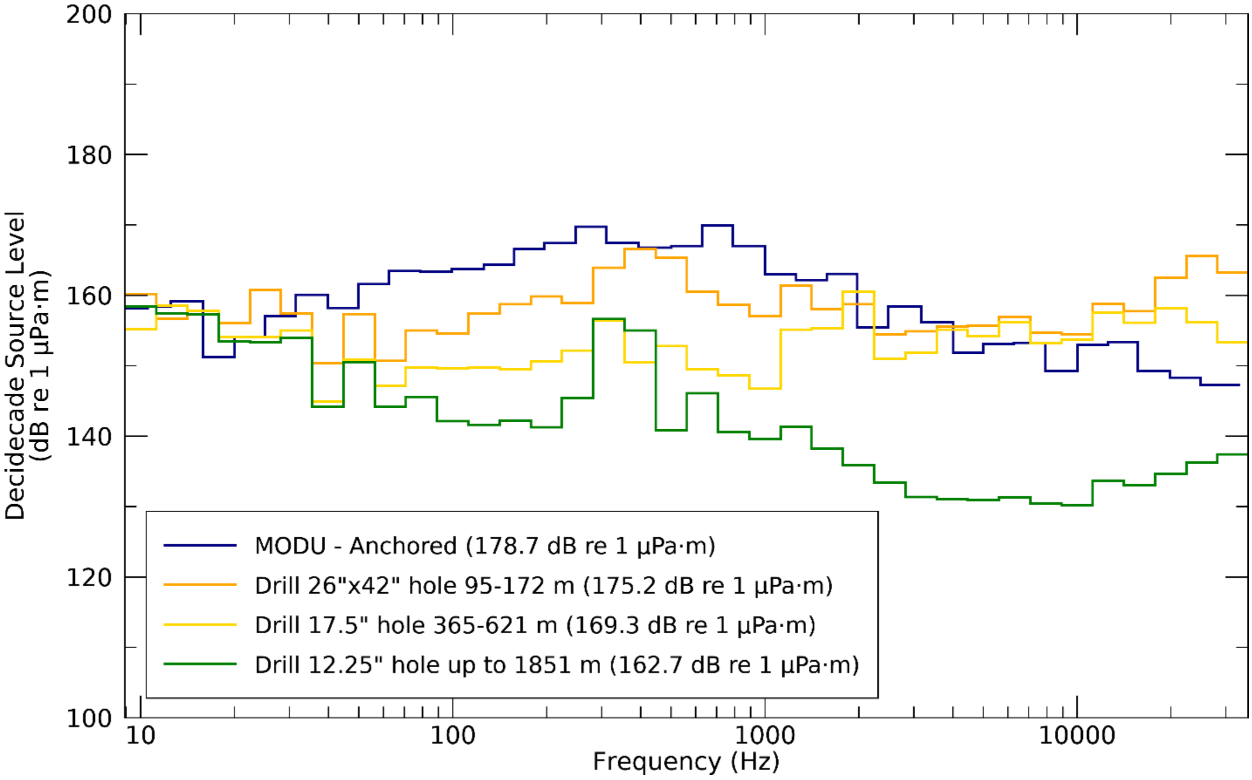


Figure 63. *Mobile Offshore Drilling Unit (MODU)*: Decidecade source level spectra of the modelled MODU, and the mean MSLs determined through the measurement program of the *Ocean Onyx* for three stages of drilling.

6.2. Understanding Propagation Loss

The plotted data and curve fits, as discussed in Section 4.2.4 and presented in Section 5.3, provide substantial detail on the environmental effects on the propagation of acoustic energy in the water column. In comparing SPL data fits for Stations 1–3, the loss rate is higher than what would have been expected in this environment, considering the higher MSLs for the support vessel on DP derived from measurements. In consideration of the potential variations in the seabed geologic compositions as indicated in Section 2.4, any difference may be attributed to the existence or absence of a thin veneer of sand.

A comparison exercise was conducted using JASCO's Marine Operations Noise Model (MONM) and JASCO's wavenumber integration model (VSTACK; Hannay et al. 2010, Jensen et al. 2011). VSTACK computes propagation loss versus depth and range for arbitrarily layered, range-independent acoustic environments using the wavenumber integration approach to solve the exact (range-independent) acoustic wave equation. Seabed reflectivity in the model is dependent on the seabed layer properties: compressional and shear wave speeds, attenuation coefficients, and layer densities. It is valid over the full angular range of the wave equation and can fully account for the elasto-acoustic properties of the sub-bottom.

A simple range-independent isovelocity water column (1500 m/s) was modelled considering a calcarenite seabed with and without a thin layer of sand as detailed in the Appendix of Koessler et al. (2020). The decidecade spectra of the measured MODU in Section 6.1 were combined with the modelled propagation loss from MONM and VSTACK to produce received level (SPL; L_p) scatter plots with range. Receivers were chosen to span the water column and the MSL source depth was located at 11 m. The results are shown below in Figures 64 and 65 when considering the mean maximum decidecade MSL presented above in Section 6.1 .

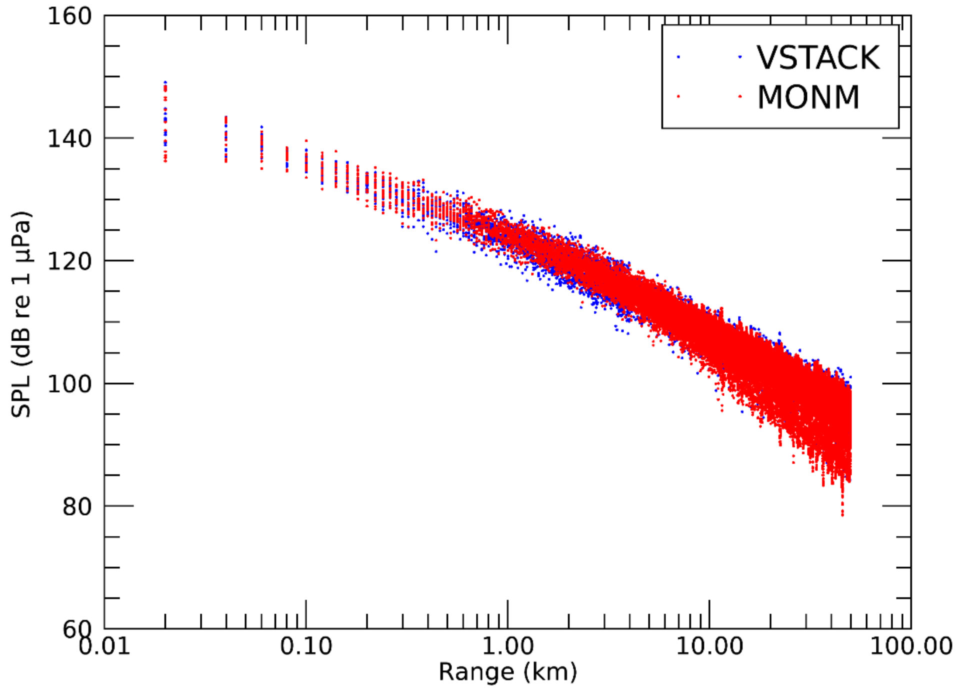


Figure 64 *Mobile Offshore Drilling Unit (MODU)*: Predicted received levels (SPL) for a simplified range independent environment with a calcarenite seabed with a thin overlying veneer of sand.

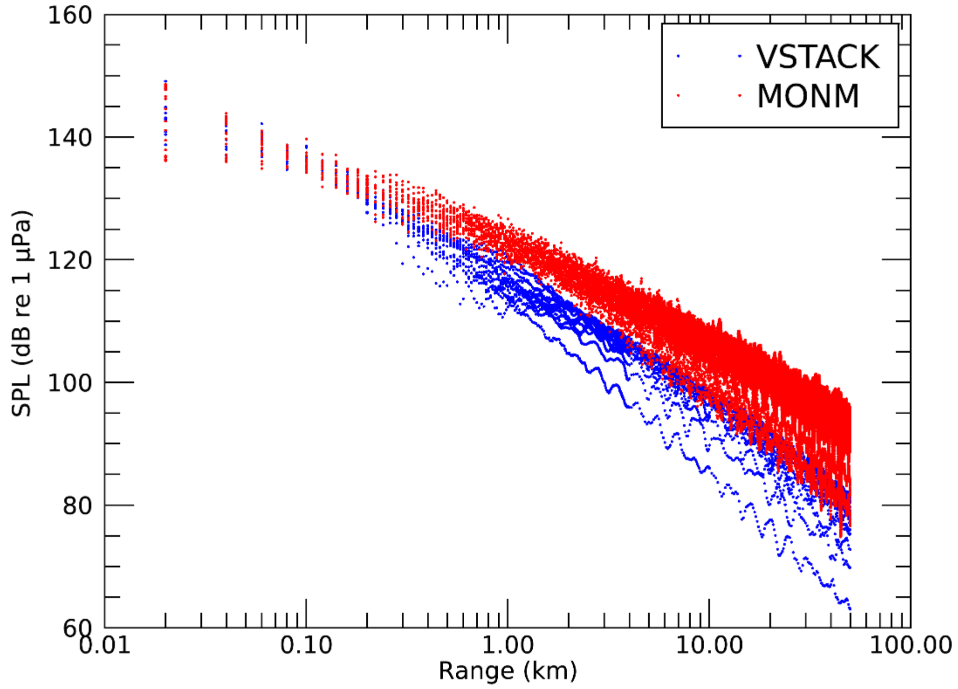


Figure 65 *Mobile Offshore Drilling Unit (MODU)*: Predicted received levels (SPL) for a simplified range independent environment with a calcarenite seabed with no sand layer.

When considering the results from VSTACK, the indication is that much higher rates of loss would be expected if no sand layer were present. Considering the variably of the distribution of seafloor sediments within the wider region, the higher rates of loss indicate that that the any overlaying sand is much thinner than or completely absent at the seafloor. In consideration of these modelled results and the SPL curve fits in in Section 5.3, the validation exercise was therefore carried out with the geoacoustic model consisting of well-cemented carbonate caprock, overlying semi-cemented carbonate rock.

An additional broadband correction was applied to the propagation loss results from MONM to account for the higher rates of loss when the full for the elasto-acoustic properties of the sub-bottom are consider. The differences between the broadband SPL from MONM and VSTACK were extracted at the same modelled ranges and depths that corresponded range independent predictions. The 90th percentile of the resultant dB differences was selected at each range to generate a generalised conversion function for each individual site to be modelled. The conversion functions were applied after the propagation loss calculation from MONM but before summing decidecade band levels, gridding, and radii calculations for each modelled site in each modelled scenario considered. Figure 66 shows an example comparison of the re-modelled results for Scenario 7 (MODU with OSV during resupply operations), at a receiver depth of 70.5 m (the median depth of measurement Stations 1–3) and an azimuth of 60°, against the data and 90th percentile data fit bounds for when the levels at Station 1 are above 150 dB re 1µPa (Figure 22). It is inferred that the data plotted here is associated with operational activity in the vicinity of the MODU and therefore may be similar to the modelled resupply operations scenario, at least for comparative purposes. The similar decay rates between the modelling and measured data indicate that re-modelled results presented here are broadly within measured range of levels for similar operations.

However, these data contain many different operations that will not exactly align with nominal representative scenarios for modelling, due to the time varying nature of the operations and associated produced sound levels. The modelled scenario produces levels that intersect the upper bound of the measured data, and therefore it is likely conservative through using the static MSL and operational representations – whilst a more detailed scenario is possible to be created (Quijano et al. 2019), that was beyond the scope of this study.

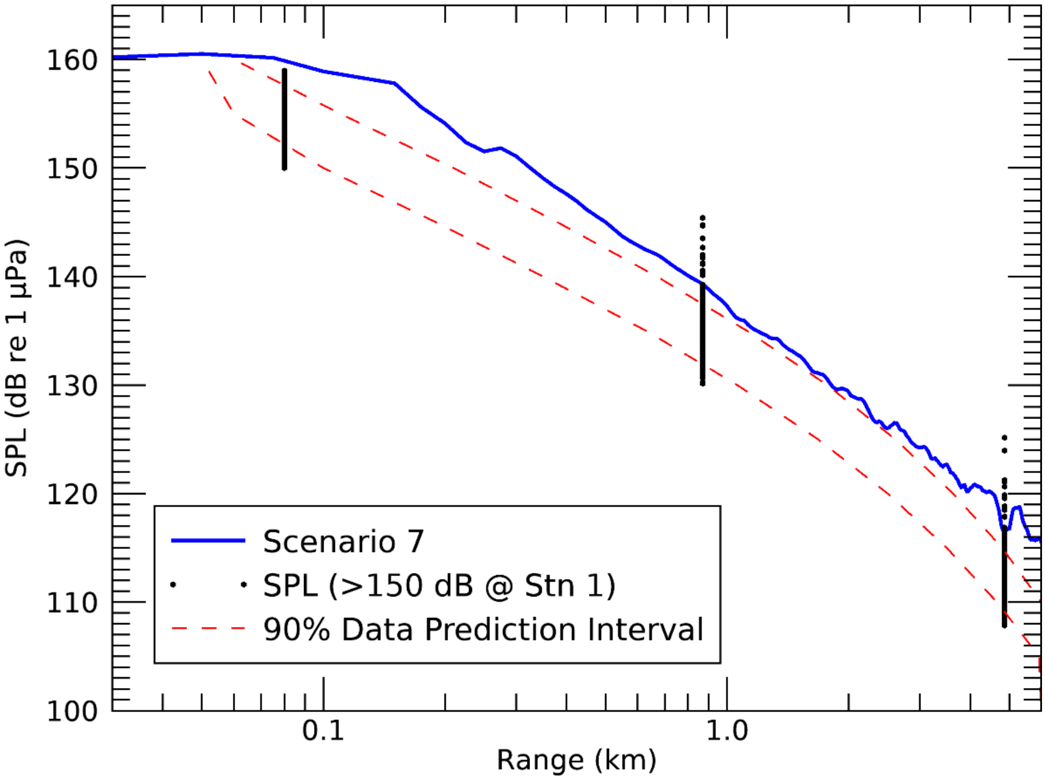


Figure 66. Generalised model validation plot.

6.3. Revised Threshold Distances

The results from the measurement study cannot be directly compared to the modelling presented in Koessler et al. (2020) due to the differences in actual events compared to the nominal representative scenarios developed and evaluated as part of the EP assessment process. Additionally, the measurements were obtained at a receiver 1.2 m off the seafloor, not at the maximum-over-depth results reported in the modelling study. The ranges obtained from the measurement study are reported in relation to the Artisan-1 well location, and thus the centre of the *Ocean Onyx*. The ranges in the modelling study are reported from a range of locations, including the centroids of multiple sources, thus it is not possible to report the measurement results in a similar fashion using the small number of recording locations used in this study.

However, the understanding of the propagation loss environment, and the revision of the representation and treatment of it as detailed in Section 6.2, enabled the modelling scenarios for activities at Artisan-1 presented in Koessler et al. (2020) to be recalculated. The revised results for distances to maximum-over-depth SPL isopleths are presented in Table 14 and compared in Table 15 to the original modelling. The revised results for distances to maximum-over-depth SEL thresholds are presented in Table 16 and compared in Table 17 to the original modelling.

Table 14. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from the most appropriate location for considered sources per scenario (see table footnotes).

SPL (L_p; dB re 1 µPa)	MODU (Scenario 5)		OSV standby (Scenario 6)		MODU and OSV resupply (Scenario 7)[A]		MODU and OSV standby (Scenario 8)[B]	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	0.03	0.03	–	–
170[C]	–	–	–	–	0.06	0.06	–	–
160	–	–	–	–	0.13	0.12	–	–
158[D]	–	–	–	–	0.16	0.15	–	–
150	0.04	0.04	–	–	0.32	0.31	–	–
140	0.12	0.11	0.03	0.03	0.83	0.78	0.03	0.03
130	0.36	0.35	0.14	0.14	2.3	2.16	0.14	0.14
120[E]	1.17	1.09	0.37	0.35	7.02	6.41	2.09	1.9
110	4.74	3.87	0.91	0.88	18.03	15.85	5.21	4.54

[A] Radial distance reported from the mid-point between the MODU and the OSV on DP in resupply operations.

[B] Radial distances for isopleths/thresholds that envelope the MODU and OSV were reported from the mid-point between the MODU and the centre of the OSV standby area. Otherwise radial distances reported from the OSV in the standby area.

[C] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).

[D] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).

[E] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

A dash indicates the level was not reached within the limits of the modelling resolution (25 m).

Table 15. Difference in maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) between Koessler et al. (2020) and modelling completed using data from measurement study. Positive values indicate and increase in distance as compared to Koessler et al. (2020), negative values indicate a decrease.

SPL (L_p; dB re 1 µPa)	MODU (Scenario 5)		OSV standby (Scenario 6)		MODU and OSV resupply (Scenario 3)		MODU and OSV standby (Scenario 4)	
	Difference R_{max} (km)	Difference $R_{95\%}$ (km)	Difference R_{max} (km)	Difference $R_{95\%}$ (km)	Difference R_{max} (km)	Difference $R_{95\%}$ (km)	Difference R_{max} (km)	Difference $R_{95\%}$ (km)
180	*	*	*	*	*	*	*	*
170	*	*	*	*	0.03	0.03	*	*
160	*	*	*	*	0.07	0.06	*	*
158	*	*	*	*	0.07	0.06	*	*
150	-0.04	-0.04	-0.05	-0.05	-0.01	0.0	-0.05	-0.05
140	-0.09	-0.09	-0.34	-0.33	-0.77	-0.75	-0.34	-0.33
130	-0.83	-0.74	-1.75	-1.67	-3.59	-3.25	-3.08	-2.68
120	-4.74	-4.3	-5.86	-5.34	-10.4	-8.99	-6.85	-5.99
110	-30.13	-18.76	-18.06	-14.43	-42.03	-32.65	-31.54	-23.44

An asterisk indicates that the difference in radial distance could not be computed due to distances less than the modelled resolution .

Table 16. Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL$_{24\text{h}}$ PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2).

Hearing group	SEL$_{24\text{h}}$ threshold ($L_{E,24\text{h}}$; dB re 1 µPa^2·s)[B]	MODU (Scenario 5)		OSV standby (Scenario 6)		MODU and OSV resupply (Scenario 7)[A]		MODU and OSV standby (Scenario 8)[A]	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS									
LF cetaceans	199	–	–	–	–	–	–	–	–
MF cetaceans	198	–	–	–	–	–	–	–	–
HF cetaceans	173	0.19	0.11	–	–	0.2	0.12	0.19	0.11
Phocid seals	201	–	–	–	–	–	–	–	–
Otariid seals	219	–	–	–	–	–	–	–	–
Turtles	220	–	–	–	–	–	–	–	–
TTS									
LF cetaceans	179	0.31	0.31	1.01	0.35	0.95	2.78	0.31	0.66
MF cetaceans	178	0.13	0.05	–	–	0.16	0.06	0.13	0.05
HF cetaceans	153	1.07	3.44	1.01	0.18	1.09	3.86	1.06	3.64
Phocid seals	181	0.12	0.05			0.35	0.28	0.12	0.05
Otariid seals	199	–	–	–	–	–	–	–	–
Turtles	200	–	–	–	–	–	–	–	–

[A] Radial distance reported from the centre of the MODU, unless indicated otherwise.

[B] Frequency weighted.

A dash indicates the level was not reached within the limits of the modelling resolution (25 m).

Table 17. Difference in maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) between Koessler et al. (2020) and modelling completed using data from measurement study. Positive values indicate and increase in distance as compared to Koessler et al. (2020), negative values indicate a decrease.

Hearing group	**SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)†**	**MODU (Scenario 5)**	**OSV standby (Scenario 6)**	**MODU and OSV resupply (Scenario 7)**	**MODU and OSV standby (Scenario 8)**
		R_{max} (km)	**R_{max} (km)**	**R_{max} (km)**	**R_{max} (km)**
PTS					
LF cetaceans	199	*	*	*	*
MF cetaceans	198	*	*	*	*
HF cetaceans	173	0.15	*	0.16	0.15
Phocid seals	201	*	*	*	*
Otariid seals	219	*	*	*	*
Turtles	220	*	*	*	*
TTS					
LF cetaceans	179	-0.61	-0.11	-1.78	-2.45
MF cetaceans	178	*	*		
HF cetaceans	153	0.47	-0.03	-1.59	0.02
Phocid seals	181	-0.09	*	0.14	-0.09
Otariid seals	199	*	*	*	*
Turtles	200	*	*	*	*

† Frequency weighted.

An asterisk indicates that the difference in radial distance could not be computed due to distances less than the modelled resolution.

7. Discussion and Conclusion

7.1. Ambient Soundscape

The insights into ambient soundscape within the Otway Basin and in the vicinity of the Development Drilling program can be obtained through the data recorded at Station 4, and in part, Station 3. Stations 1 and 2 are too close to the location of the Artisan-1 well and associated activity to provide any information about ambient noise while the *Ocean Onyx* is present. Whilst data exists outside the period in which the *Ocean Onyx* is present, this data includes noise from the moored rig anchor chains, which are not a typical soundscape contributor.

The correlograms (Section 5.2) show a positive correlation between wind speeds and wave heights and sound levels for frequencies over 100 Hz, with the relationship with wind speed being stronger than that for wave height. For both stations shipping is a strong contributor: most days recorded a significant number of vessel detections (Section 5.6), with the contributions at Station 4 apparent in the power spectral density and percentile plot (Figure 16), between 40 and approximately 100 Hz. If the support vessels for the Development Drilling program did not pass near Station 3 as often while under station keeping, the number of close vessel passes would have been less, and thus it is likely that the statistics presented in Table 10 would have reflected a soundscape with quieter sound levels on average.

In terms of monitoring work with the Otway and Bass Strait regions, between 2009 and 2016 the Integrated Marine Observing System (IMOS) has been recording underwater sound south of Portland, Victoria (38°32.5' S, 115°0.1'E). Prominent sound sources identified in recordings include blue and fin whales at frequencies below 100 Hz, ship noise at 20 to 200 Hz, and fish at 1 to 2 kHz (Erbe et al. 2016). In the broader region, primary contributors to background sound levels were wind, rain and currents-and waves-associated sound at low frequencies under 2 kHz (Przeslawski et al. 2016), and biological sound sources including dolphin vocalisations were also recorded.

To gain an understanding of the existing marine acoustic environment to inform the impact assessment for the Otway Gas Development, acoustic monitoring was undertaken by Woodside (2003). During April-May 2001, two underwater noise loggers were placed (5.1 km and 2.9 km) south-west of an exploration petroleum drilling vessel at the Thylacine site to measure underwater noise before, during, and after drilling activity. Only one of the loggers (5.9 km) was able to be recovered. A further logger was placed in the shipping lane approximately 60 kms due south of Port Fairy to measure ambient noise produced by physical, man-made and biological sources between late November 2001 and early March 2002.

A summary of the report states that the following features were noted with respect to underwater noise environment at the Thylacine location:

- Relatively quiet with only the passage of several boats (about ten) evident.
- The rig tender and drill rig noise show clearly from 13:00 on the 3 May 2001.
- Drill rig noise was evident as sharp tones.
- Rig tender noise was evident either at a low but persistent level for days or in short bursts of high level noise for several hours associated with manoeuvring, use of thrusters or as a close passage by the receiver.
- The horizontal banding characteristic of persistent calling by pygmy blue whales was not evident, rather these call types occurred infrequently and at low levels indicating the respective sources were at long range.
- Evidence of low-level, distant evening fish choruses only.

However, at the shipping lane location, it was noted:

- Regular passages of boats evident.
- Regular evening fish choruses, there were also dawn choruses and persistent low level calling by these sources over daytime.
- Blue whale calling persisted over many hours, an example is the first close passage for the season just before midday on 4 January 2002 followed by several more animals a day later.
- Evidence of calling from at least three other whale species.
- Baseline broadband underwater noise for the period was in the order of 93 to 97 dB re 1 µPa with shipping raising the averaged noise level above 105 dB re 1 µPa for 6% of the deployment time.

An acoustic monitoring program was also undertaken during exploratory drilling of the Casino-3 well. A sound logger located 28.03 km from the drill site did not detect drilling noise and recorded ambient noise that ranged between 90 and 110 dB re 1 µPa (McCauley 2004). Passive acoustic monitoring commissioned by Origin from April 2012 to January 2013, 5 km offshore from the coastline east of Warrnambool, identified that ambient underwater noise in coastal areas is generally higher than further offshore, with a mean of 110 dB re 1 µPa and maximum of 161 dB re 1 µPa.

JASCO has not reviewed these historical reports and the associated activity descriptions within them, or information on the vessels and MODU used, therefore direct comparison between the data collected during exploratory drilling of the Casino-3 well and the Artisan-1 well should be conducted with caution.

Comparing the results from a recorder 28.3 km from drilling operations at Casino 3 with Station 4, the results for Station 4 were a median broadband ambient noise of 104.5 dB re 1 µPa, a mean of 118.3 dB re 1 µPa, a minimum of 86.6 dB re 1 µPa, and a maximum of 153.6 dB re 1 µPa, which is both quieter and louder than those for Casino 3. The mean levels at Station 4 are 8.3 dB higher than those recorded 5 km offshore of Warrnambool, while the maximum recorded at Station 4 is lower by 7.4 dB. The use of percentiles, as provided in Section 5.1.1, Figure 16 and Table 10, in the context of contributors such as weather (Section 5.2), shipping (Section 5.6), and marine mammals (Section 5.7), provides a more nuanced understanding of sound levels received at a recording station. Local variations in ambient noise and received levels can depend upon water depth and the proximity to contributors In this case, the shipping lanes (Section 2.2) and the frequency and proximity of vessel passes are strong drivers of the ambient noise at Station 4. The use of Station 4 as a dedicated measurement location for the support vessels (Section 2.5.2) does not change the relevance of the results from this measurement location, as those vessels would still have been transiting at similar speeds and along similar tracks on trips between Geelong and Artisan-1. The quieter levels reported at Thylacine in Lattice Energy (2017) are likely due to the placement of the monitoring station at a distance from the shipping lanes (Figure 3), which limited their contributions to the data set and thus resulted in a lower reported range of received sound levels.

7.2. Modelling Validation

The Monopole Source Levels determined through the measurement study differed from those either estimated for use in the modelling study or those determined using proxy sources. The key differences are as follows:

- The support vessels are quieter than estimated when they are under slow transit speeds, such as 7 kn.
- The support vessels are louder than estimated when they are travelling at faster transit speeds, with 9 kn used to represent these speeds and the associated MSL.
- The support vessels are louder than estimated when holding station or moving under dynamic positioning.
- The drilling operations of the *Ocean Onyx* are both louder at some frequencies and quieter at others than those for the proxy rig the *Polar Pioneer* (Austin et al. 2018), although the results presented for the *Polar Pioneer* did not examine the changes in level with increased drilling depth (over time) as completed within this study.

The relationship between vessel speed and MSL is well known, with recent detailed examinations on shipping traffic associated with the Port of Vancouver (Joy et al. 2019, Trounce et al. 2019, JASCO Applied Sciences and SMRU Consulting 2020). Conducting the measurement campaign in deeper water, along with higher time resolution location reporting systems for the vessels, automated high time resolution engine information reporting, and a greater number of vessel passes at a range of speeds would further develop this dataset to allow for more accurate predictions of sound level in relation to vessel speed or operations. Predictions of sound levels using speed and operational state is preferred to estimates determined using scaling of power levels, particularly when considering the range of propulsion systems on the vessels.

The measurement of sound levels for vessels under DP is complex and time consuming. It requires dedicated operations in the absence of other activities, which is a challenge considering the task requirements of typical support and anchor handling vessels. Few studies have reported the MSL of support vessels under DP, with the majority estimating the RNL rather than MSL. The large range of thrusters and operational control systems and the variable source depths of each individual thruster contribute to the complexity of estimating source levels. Measurement studies are complicated by environmental conditions and the specifics of each vessel. The MSLs calculated from each of the three DP exercises defined (Section 2.5.2) were very similar. However, the ability to replicate these across different weather conditions and position holding constraints would likely provide valuable information which could help contextualise future modelling studies.

The MSLs reported within this study can be used as inputs to modelling studies for other operations for the same or similar vessels or MODU’s. However, the reported ranges to thresholds are specific to the Artisan-1 well location, and not transferrable to other locations, particularly in different water depths, geologic environments, and sound speed profiles. The approach developed to represent the propagation loss based upon the measurement results is suitable for other locations within the continental shelf portion of the Otway Basin. However, the accuracy of the representation of the propagation loss within this environment depends significantly upon the frequency content of the radiating sound source together with thickness of the sand layer on the calcarenite seabed within the region. In general, the thinner the sand layer, the greater the propagation loss.

The agreement between VSTACK and MONM would be expected depend on the level and frequency content of the modelled source and the thickness of any unconsolidated sediments at the seafloor as low frequency energy will be less sensitive to thin layers. For the comparison conducted here in Section 6.2, the comparison between VSTACK and MONM is excellent when only a comparatively thin 1 m thick layer of sand overlies the carbonate seabed structure. If the data decay rates were more indicative of propagation over a layer of sediment, then MONM could have been used without correction.

The distances to the effect thresholds based on the measurement study results (Section 6.3) are reduced compared to those presented in Koessler et al. (2020). The understanding of the environment gained through the measurement study allowed for the geological environment to be represented in a site specific fashion, and a more appropriate configuration of numerical models to represent the propagation loss. The application of the revised modelling approach to represent other Beach Energy activities on the continental shelf of the Otway Basin would be appropriate.

7.3. Development Drilling Program Contributions

Soundscape contributions of the Development Drilling operations were activity-dependent and depended upon proximity to both the *Ocean Onyx* and associated support vessels. At the three closest stations, the relative contributions are demonstrated through the LTSAs and percentiles for the entire period the *Ocean Onyx* was operational at Artisan-1, and two presented example periods. One of the presented example periods involved significant contributions to the sound fields at the three stations close to the rig presented in Section 5.1.1, as well as considering the per station daily SELs (Section 5.1.2).

A better understanding of the contributions from the Development Drilling operations on a regional scale is provided through the data recorded at Station 4, 25 km from the *Ocean Onyx* (whilst drilling operations were being conducted at Artisan-1), and they did not appear to be a significant contributor to the overall soundscape. While the operational contributions were not significant at Station 4, they were apparent throughout different stages of the activity. At long ranges, the contribution from the drilling itself is hard to distinguish from associated vessel operations, complicated by support vessels manoeuvring over an area greater than 100 km^2. The support vessels operating under dynamic position while completing tasks at Artisan-1 which required high thrust levels, such as anchor handling and accurate station keeping in high sea states, were apparent at Station 4 (for example Figure 44). The configuration of Station 4 to be able to present received signals with the context of direction allowed for the attribution of signals to specific sources. Whilst the recording station 28 km from the Casino 3 drilling operation reported in Lattice Energy (2017) was not able to detect drilling noise, the analysis would not have been able to attribute detected vessel noise to the support vessels for the rig. Therefore, it is likely that the Casino 3 monitoring program recorded noise associated with the drilling program but was unable to attribute it due to the lack of context provided by single omni-directional hydrophone recorder configurations (similar to Stations 1–3).

Periods with less dynamic positioning utilisation, such as between 17:00 and 18:39 on 8 Mar 2021, ShipSound report in Appendix G.1.2, with the spectrogram shown in Figure 37, had only faint potential contributions noticeable at Station 4 (Figure 67). In this figure, long tonals which originate in a north-west direction (the direction of Artisan-1) are apparent between 100 and 250 Hz. However, these are not apparent in data at Station 1 (Figure 37), and thus potentially do not originate close to the rig. In addition to these tonals, the spectrogram shown in Figure 67 shows periods of rain, the approach of the 17 m long sailing boat *Zatara* (Figure 68), which passes within 686 m of Station 4 at a speed of 8 kn, and a likely fish chorus between 800 and 1000 Hz from the north-west.

The rig move operations were apparent, similarly to other periods of high thrust levels, with contributions from the support vessels throughout the tow period matching the relative direction received at Station 4 (Figures 69 and 70). The frequency range, which was still typically detectable at long ranges, 100 to up to 1000 Hz, is above the frequency range for the fundamentals and primary harmonics for pygmy blue whale vocalisations (Section 5.7.2), as shown in Figure 69. Therefore, the potential effect on the communication and listening space (Hannay et al. 2016a), and thus masking, at longer ranges is less apparent than it is for seismic survey activity, or regions in which low frequency signals experience less loss then they do in locations with highly absorptive seabeds.

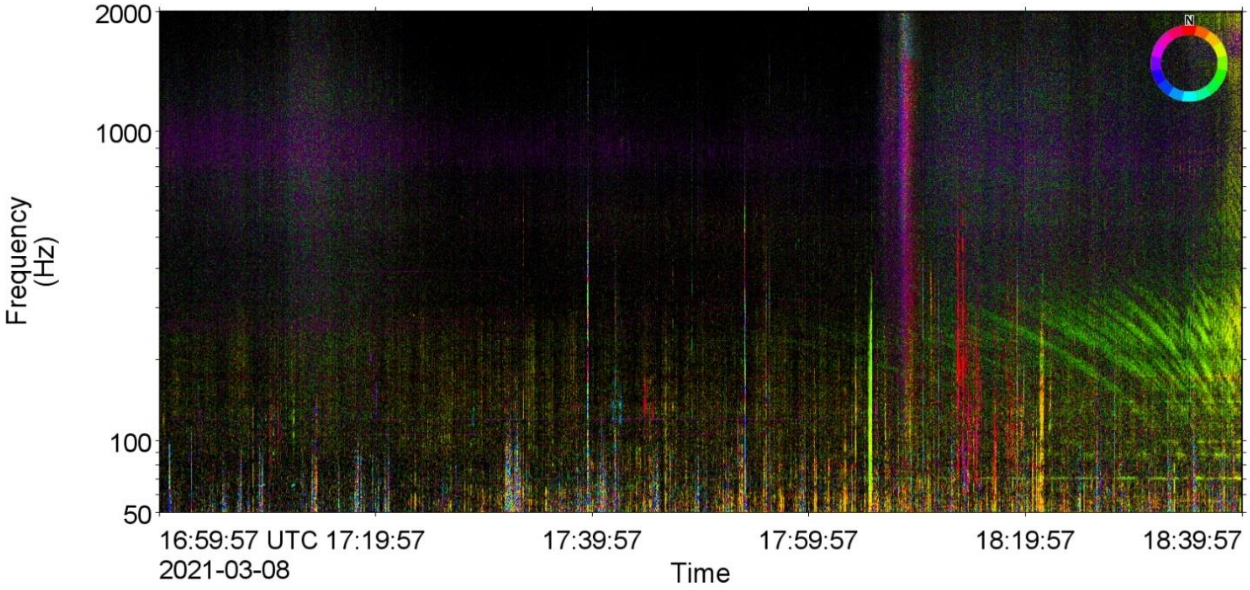


Figure 67. Data recorded on Station 4 including *Ocean Onyx* ShipSound analysis reports between 17:00 and 18:39 on 8 Mar 2021, ShipSound report in Appendix G.1.2, with the spectrogram shown in Figure 37 (0.4 Hz frequency resolution, 2 s time window, 0.5 s time step, Hamming window, normalised across time).

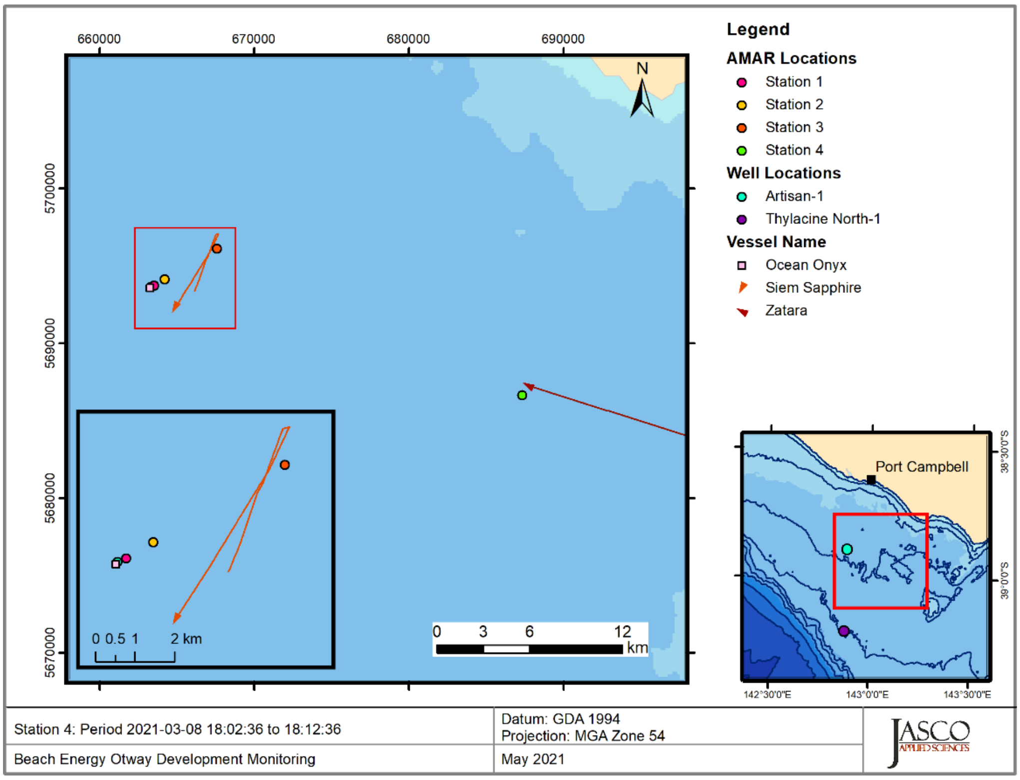


Figure 68. Map of AIS reported vessel locations for the spectrogram shown in Figure 67.

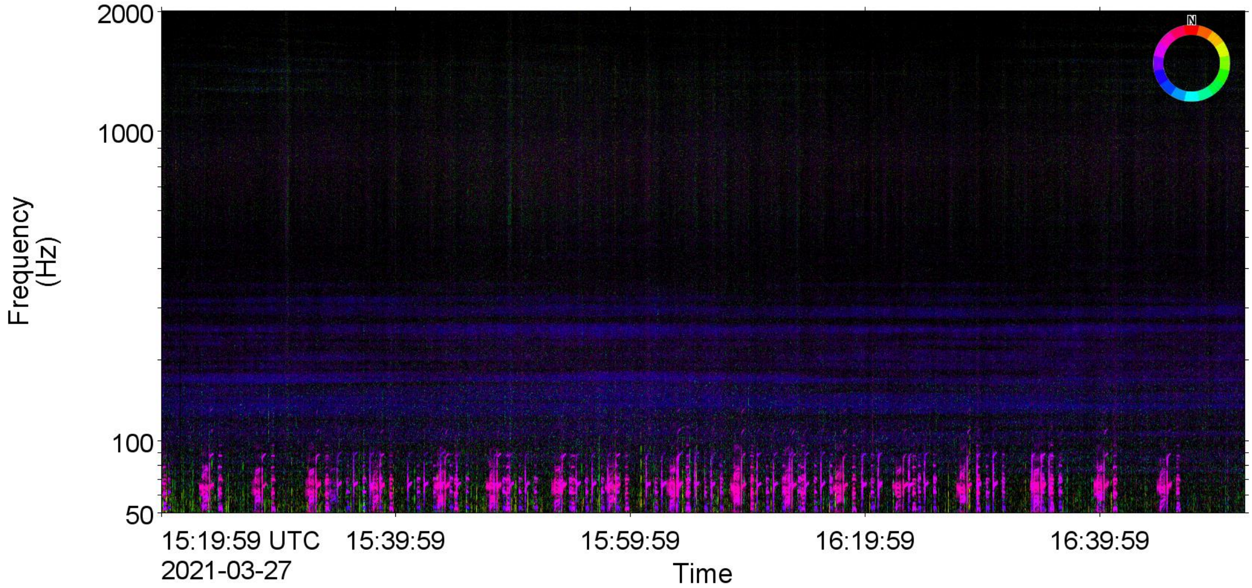


Figure 69. Example of the contribution of the three support vessels and the *Ocean Onyx* while ~23 km away in a south-west direction under tow from Artisan-1 to Geographe, apparent via the blue horizontal striations between 100 and 500 Hz, along with multiple pygmy blue whales in a west to north-west direction of Station 4 (0.4 Hz frequency resolution, 2 s time window, 0.5 s time step, Hamming window, normalised across time).

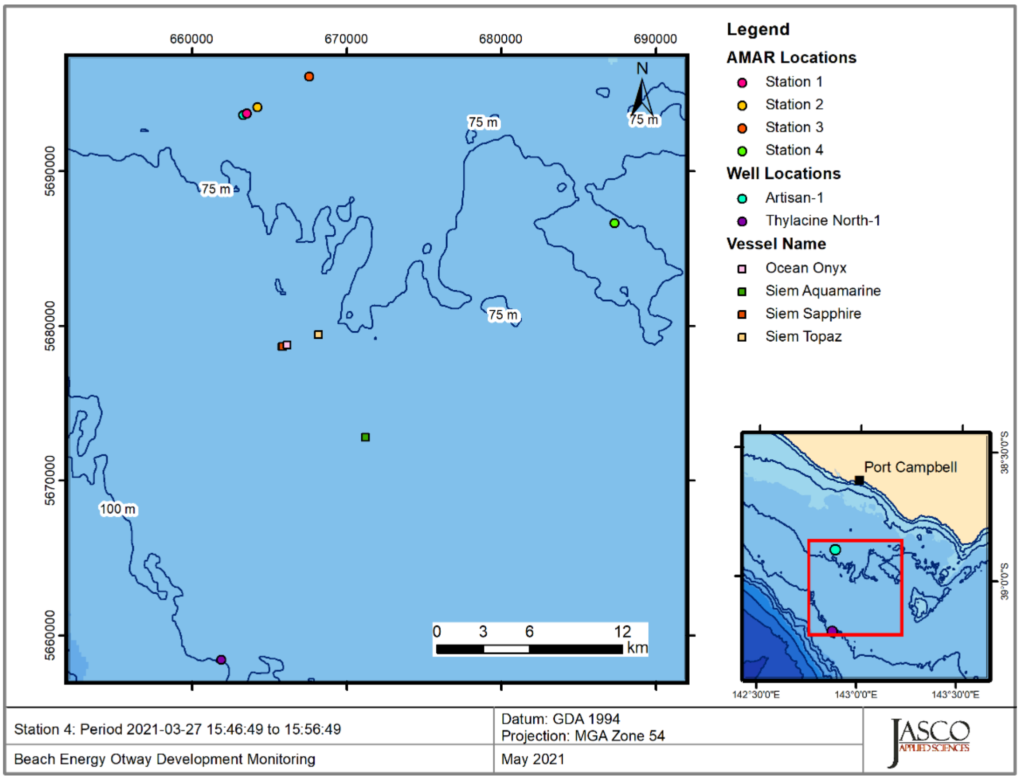


Figure 70. Map of automatic identification system (AIS) reported vessel locations for the spectrogram shown in Figure 69.

7.4. Marine Mammals

The marine mammal acoustic detection results presented in this report provide an index of acoustic occurrence for each species. Although they can be used to describe the relative occurrence of a species, several factors influence the detectability of the targeted signals. Although acoustic detection does indicate presence, an absence of detections (automated or manual) does not necessarily indicate an absence of animals. An animal may be present but not detected if no individuals were vocalising near the recorder, their signals were masked by environmental and/or anthropogenic noise sources, or a combination of these factors. Different sound propagation environments and different seasonal effects will impact the detection range of a given signal over time and, therefore, influence the number of detectable signals. The acoustic signals of both dolphins and pygmy blue whales were present in the acoustic data. vVcalisations of other mysticetes, such as humpback and southern right whales, were not detected by the detectors (D.2), or observed during the 0.5% manual review.

7.4.1. Dolphins

Dolphin species reported in offshore Victorian waters include the short-beaked common and bottlenose dolphins (Bilgmann et al. 2007, Bilgmann et al. 2014). Burrunan dolphins (*Tursiops australis*) can also occur in the region (Charlton-Robb et al. 2015), although they are likely more coastal. While it would be ideal to discriminate between species, success has been limited using automated detectors, and the detailed manual analysis required to attempt to identify individual species is beyond the scope of this report (Steiner 1981, Rendell et al. 1999, Oswald et al. 2003, Baron et al. 2008).

Based on the occurrence of echolocation clicks and whistles, dolphins occurred in the area throughout the recording period at all stations. Dolphin acoustic occurrence was low in February and increased through March at Stations 1, 2, and 3. In contrast, dolphins were consistently present at an almost hourly basis at Station 4. It is impossible to say whether the sparsity of dolphins at Stations 2 and 3 in February is a result of the animals not being common or of their signals being masked by the high noise environment (Figure 16).

The predominance of delphinid clicks during hours of darkness could correspond to foraging on prey species that follow the diel vertical migrations of zooplankton. Similar patterns have been observed in studies of a number of whale species (Víkingsson 1997, Au et al. 2000, Wiggins et al. 2005, Baumgartner and Fratantoni 2008, Sayigh et al. 2013) and by JASCO in studies conducted in northern Australian waters (McPherson et al. 2012, McPherson et al. 2014, McPherson et al. 2016). However, recent research suggests that though such patterns are common, they may not be as closely linked to prey as previously thought (Osiecka et al. 2020).

The presence of sounds believed to be produced by young bottlenose dolphins suggests that not only were dolphins using this region to socialize (indicated by presence of whistles) and forage (indicated by presence of clicks), but they also care for their young.

7.4.2. Pygmy Blue Whales

The acoustic occurrence of pygmy blue whale vocalisations in the acoustic data was unsurprising as they have previously been reported in the region and the Bonney Upwelling is a known foraging area for this species (Garcia-Rojas et al. 2018, McCauley et al. 2018, Möller et al. 2020). Tag data indicates that blue whales are most common in the recording area between January and July, coinciding with the upwelling season of the region (Möller et al. 2020). The lack of clear directional movement during the recording period is unsurprising given both the small sample size and that this area is believed to be a location where blue whales aggregate, as opposed to a migratory corridor where a more consistent pattern in direction over time would be expected. The data does indicate an apparent trend in the animals early in the recording being more to the east and later in the recording being more to the west, but the data were too sparse to confirm anything about animal movements. A monitoring program with directional stations distributed across the Otway Basin would be able to provide this information.

The presence of songs indicates the presence of male pygmy blue whales and the increased regularity of songs at the end of March at all stations corresponds with the onset of the winter singing season for this species (McCauley et al. 2018). Indeed, we cannot say whether the increased vocal activity in March is a result of increased animals in the region or a shift in acoustic behaviour. The blue whale occurrence results were extremely similar across recording stations which is unsurprising given the close vicinity of the recorders that were likely simultaneously recording the same blue whale vocalisations which can propagate great distances, as demonstrated for both pygmy and Antarctic blue whales (Gavrilov and McCauley 2013, Miller et al. 2013, Warren et al. 2021). It is believed that non-song D calls can be produced by male or female blue whales, and it may be a social call (Recalde-Salas et al. 2014).

Acknowledgements

The authors would like to thank the captain and crew of the Siem vessels *Sapphire*, *Aquamarine* and *Topaz*, as well as Klaus Lucke from JASCO for performing the fieldwork.

Glossary

1/3-octave

One third of an octave. Note: A one-third octave is approximately equal to one decidecade (1/3 oct ≈ 1.003 ddec; ISO 2017a).

1/3-octave-band

Frequency band whose bandwidth is one one-third octave. Note: The bandwidth of a one-third octave-band increases with increasing centre frequency.

90%-energy time window

The time interval over which the cumulative energy rises from 5 to 95% of the total pulse energy. This interval contains 90% of the total pulse energy. Symbol: T_{90}.

90% sound pressure level (90% SPL)

The root-mean-square sound pressure levels calculated over the 90%-energy time window of a pulse. Used only for pulsed sounds.

absorption

The reduction of acoustic pressure amplitude due to acoustic particle motion energy converting to heat in the propagation medium.

ambient noise

All-encompassing sound at a given place, usually a composite of sound from many sources near and far (ANSI S1.1-1994 (R2004)), e.g., shipping vessels, seismic activity, precipitation, sea ice movement, wave action, and biological activity.

annotation

A labelled selection of a period of time and frequency within a spectrogram as created by a human analyst during **manual analysis**.

attenuation

The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium.

audiogram

A graph of hearing threshold level (sound pressure levels) as a function of frequency, which describes the hearing sensitivity of an animal over its hearing range.

audiogram weighting

The process of applying an animal’s audiogram to sound pressure levels to determine the sound level relative to the animal’s hearing threshold (HT). Unit: dB re HT.

Auditory frequency weighting (auditory weighting function, frequency-weighting function)

The process of band-pass filtering sounds to reduce the importance of inaudible or less-audible frequencies for individual species or groups of species of aquatic mammals (ISO 2017a). One example is M-weighting introduced by Southall et al. (2007) to describe “Generalised frequency weightings for various functional hearing groups of marine mammals, allowing for their functional bandwidths and appropriate in characterizing auditory effects of strong sounds”.

automated detection

The output of an **automated detector**.

automated detector

An algorithm that includes both the **automated detection** of a sound of interest based on how it stands out from the background and its automated classification based on similarities to templates in a library of reference signals.

background noise

Total of all sources of interference in a system used for the production, detection, measurement, or recording of a signal, independent of the presence of the signal (ANSI S1.1-1994 (R2004)). Ambient noise detected, measured, or recorded with a signal is part of the background noise.

bandwidth

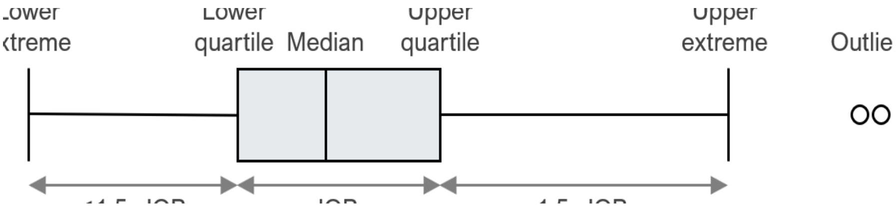
The range of frequencies over which a sound occurs. Broadband refers to a source that produces sound over a broad range of frequencies (e.g., seismic airguns, vessels) whereas narrowband sources produce sounds over a narrow frequency range (e.g., sonar) (ANSI and ASA S1.13-2005 (R2010)).

bar

Unit of pressure equal to 100 kPa, which is approximately equal to the atmospheric pressure on Earth at sea level. 1 bar is equal to 10^5 Pa or 10^{11} µPa.

box-and-whisker plot

A plot that illustrates the centre, spread, and overall range of data from a visual 5-number summary. The box is the interquartile range (IQR), which shows the middle 50% of the data—from the lower quartile (25th percentile) to the upper quartile (75th percentiles). The line inside the box is the median (50th percentile). The whiskers show the lower and upper extremes excluding outliers, which are data points that fall more than 1.5 × IQR beyond the upper and lower quartiles.



broadband sound level

The total sound pressure level measured over a specified frequency range. If the frequency range is unspecified, it refers to the entire measured frequency range.

cavitation

A rapid formation and collapse of vapor cavities (i.e., bubbles or voids) in water, most often caused by a rapid change in pressure. Fast-spinning vessel propellers typically cause cavitation, which creates a lot of noise.

cetacean

Any animal in the order Cetacea. These are aquatic, mostly marine mammals and include whales, dolphins, and porpoises.

continuous sound

A sound whose sound pressure level remains above ambient sound during the observation period (ANSI and ASA S1.13-2005 (R2010)). A sound that gradually varies in intensity with time, for example, sound from a marine vessel.

decade

Logarithmic frequency interval whose upper bound is ten times larger than its lower bound (ISO 2006).

decidecade

One tenth of a decade (ISO 2017a). Note: An alternative name for decidecade (symbol ddec) is “one-tenth decade”. A decidecade is approximately equal to one third of an octave (1 ddec ≈ 0.3322 oct) and for this reason is sometimes referred to as a “one-third octave”.

decidecade band

Frequency band whose bandwidth is one decidecade. Note: The bandwidth of a decidecade band increases with increasing centre frequency.

decibel (dB)

One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power ([ANSI] American National Standards Institute S1.1-1994 (R2004)).

delphinid

Family of oceanic dolphins, or Delphinidae, composed of approximately thirty extant species, including dolphins, porpoises, and killer whales.

duty cycle

The time when sound is periodically recorded by an acoustic recording system.

far-field

The zone where, to an observer, sound originating from an array of sources (or a spatially distributed source) appears to radiate from a single point. The distance to the acoustic far-field increases with frequency.

fast-average sound pressure level

The time-averaged sound pressure levels calculated over the duration of a pulse (e.g., 90%-energy time window), using the leaky time integrator from Plomp and Bouman (1959) and a time constant of 125 ms. Typically used only for pulsed sounds.

fast Fourier transform (FFT)

A computationally efficiently algorithm for computing the discrete Fourier transform.

frequency

The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

hearing group

Groups of marine mammal species with similar hearing ranges. Commonly defined functional hearing groups include low-, mid-, and high-frequency cetaceans, pinnipeds in water, and pinnipeds in air.

harmonic

A sinusoidal sound component that has a frequency that is an integer multiple of the frequency of a sound to which it is related. For example, the second harmonic of a sound has a frequency that is double the fundamental frequency of the sound.

hearing threshold

The sound pressure level for any frequency of the hearing group that is barely audible for a given individual in the absence of significant background noise during a specific percentage of experimental trials.

hertz (Hz)

A unit of frequency defined as one cycle per second.

high-frequency (HF) cetacean

The functional cetacean hearing group that represents those odontocetes (toothed whales) specialised for hearing high frequencies.

hydrophone

An underwater sound pressure transducer. A passive electronic device for recording or listening to underwater sound.

intermittent sound

A level of sound that abruptly drops to the background noise level several times during the observation period.

impulsive sound

Sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA 2013, ANSI S12.7-1986 (R2006)). For example, seismic airguns and impact pile driving.

low-frequency (LF) cetacean

The functional cetacean hearing group that represents mysticetes (baleen whales) specialised for hearing low frequencies.

manual analysis

Human examination of acoustic data via visual review of spectrograms and/or aural inspection of data.

manual detection

The output of **manual analysis** as recorded in an **annotation**.

masking

Obscuring of sounds of interest by sounds at similar frequencies.

mean-square sound pressure spectral density

Distribution as a function of frequency of the mean-square sound pressure per unit bandwidth (usually 1 Hz) of a sound having a continuous spectrum (ANSI S1.1-1994 (R2004)). Unit: $\mu Pa^2/Hz$.

median

The 50th percentile of a statistical distribution.

mid-frequency (MF) cetacean

The functional cetacean hearing group that represents those odontocetes (toothed whales) specialised for mid-frequency hearing.

mysticete

Mysticeti, a suborder of cetaceans, use their baleen plates, rather than teeth, to filter food from water. They are not known to echolocate, but they use sound for communication. Members of this group include rorquals (Balaenopteridae), right whales (Balaenidae), and grey whales (*Eschrichtius robustus*).

non-impulsive sound

Sound that is broadband, narrowband or tonal, brief or prolonged, continuous or intermittent, and typically does not have a high peak pressure with rapid rise time (typically only small fluctuations in decibel level) that impulsive signals have (ANSI S3.20-1995 (R2008)). For example, marine vessels, aircraft, machinery, construction, and vibratory pile driving (NIOSH 1998, NOAA 2015).

octave

The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

odontocete

The presence of teeth, rather than baleen, characterizes these whales. Members of the Odontoceti are a suborder of cetaceans, a group comprised of whales, dolphins, and porpoises. The skulls of toothed whales are mostly asymmetric, an adaptation for their echolocation. This group includes sperm whales, killer whales, belugas, narwhals, dolphins, and porpoises.

peak pressure level (PK)

The maximum instantaneous sound pressure level, in a stated frequency band, within a stated period. Also called zero-to-peak pressure level. Unit: decibel (dB).

percentile level, exceedance

The sound level exceeded *n* % of the time during a measurement.

permanent threshold shift (PTS)

A permanent loss of hearing sensitivity caused by excessive noise exposure. PTS is considered auditory injury.

pinniped

A common term used to describe all three groups that form the superfamily Pinnipedia: phocids (true seals or earless seals), otariids (eared seals or fur seals and sea lions), and walrus.

power spectrum density

Generic term, formally defined as power in W/Hz, but sometimes loosely used to refer to the spectral density of other parameters such as square pressure or time-integrated square pressure.

pressure, acoustic

The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: *p*.

received level (RL)

The sound level measured (or that would be measured) at a defined location.

rms

root-mean-square.

signature

Pressure signal generated by a source.

sound

A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound exposure

Time integral of squared, instantaneous frequency-weighted sound pressure over a stated time interval or event. Unit: pascal-squared second ($Pa^2 \cdot s$) (ANSI S1.1-1994 (R2004)).

sound exposure level (SEL)

A cumulative measure related to the sound energy in one or more pulses. Unit: dB re 1 $\mu Pa^2 \cdot s$. SEL is expressed over the summation period (e.g., per-pulse SEL [for airguns], single-strike SEL [for pile drivers], 24-hour SEL).

sound exposure spectral density

Distribution as a function of frequency of the time-integrated squared sound pressure per unit bandwidth of a sound having a continuous spectrum (ANSI S1.1-1994 (R2004)). Unit: $\mu Pa^2 \cdot s/Hz$.

sound pressure level (SPL)

The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 (R2004)).

For sound in water, the reference sound pressure is one micropascal (p_0 = 1 μPa) and the unit for SPL is dB re 1 μPa^2:

$$L_p = 10\log_{10}(p^2/p_0^2) = 20\log_{10}(p/p_0)$$

Unless otherwise stated, SPL refers to the root-mean-square (rms) pressure level. See also 90% sound pressure level and fast-average sound pressure level. Non-rectangular time window functions may be applied during calculation of the rms value, in which case the SPL unit should identify the window type.

source level (SL)

The sound level measured in the far-field and scaled back to a standard reference distance of 1 metre from the acoustic centre of the source. Unit: dB re 1 μPa·m (pressure level) or dB re 1 $\mu Pa^2 \cdot s \cdot m$ (exposure level).

spectral density level

The decibel level ($10 \cdot \log_{10}$) of the spectral density of a given parameter such as SPL or SEL, for which the units are dB re 1 $\mu Pa^2/Hz$ and dB re 1 $\mu Pa^2 \cdot s/Hz$, respectively.

spectrogram

A visual representation of acoustic amplitude compared with time and frequency.

spectrum

An acoustic signal represented in terms of its power, energy, mean-square sound pressure, or sound exposure distribution with frequency.

validated detection

The output of an **automated detector** that has been subsequently validated by a human analyst.

Literature Cited

[ANSI] American National Standards Institute. 12.64-2009 (R2014). *Grade C – Survey Method - Quantities and Procedures for Description and Measurement of Underwater Sound from Ships – Part 1: General Requirements*.

[ANSI] American National Standards Institute. S1.1-1994 (R2004). *American National Standard: Acoustical Terminology*. NY, USA. https://webstore.ansi.org/Standards/ASA/ANSIS11994R2004.

[ANSI] American National Standards Institute and [ASA] Acoustical Society of America. S1.1-2013. *American National Standard: Acoustical Terminology*. NY, USA. https://webstore.ansi.org/Standards/ASA/ANSIASAS12013.

[ANSI] American National Standards Institute and [ASA] Acoustical Society of America. S1.13-2005 (R2010). *American National Standard: Measurement of Sound Pressure Levels in Air*. NY, USA. https://webstore.ansi.org/Standards/ASA/ANSIASAS1132005R2010.

[ANSI] American National Standards Institute and [ASA] Acoustical Society of America. S3.20-1995 (R2008). *American National Standard: Bioacoustical Terminology*. NY, USA. https://webstore.ansi.org/Standards/ASA/ANSIASAS3201995R2008.

[ANSI] American National Standards Institute. S12.7-1986 (R2006). *American National Standard: Methods for Measurements of Impulsive Noise*. NY, USA. https://webstore.ansi.org/Standards/ASA/ANSIS121986R2006.

[ISO] International Organization for Standardization. 2006. *ISO 80000-3:2006 Quantities and units – Part 3: Space and time*. https://www.iso.org/standard/31888.html.

[ISO] International Organization for Standardization. 2017a. *ISO 18405:2017. Underwater acoustics – Terminology*. Geneva. https://www.iso.org/standard/62406.html.

[ISO] International Organization for Standardization. 2017b. *ISO 18406:2017(E). Underwater acoustics – Measurement of radiated underwater sound from percussive pile driving*. Geneva. https://www.iso.org/obp/ui/#iso:std:iso:18406:ed-1:v1:en.

[NIOSH] National Institute for Occupational Safety and Health. 1998. *Criteria for a recommended standard: Occupational noise exposure. Revised Criteria*. Document Number 98-126. US Department of Health and Human Services, NIOSH, Cincinnati, OH, USA. 122 p. https://www.cdc.gov/niosh/docs/98-126/pdfs/98-126.pdf.

[NMFS] National Marine Fisheries Service (US). 2016. *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. 178 p.

[NMFS] National Marine Fisheries Service (US). 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p. https://www.fisheries.noaa.gov/webdam/download/75962998.

[NOAA] National Oceanic and Atmospheric Administration (US). 2013. *Draft guidance for assessing the effects of anthropogenic sound on marine mammals: Acoustic threshold levels for onset of permanent and temporary threshold shifts*. National Oceanic and Atmospheric Administration, US Department of Commerce, and NMFS Office of Protected Resources, Silver Spring, MD, USA. 76 p.

[NOAA] National Oceanic and Atmospheric Administration (US). 2015. *Draft guidance for assessing the effects of anthropogenic sound on marine mammal hearing: Underwater acoustic threshold levels for onset of permanent and temporary threshold shifts*. NMFS Office of Protected Resources, Silver Spring, MD, USA. 180 p.

[NOAA] National Oceanic and Atmospheric Administration (US). 2019. *ESA Section 7 Consultation Tools for Marine Mammals on the West Coast* (webpage), 27 Sep 2019. https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west. (Accessed 10 Mar 2020).

[NRC] National Research Council (US). 2003. *Ocean Noise and Marine Mammals*. National Research Council (US), Ocean Studies Board, Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals. The National Academies Press, Washington, DC, USA. https://doi.org/10.17226/10564.

Ainslie, M.A., J.L. Miksis-Olds, S.B. Martin, K.D. Heaney, C.A.F. de Jong, A.M. von Benda-Beckmann, and A.P. Lyons. 2018. *ADEON Underwater Soundscape and Modeling Metadata Standard*. Version 1.0. Technical report by JASCO Applied Sciences for ADEON Prime Contract No. M16PC00003. https://doi.org/10.6084/m9.figshare.6792359.v2.

Ainslie, M.A., S.B. Martin, T.J. Deveau, A.O. MacGillivray, C. Bae, and D. Wittekind. 2020. *Towards a Standard for Vessel URN Measurement in Shallow Water: Applying Acoustical Propagation Modelling to Inform the Design of a Measurement Program that Determines if Shallow Water URN Measurements can be Comparable to those from Deep Water*. Document Number 02167, Version 1.0. White paper by JASCO Applied Sciences for Transport Canada Innovation Center.

Ainslie, M.A., R.K. Andrew, B.M. Howe, and J.A. Mercer. 2021. Temperature-driven seasonal and longer term changes in spatially averaged deep ocean ambient sound at frequencies 63–125 Hz. *Journal of the Acoustical Society of America* 149(4): 2531-2545. https://doi.org/10.1121/10.0003960.

Amorim, M.C.P. 2006. Diversity of sound production in fish. *In* Ladich, F., S.P. Collin, P. Moller, and B.G. Kapoor (eds.). *Communication in fishes*. Volume 1. Science Publishers. pp. 71-104.

Andrew, R.K., B.M. Howe, and J.A. Mercer. 2011. Long-time trends in ship traffic noise for four sites off the North American West Coast. *Journal of the Acoustical Society of America* 129(2): 642-651. https://doi.org/10.1121/1.3518770.

Au, W.W.L., R.A. Kastelein, T. Rippe, and N.M. Schooneman. 1999. Transmission beam pattern and echolocation signals of a harbor porpoise (*Phocoena phocoena*). *Journal of the Acoustical Society of America* 106(6): 3699-3705. https://doi.org/10.1121/1.428221.

Au, W.W.L., J. Mobley, W.C. Burgess, M.O. Lammers, and P.E. Nachtigall. 2000. Seasonal and diurnal trends of chorusing humpback whales wintering in waters off Western Maui. *Marine Mammal Science* 16(3): 530-544. https://doi.org/10.1111/j.1748-7692.2000.tb00949.x.

Austin, M.E., D.E. Hannay, and K.C. Bröker. 2018. Acoustic characterization of exploration drilling in the Chukchi and Beaufort seas. *Journal of the Acoustical Society of America* 144: 115-123. https://doi.org/10.1121/1.5044417

Bailey, H., G. Clay, E.A. Coates, D. Lusseau, B. Senior, and P.M. Thompson. 2010. Using T-PODs to assess variations in the occurrence of coastal bottlenose dolphins and harbour porpoises. *Aquatic Conservation: Marine and Freshwater Ecosystems* 20(2): 150-158. https://doi.org/10.1002/aqc.1060.

Baron, S.C., A. Martinez, L.P. Garrison, and E.O. Keith. 2008. Differences in acoustic signals from Delphinids in the western North Atlantic and northern Gulf of Mexico. *Marine Mammal Science* 24(1): 42-56. https://doi.org/10.1111/j.1748-7692.2007.00168.x.

Baumgartner, M.F. and D.M. Fratantoni. 2008. Diel periodicity in both sei whale vocalization rates and the vertical migration of their copepod prey observed from ocean gliders. *Limnology and Oceanography* 53(5): 2197-2209. https://doi.org/10.4319/lo.2008.53.5_part_2.2197.

Berchok, C.L., D.L. Bradley, and T.B. Gabrielson. 2006. St. Lawrence blue whale vocalizations revisited: Characterization of calls detected from 1998 to 2001. *Journal of the Acoustical Society of America* 120(4): 2340-2354. https://doi.org/10.1121/1.2335676.

Bilgmann, K., L.M. Möller, R.G. Harcourt, S.E. Gibbs, and L.B. Beheregaray. 2007. Genetic differentiation in bottlenose dolphins from South Australia: association with local oceanography and coastal geography. *Marine Ecology Progress Series* 341: 265-276.

Bilgmann, K., G.J. Parra, N. Zanardo, L.B. Beheregaray, and L.M. Möller. 2014. Multiple management units of short-beaked common dolphins subject to fisheries bycatch off southern and southeastern Australia. *Marine Ecology Progress Series* 500: 265-279.

Bom, N. 1969. Effect of rain on underwater noise level. *Journal of the Acoustical Society of America* 45(1): 150-156. https://doi.org/10.1121/1.1911351.

Brekhovskikh, L.M. 1980. *Waves in Layered Media*. 2nd edition. Applied mathematics and mechanics, Volume 16. Academic Press, New York. 503 p.

Brekhovskikh, L.M. and Y.P. Lysanov. 2003. *Fundamentals of Ocean Acoustics*, New York.

Carnes, M.R. 2009. *Description and Evaluation of GDEM-V 3.0*. US Naval Research Laboratory, Stennis Space Center, MS. NRL Memorandum Report 7330-09-9165. 21 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/a494306.pdf.

Cato, D.H. 1991. *Songs of humpback whales: The Australian perspective*. Defence Science and Technology Organisation, Canberra, Australia.

Cato, D.H. 1992. The biological contribution to the ambient noise in waters near Australia. *Acoustics Australia* 20(3): 76-80. http://www.acoustics.asn.au/journal/Vol20No3.pdf#page=10.

Cato, D.H. 1997. Ambient sea noise in Australian waters. *5th International Congress on Sound and Vibration*. Volume 5, 15-18 Dec 1997, Adelaide, Australia. pp. 2813-2818.

Charlton-Robb, K., A. Taylor, and S. McKechnie. 2015. Population genetic structure of the Burrunan dolphin (*Tursiops australis*) in coastal waters of south-eastern Australia: conservation implications. *Conservation Genetics* 16(1): 195-207.

Clark, C.W. 1990. Acoustic behaviour of mysticete whales. *In* Thomas, J.A. and R.A. Kastelein (eds.). *Sensory Abilities of Cetaceans*. Springer, Boston, MA. pp. 571-583. https://doi.org/10.1007/978-1-4899-0858-2_40.

Collins, M.D. 1993. A split-step Padé solution for the parabolic equation method. *Journal of the Acoustical Society of America* 93(4): 1736-1742. https://doi.org/10.1121/1.406739.

Coppens, A.B. 1981. Simple equations for the speed of sound in Neptunian waters. *Journal of the Acoustical Society of America* 69(3): 862-863. https://doi.org/10.1121/1.382038.

D'Spain, G.L. and H.H. Batchelor. 2006. Observations of biological choruses in the Southern California Bight: A chorus at midfrequencies. *Journal of the Acoustical Society of America* 120(4): 1942-1955.

Delarue, J.J.-Y., K.A. Kowarski, E.E. Maxner, J.T. MacDonnell, and S.B. Martin. 2018. *Acoustic Monitoring Along Canada's East Coast: August 2015 to July 2017*. Document Number 01279, Environmental Studies Research Funds Report Number 215, Version 1.0. Technical report by JASCO Applied Sciences for Environmental Studies Research Fund, Dartmouth, NS, Canada. 120 pp + appendices.

Edds-Walton, P.L. 1997. Acoustic communication signals of mysticetes whales. *Bioacoustics* 8(1-2): 47-60. https://doi.org/10.1080/09524622.1997.9753353.

Erbe, C., A. Verma, R.D. McCauley, A. Gavrilov, and I. Parnum. 2015. The marine soundscape of the Perth Canyon. *Progress in Oceanography* 137: 38-51. https://doi.org/10.1016/j.pocean.2015.05.015.

Erbe, C., R.D. McCauley, A. Gavrilov, S. Madhusudhana, and A. Verma. 2016. The underwater soundscape around Australia. *ACOUSTICS 2016*. 9-11 Nov 2016, Brisbane, Australia.

Erbe, C., R. Dunlop, K.C.S. Jenner, M.-N.M. Jenner, R.D. McCauley, I. Parnum, M. Parsons, T. Rogers, and C. Salgado-Kent. 2017. Review of underwater and in-air sounds emitted by Australian and Antarctic marine mammals. *Acoustics Australia*. https://doi.org/10.1007/s40857-017-0101-z.

Erbs, F., S.H. Elwen, and T. Gridley. 2017. Automatic classification of whistles from coastal dolphins of the southern African subregion. *Journal of the Acoustical Society of America* 141(4): 2489-2500. https://doi.org/10.1121/1.4978000.

Finneran, J.J. and A.K. Jenkins. 2012. *Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis*. SPAWAR Systems Center Pacific, San Diego, CA, USA. 64 p.

Finneran, J.J. 2015. *Auditory weighting functions and TTS/PTS exposure functions for cetaceans and marine carnivores*. Technical report by SSC Pacific, San Diego, CA, USA.

Finneran, J.J. 2016. *Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise*. Technical Report for Space and Naval Warfare Systems Center Pacific, San Diego, CA, USA. 49 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/1026445.pdf.

François, R.E. and G.R. Garrison. 1982a. Sound absorption based on ocean measurements: Part I: Pure water and magnesium sulfate contributions. *Journal of the Acoustical Society of America* 72(3): 896-907. https://doi.org/10.1121/1.388170.

François, R.E. and G.R. Garrison. 1982b. Sound absorption based on ocean measurements: Part II: Boric acid contribution and equation for total absorption. *Journal of the Acoustical Society of America* 72(6): 1879-1890. https://doi.org/10.1121/1.388673.

Garcia-Rojas, M.I., K.C.S. Jenner, P.C. Gill, M.N.M. Jenner, A.L. Sutton, and R.D. McCauley. 2018. Environmental evidence for a pygmy blue whale aggregation area in the Subtropical Convergence Zone south of Australia. *Marine Mammal Science* 34(4): 901-923.

Gavrilov, A.N. and R.D. McCauley. 2013. Acoustic detection and long-term monitoring of pygmy blue whales over the continental slope in southwest Australia. *Journal of the Acoustical Society of America* 134(3): 2505-2513. https://doi.org/10.1121/1.4816576.

Gavrilov, A.N., R.D. McCauley, G. Paskos, and A. Goncharov. 2018. Southbound migration corridor of pygmy blue whales off the northwest coast of Australia based on data from ocean bottom seismographs. *Journal of the Acoustical Society of America* 144(4): EL281-EL285. https://doi.org/10.1121/1.5063452.

Hannay, D., R. Racca, S. Carr, M. Jenkerson, R. Melton, D. Hedgeland, and S.L. Tsoflias. 2010. A model based assessment of underwater sound levels during a seismic source soft-start operation. *SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production* 12–14 April 2010. Society of Petroleum Engineers, Rio de Janeiro, Brazi. p. 7.

Hannay, D.E., J.J.-Y. Delarue, X. Mouy, S.B. Martin, D. Leary, J.N. Oswald, and J. Vallarta. 2013. Marine mammal acoustic detections in the northeastern Chukchi Sea, September 2007–July 2011. *Continental Shelf Research* 67: 127-146. https://doi.org/10.1016/j.csr.2013.07.009.

Hannay, D.E., M.-N.R. Matthews, A. Schlesinger, L. Hatch, and J. Harrison. 2016a. Lost listening area assessment of anthropogenic sounds in the Chukchi Sea [abstact]. *Journal of the Acoustical Society of America* 140(4): 3072-3073. https://doi.org/10.1121/1.4969572.

Hannay, D.E., X. Mouy, and Z. Li. 2016b. An automated real-time vessel sound measurement system for calculating monopole source levels using a modified version of ANSI/ASA S12.64-2009. *Canadian Acoustics* 44(3). https://jcaa.caa-aca.ca/index.php/jcaa/article/view/3002.

Hawkins, A.D., L. Casaretto, M. Picciulin, and K. Olsen. 2002. Locating Spawning Haddock by Means of Sound. *Bioacoustics* 12(2-3): 284-286. https://doi.org/10.1080/09524622.2002.9753723.

Heap, A.D. 2009. *Marine Sediments (MARS) Database* (webpage). Commonwealth of Australia (Geoscience Australia), Creative Commons Attribution 4.0 International Licence. http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_69869.

Heindsmann, T.E., R.H. Smith, and A.D. Arneson. 1955. Effect of rain upon underwater noise levels [Letter to the editor]. *Journal of the Acoustical Society of America* 27(2): 378-379. https://doi.org/10.1121/1.1907897.

Hildebrand, J.A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. *Marine Ecology Progress Series* 395: 5-20. https://doi.org/10.3354/meps08353.

Hodge, K.B., C.A. Muirhead, J.L. Morano, C.W. Clark, and A.N. Rice. 2015. North Atlantic right whale occurrence near wind energy areas along the mid-Atlantic US coast: Implications for management. *Endangered Species Research* 28(3): 225-234. https://doi.org/10.3354/esr00683.

Houser, D.S., W. Yost, R. Burkard, J.J. Finneran, C. Reichmuth, and J. Mulsow. 2017. A review of the history, development and application of auditory weighting functions in humans and marine mammals. *Journal of the Acoustical Society of America* 141(3): 1371-1413. https://doi.org/10.1121/1.4976086.

James, N.P. and Y. Bone. 2010. *Neritic carbonate sediments in a temperate realm: southern Australia*. Springer Science & Business Media.

JASCO Applied Sciences and SMRU Consulting. 2020. *ECHO Program 2019 Voluntary Vessel Slowdown Hydroacoustic Studies: Final Report*. Document Number 01994, Version 1.0. Technical report by JASCO Applied Sciences and SMRU Consulting for Vancouver Fraser Port Authority.

Jensen, F.B., W.A. Kuperman, M.B. Porter, and H. Schmidt. 2011. *Computational Ocean Acoustics*. 2nd edition. AIP Series in Modern Acourics and Signal Processing. AIP Press - Springer, New York. 794 p. https://doi.org/10.1007/978-1-4419-8678-8.

Jolliffe, C.D., R.D. McCauley, A.N. Gavrilov, K.C.S. Jenner, M.-N.M. Jenner, and A.J. Duncan. 2019. Song variation of the South Eastern Indian Ocean pygmy blue whale population in the Perth Canyon, Western Australia. *PLOS ONE* 14(1): e0208619. https://doi.org/10.1371/journal.pone.0208619.

Joy, R., D.J. Tollit, J.D. Wood, A.O. MacGillivray, Z. Li, K. Trounce, and O. Robinson. 2019. Potential Benefits of Vessel Slowdowns on Endangered Southern Resident Killer Whales. *Frontiers in Marine Science* 6: 344. https://doi.org/10.3389/fmars.2019.00344.

Knudsen, V.O., R.S. Alford, and J.W. Emling. 1948. Underwater ambient noise. *Journal of Marine Research* 7: 410-429.

Koessler, M.W., M.-N.R. Matthews, and C.R. McPherson. 2020. *Otway Offshore Project – Drilling Program: Assessing Marine Fauna Sound Exposures*. Document Number 02033, Version 1.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

Kowarski, K.A., J.J.-Y. Delarue, B.J. Gaudet, and S.B. Martin. 2021. Automatic data selection for validation: A method to determine cetacean occurrence in large acoustic data sets. *JASA Express Letters* 1: 051201. https://doi.org/10.1121/10.0004851.

Krause, B. 2008. Anatomy of the Soundscape: Evolving Perspectives. *Journal of the Audio Engineering Society* 56(1/2): 73-80. http://www.aes.org/e-lib/browse.cfm?elib=14377.

Lattice Energy. 2017. *OFFSHORE ENVIRONMENT PLAN SUMMARY: Otway*. VIC 9000 ENV PLN CDN/ID 17275058. https://earthresources.vic.gov.au/__data/assets/word_doc/0006/459510/Lattice-Energy-Otway-Offshore-Continued-Operations-Envionment-Plan-Summary.docx.

Leroy, E.C., F. Samaran, J. Bonnel, and J.-Y. Royer. 2016. Seasonal and Diel Vocalization Patterns of Antarctic Blue Whale (*Balaenoptera musculus intermedia*) in the Southern Indian Ocean: A Multi-Year and Multi-Site Study. *PLOS ONE* 11(11): e0163587. https://doi.org/10.1371/journal.pone.0163587.

MacGillivray, A.O., Z. Li, D.E. Hannay, K.B. Trounce, and O. Robinson. 2019. Slowing deep-sea commercial vessels reduces underwater radiated noise. *Journal of the Acoustical Society of America* 146: 340-351. https://doi.org/10.1121/1.5116140.

Martin, B. 2013. Computing cumulative sound exposure levels from anthropogenic sources in large data sets. *Proceedings of Meetings on Acoustics* 19(1): 9. https://doi.org/10.1121/1.4800967.

Martin, S.B., C. Morris, K. Bröker, and C. O'Neill. 2019. Sound exposure level as a metric for analyzing and managing underwater soundscapes. *Journal of the Acoustical Society of America* 146(1): 135-149. https://doi.org/10.1121/1.5113578.

Martin, S.B., B.J. Gaudet, H. Klinck, P.J. Dugan, J.L. Miksis-Olds, D.K. Mellinger, D.A. Mann, O. Boebel, C.C. Wilson, et al. 2021. Hybrid millidecade spectra: A practical format for exchange of long-term ambient sound data. *JASA Express Letters* 1(1). https://doi.org/10.1121/10.0003324.

Matsumoto, H., D.R. Bohnenstiehl, J. Tournadre, R.P. Dziak, J.H. Haxel, T.K.A. Lau, M. Fowler, and S.A. Salo. 2014. Antarctic icebergs: A significant natural ocean sound source in the Southern Hemisphere. *Geochemistry, Geophysics, Geosystems* 15(8): 3448-3458. https://doi.org/10.1002/2014GC005454.

McCauley, R.D. and D.H. Cato. 2000. Patterns of fish calling in a nearshore environment in the Great Barrier Reef. *Philosophical Transactions of the Royal Society B* 355(1401): 1289-1293. https://doi.org/10.1098/rstb.2000.0686.

McCauley, R.D., C. Jenner, J.L. Bannister, C.K.L. Burton, D.H. Cato, and A. Duncan. 2001. *Blue Whale Calling In The Rottnest Trench - 2000, Western Australia*. Document Number R2001-6 Report Number R2001-6. Report by Centre for Marine Science and Technology (CMST), Curtin University of Technology, Perth, Western Australia. 55 p.

McCauley, R.D. 2004. *Underwater sea noise in the Otway Basin – drilling, seismic and blue whales.* Report prepared by Centre for Marine Science and Technology, Curtin University, for Santos Ltd.

McCauley, R.D. and D.H. Cato. 2016. Evening choruses in the Perth Canyon and their potential link with Myctophidae fishes. *Journal of the Acoustical Society of America* 140(4): 2384-2398.

McCauley, R.D., A.N. Gavrilov, C.D. Jolliffe, R. Ward, and P.C. Gill. 2018. Pygmy blue and Antarctic blue whale presence, distribution and population parameters in southern Australia based on passive acoustics. *Deep Sea Research Part II* 157–158: 154-168. https://doi.org/10.1016/j.dsr2.2018.09.006.

McDonald, M.A., S.L. Mesnick, and J.A. Hildebrand. 2006. Biogeographic characterization of blue whale song worldwide: Using song to identify populations. *Journal of Cetacean Research and Management* 8(1): 55-65.

McDonald, M.A., J.A. Hildebrand, S.M. Wiggins, and D. Ross. 2008. A 50 year comparison of ambient ocean noise near San Clemente Island: A bathymetrically complex coastal region off southern California. *Journal of the Acoustical Society of America* 124(4): 1985-1992. https://doi.org/10.1121/1.2967889.

McPherson, C.R., B. Martin, and C. Erbe. 2012. *Ambient Noise Monitoring in the Timor Sea: December 2010–December 2011*. Document Number 00329, Version 1.0. Technical report by JASCO Applied Sciences for Environmental Resources Management.

McPherson, C.R., H. Frouin-Mouy, J.T. MacDonnell, and B. Martin. 2014. *Poseidon Field–Baseline Underwater Acoustic Monitoring: October 2012–February 2014*. Document Number 00737, Version 1.0 DRAFT. Technical report by JASCO Applied Sciences for Sinclair Knight Merz.

McPherson, C.R., K.A. Kowarski, J.J.-Y. Delarue, C.J. Whitt, J.T. MacDonnell, and B. Martin. 2016. *Passive Acoustic Monitoring of Ambient Noise and Marine Mammals—Barossa Field: July 2014 to July 2015*. Document Number 00997, Version 1.0. Technical report by JASCO Applied Sciences for ANZ Infrastructure & Environment, Jacobs. Appendix M of Barossa Area Development Offshore Project Proposal. http://static.conocophillips.com/files/resources/appendix-e.pdf.

McPherson, C.R., J.J.-Y. Delarue, and E.E. Maxner. 2017. Investigating the presence of Omura's whale in Northwest Australian waters using passive acoustic data. *The Society for Marine Mammalogy Conference*. Halifax, NS, Canada.

Miksis-Olds, J.L. and S.M. Nichols. 2016. Is low frequency ocean sound increasing globally? *Journal of the Acoustical Society of America* 139(1): 501-511. https://doi.org/10.1121/1.4938237.

Miller, B.S., K. Natalie, P. David, B. Jay, C. Susannah, C. Kym, L. Russell, O. Paula, E. Paul, et al. 2013. Real-time acoustic tracking of Antarctic blue whales in the Southern Ocean: Towards a precise abundance estimate. *20th Biennial Conference on the Biology of Marine Mammals*. 9-13 Dec 2013, Dunedin, New Zealand.

Møhl, B., M. Wahlberg, P.T. Madsen, L.A. Miller, and A. Surlykke. 2000. Sperm whale clicks: Directionality and source level revisited. *Journal of the Acoustical Society of America* 107(1): 638-648. https://doi.org/10.1121/1.428329.

Möller, L.M., C.R.M. Attard, K. Bilgmann, V. Andrews-Goff, I. Jonsen, D. Paton, and M.C. Double. 2020. Movements and behaviour of blue whales satellite tagged in an Australian upwelling system. *Scientific Reports* 10(1): 21165. https://doi.org/10.1038/s41598-020-78143-2.

Nedwell, J.R. and A.W. Turnpenny. 1998. The use of a generic frequency weighting scale in estimating environmental effect. *Workshop on Seismics and Marine Mammals*. 23–25 Jun 1998, London, UK.

Nedwell, J.R., A.W. Turnpenny, J. Lovell, S.J. Parvin, R. Workman, J.A.L. Spinks, and D. Howell. 2007. *A validation of the dB$_{ht}$ as a measure of the behavioural and auditory effects of underwater noise*. Document Number 534R1231 Report prepared by Subacoustech Ltd. for Chevron Ltd, TotalFinaElf Exploration UK PLC, Department of Business, Enterprise and Regulatory Reform, Shell UK Exploration and Production Ltd, The Industry Technology Facilitator, Joint Nature Conservation Committee, and The UK Ministry of Defence. 74 p. https://tethys.pnnl.gov/sites/default/files/publications/Nedwell-et-al-2007.pdf.

Nieukirk, S.L., K.M. Stafford, D.K. Mellinger, R.P. Dziak, and C.G. Fox. 2004. Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean. *Journal of the Acoustical Society of America* 115(4): 1832-1843. https://doi.org/10.1121/1.1675816.

Nieukirk, S.L., D.K. Mellinger, S.E. Moore, K. Klinck, R.P. Dziak, and J. Goslin. 2012. Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999–2009. *Journal of the Acoustical Society of America* 131(2): 1102-1112. https://doi.org/10.1121/1.3672648.

Nordeide, J.T. and E. Kjellsby. 1999. Sound from spawning cod at their spawning grounds. *ICES Journal of Marine Science* 56(3): 326-332. https://doi.org/10.1006/jmsc.1999.0473.

Ocean Time Series Group. 2009. *MATLAB Numerical Scientific and Technical Computing*. Scripps Institution of Oceanography, University of California San Diego. http://mooring.ucsd.edu/software.

Osiecka, A.N., O. Jones, and M. Wahlberg. 2020. The diel pattern in harbour porpoise clicking behaviour is not a response to prey activity. *Scientific Reports* 10(1): 1-7.

Oswald, J.N., J.P. Barlow, and T.F. Norris. 2003. Acoustic identification of nine delphinid species in the eastern tropical Pacific Ocean. *Marine Mammal Science* 19(1): 20-37. https://doi.org/10.1111/j.1748-7692.2003.tb01090.x.

Parsons, M.J.G., C.P. Salgado-Kent, S.A. Marley, A.N. Gavrilov, and R.D. McCauley. 2016. Characterizing diversity and variation in fish choruses in Darwin Harbour. *ICES Journal of Marine Science* 73(8): 2058–2074. https://doi.org/10.1093/icesjms/fsw037.

Parsons, M.J.G., C.P. Salgado Kent, A. Recalde-Salas, and R.D. McCauley. 2017. Fish choruses off Port Hedland, Western Australia. *Bioacoustics* 26(2): 135-152. https://doi.org/10.1080/09524622.2016.1227940.

Plomp, R. and M.A. Bouman. 1959. Relation between Hearing Threshold and Duration for Tone Pulses. *Journal of the Acoustical Society of America* 31(6): 749-758. https://doi.org/10.1121/1.1907781.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, et al. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. ASA S3/SC1.4 TR-2014. SpringerBriefs in Oceanography. ASA Press and Springer. https://doi.org/10.1007/978-3-319-06659-2.

Przeslawski, R., D. Bruce, J. Anderson, S. Foster, M. Edmunds, A. Durrant, R. Bradford, A.G. Carroll, S. Williams, et al. 2016. *Marine Seismic Survey Impacts on Fish and Invertebrates*. Final report by Geoscience Australia for the Gippsland Marine Environmental Monitoring Project, Canberra, Australia.

Quijano, J.E., D.E. Hannay, and M.E. Austin. 2019. Composite Underwater Noise Footprint of a Shallow Arctic Exploration Drilling Project. *IEEE Journal of Oceanic Engineering* 44(4): 1228-1239. https://doi.org/10.1109/JOE.2018.2858606.

R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/.

Recalde-Salas, A., C.P. Salgado Kent, M.J.G. Parsons, S.A. Marley, and R.D. McCauley. 2014. Non-song vocalizations of pygmy blue whales in Geographe Bay, Western Australia. *Journal of the Acoustical Society of America* 135(5): EL213-EL218. https://doi.org/10.1121/1.4871581.

Rendell, L.E., J.N. Matthews, A. Gill, J.C.D. Gordon, and D.W. MacDonald. 1999. Quantitative analysis of tonal calls from five odontocete species, examining interspecific and intraspecific variation. *Journal of Zoology* 249(4): 403-410. https://doi.org/10.1111/j.1469-7998.1999.tb01209.x.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. *Marine Mammals and Noise*. Academic Press, San Diego, CA, USA. 576 p. https://doi.org/10.1016/C2009-0-02253-3.

Risch, D., C.W. Clark, P.J. Corkeron, A. Elepfandt, K.M. Kovacs, C. Lydersen, I. Stirling, and S.M. Van Parijs. 2007. Vocalizations of male bearded seals, *Erignathus barbatus*: Classification and geographical variation. *Animal Behaviour* 73(5): 747-762. https://doi.org/10.1016/j.anbehav.2006.06.012.

Ross, D. 1976. *Mechanics of Underwater Noise*. Pergamon Press, NY, USA.

Sayigh, L., N. Quick, G. Hastie, and P.L. Tyack. 2013. Repeated call types in short-finned pilot whales, *Globicephala macrorhynchus*. *Marine Mammal Science* 29(2): 312-324.

Scrimger, J.A., D.J. Evans, G.A. McBean, D.M. Farmer, and B.R. Kerman. 1987. Underwater noise due to rain, hail, and snow. *Journal of the Acoustical Society of America* 81(1): 79-86. https://doi.org/10.1121/1.394936.

Simon, M., K.M. Stafford, K. Beedholm, C.M. Lee, and P.T. Madsen. 2010. Singing behavior of fin whales in the Davis Strait with implications for mating, migration and foraging. *Journal of the Acoustical Society of America* 128(5): 3200-3210. https://doi.org/10.1121/1.3495946.

Širović, A., A. Rice, E. Chou, J.A. Hildebrand, S.M. Wiggins, and M.A. Roch. 2015. Seven years of blue and fin whale call abundance in the Southern California Bight. *Endangered Species Research* 28(1): 61-76. https://doi.org/10.3354/esr00676.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, et al. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals* 33(4): 411-521. https://doi.org/10.1578/AM.33.4.2007.411.

Southall, B.L., J.J. Finneran, C.J. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals* 45(2): 125-232. https://doi.org/10.1578/AM.45.2.2019.125.

Steiner, W.W. 1981. Species-specific differences in pure tonal whistle vocalizations of five western North Atlantic dolphin species. *Behavioral Ecology and Sociobiology* 9(4): 241-246. https://doi.org/10.1007/BF00299878.

Strasberg, M. 1979. Nonacoustic noise interference in measurements of infrasonic ambient noise. *Journal of the Acoustical Society of America* 66(5): 1487-1493. https://doi.org/10.1121/1.383543.

Teague, W.J., M.J. Carron, and P.J. Hogan. 1990. A comparison between the Generalized Digital Environmental Model and Levitus climatologies. *Journal of Geophysical Research* 95(C5): 7167-7183. https://doi.org/10.1029/JC095iC05p07167.

Thode, A.M., T. Sakai, J. Michalec, S. Rankin, M.S. Soldevilla, B. Martin, and K.H. Kim. 2019. Displaying bioacoustic directional information from sonobuoys using “azigrams”. *Journal of the Acoustical Society of America* 146(1): 95-102. https://doi.org/10.1121/1.5114810.

Trounce, K.B., O. Robinson, A.O. MacGillivray, D.E. Hannay, J.D. Wood, D.J. Tollit, and R. Joy. 2019. The effects of vessel slowdowns on foraging habitat of the southern resident killer whales. *Proceedings of Meetings on Acoustics* 37(1). https://doi.org/10.1121/2.0001230.

Tyack, P.L. and C.W. Clark. 2000. Communication and acoustic behavior of dolphins and whales. (Chapter 4) *In* Au, W.W.L., A.N. Popper, and R.R. Fay (eds.). *Hearing by Whales and Dolphins*. Springer, New York. pp. 156-224.

Urazghildiiev, I.R. and S.M. Van Parijs. 2016. Automatic grunt detector and recognizer for Atlantic cod (*Gadus morhua*). *Journal of the Acoustical Society of America* 139(5): 2532-2540. https://doi.org/10.1121/1.4948569.

Urazghildiiev, I.R. and D.E. Hannay. 2017. Maximum likelihood estimators and Cramér–Rao bound for estimating azimuth and elevation angles using compact arrays. *Journal of the Acoustical Society of America* 141(4): 2548-2555. https://doi.org/10.1121/1.4979792.

Urick, R.J. 1974. Sea-bed motion as a source of the ambient noise background of the sea. *Journal of the Acoustical Society of America* 56(3): 1010-1011.

Urick, R.J. 1983. *Principles of Underwater Sound*. 3rd edition. McGraw-Hill, New York, London. 423 p.

van Opzeeland, I. and O. Boebel. 2018. Marine soundscape planning: Seeking acoustic niches for anthropogenic sound. *Journal of Ecoacoustics* 2(5GSNT). https://doi.org/10.22261/JEA.5GSNT8.

Versluis, M., B. Schmitz, A. von der Heydt, and D. Lohse. 2000. How Snapping Shrimp Snap: Through Cavitating Bubbles. *Science* 289(5487): 2114-2117. https://doi.org/10.1126/science.289.5487.2114.

Víkingsson, G.A. 1997. Feeding of fin whales (*Balaenoptera physalus*) off Iceland–diurnal and seasonal variation and possible rates. *Journal of Northwest Atlantic Fishery Science* 22: 77-89.

Wales, S.C. and R.M. Heitmeyer. 2002. An ensemble source spectra model for merchant ship-radiated noise. *Journal of the Acoustical Society of America* 111(3): 1211-1231. https://doi.org/10.1121/1.1427355.

Warren, V.E., A. Širović, C.R. McPherson, K.T. Goetz, C.A. Radford, and R. Constantine. 2021. Passive Acoustic Monitoring Reveals Spatio-Temporal Distributions of Antarctic and Pygmy Blue Whales Around Central New Zealand. *Frontiers in Marine Science* 7(1162). https://doi.org/10.3389/fmars.2020.575257.

Wenz, G.M. 1962. Acoustic Ambient Noise in the Ocean: Spectra and Sources. *Journal of the Acoustical Society of America* 34(12): 1936-1956. https://doi.org/10.1121/1.1909155.

Whiteway, T. 2009. *Australian Bathymetry and Topography Grid, June 2009*. GeoScience Australia, Canberra. http://pid.geoscience.gov.au/dataset/ga/67703.

Wiggins, S.M., E.M. Oleson, M.A. McDonald, and J.A. Hildebrand. 2005. Blue whale (*Balaenoptera musculus*) diel call patterns offshore of Southern California. *Aquatic Mammals* 31(2): 161-168. https://doi.org/10.1578/AM.31.2.2005.161.

Wood, M.A. and C.R. McPherson. 2018. *VSP Acoustic Modelling: Coastal Sound Levels: Enterprise 1 Drilling Program - Otway Basin*. Document Number 01794, Version 1.0. Technical report by JASCO Applied Sciences for Beach Energy Limited.

Woodside. 2003. *Environmental Impact Statement/Environmental Effects Statement: Otway Gas Project*. Woodside Energy Ltd, Perth.

Zelick, R., D. Mann, and A.N. Popper. 1999. Acoustic communication in fishes and frogs. *In* Fay, R.R. and A.N. Popper (eds.). *Comparative Hearing: Fish and Amphibians* Springer-Verlag, New York. pp. 363-411. https://doi.org/10.1007/978-1-4612-0533-3_9.

Zhang, Z.Y. and C.T. Tindle. 1995. Improved equivalent fluid approximations for a low shear speed ocean bottom. *Journal of the Acoustical Society of America* 98(6): 3391-3396. https://doi.org/10.1121/1.413789.

Appendix A. Underwater Acoustics

A.1. Acoustic Metrics

Sound levels with individual metrics defined below, are presented as:

- Broadband and approximate-decade-band SPL over time for these frequency bands for the low sample rate: 10 Hz–32 kHz (Nyquist), 10–100 Hz, 100 Hz to 1 kHz, 1–10 kHz, and 10–32 kHz. For the high sample rate, the Nyquist is 256 kHz.
- Spectrograms: Ambient noise at each station was analysed by Hamming-windowed fast Fourier transforms (FFTs), with 1 Hz resolution and 50% window overlap. The 120 FFTs performed with these settings are averaged to yield 1 min average spectra.
- Statistical distribution of SPL in each decidecade. The boxes of the statistical distributions indicate the first (L_5), second (L_{50}), and third (L_{75}) quartiles. The whiskers indicate the maximum and minimum range of the data. The solid line indicates the sound pressure level (SPL) or L_{eq} in each decidecade.
- Spectral level percentiles: Histograms of each frequency bin per 1 min of data. The L_{eq}, L_5, L_{25}, L_{50}, L_{75}, and L_{95} percentiles are plotted. The L_5 percentile curve is the frequency-dependent level exceeded by 95% of the 1 min averages. Equivalently, 5% of the 1 min spectral levels are above the 95th percentile curve.
- Daily cumulative sound exposure levels (SEL (24 h)): computed for the total received sound energy. The SEL (24 h) is the linear sum of the 1 min sound exposure levels (SEL). These SEL values were weighted to mimic different functional hearing groups according to the marine mammal frequency-weighted curves described in Appendix E.

Sound is most commonly described using the sound pressure level (SPL) metric. Underwater sound amplitude levels are commonly measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 μPa.

SPL (dB re 1 μPa) is the decibel level of the rms pressure in a stated frequency band over a time window (*T; s*) containing the acoustic event:

$$\mathrm{SPL} = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)\,dt \Big/ p_0^2\right) \tag{A-1}$$

The SPL is a measure of the effective pressure level over the duration of an acoustic event, such as the emission of one acoustic pulse or sweep. Because the window length, T, is the divisor, events more spread out in time have a lower SPL even though they may have similar total acoustic energy density.

Power spectral density (PSD) level is a description of how the acoustic power is distributed over different frequencies within a spectrum. It is expressed in dB re 1 μPa^2/Hz.

The sound exposure level (SEL, dB re 1 μPa^2·s) is a measure of the total acoustic energy contained in one or more acoustic events. The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T_{100}):

$$\mathrm{SEL} = 10\log_{10}\left(\int_{T_{100}} p^2(t)\,dt \Big/ T_0 p_0^2\right) \tag{A-2}$$

where T_0 is a reference time interval of 1 s. The SEL represents the total acoustic energy received at a location during an acoustic event; it measures the total sound energy an organism at that location would be exposed to.

Because the SPL and SEL are both computed from the integral of square pressure, these metrics are related by the following expression, which depends only on the duration of the energy time window T:

$$\mathrm{SPL} = \mathrm{SEL} - 10\log_{10}(T) \tag{A-3}$$

Sound level statistics, namely percentiles, were used to quantify the distribution of recorded sound levels. The *n*th percentile level (L_n) is the level (i.e., PSD level, SPL, or SEL) *n*% of the data are below this level. L_{eq} is the linear arithmetic mean of the sound power, which can be substantially different from the median sound level L_{50}. SPL can also be referred to as L_{eq}, which stands for ‘equivalent level’. The two terms are used interchangeably throughout. L_{95}, the level exceeded by only 5% of the data, represents the highest typical sound levels measured. Sound levels between L_5 and L_{99} are generally from very close passes of vessels, very intense weather events, and other infrequent conditions. L_5 represents the quietest typical conditions.

Appendix B. Acoustic Data Analysis Methods

The data sampled at 64 kHz and 512 kHz was processed for ambient sound analysis, vessel noise detection, and detection of all marine mammal vocalisations. This section describes the ambient, vessel, and marine mammal detection algorithms employed (Figure B-1).

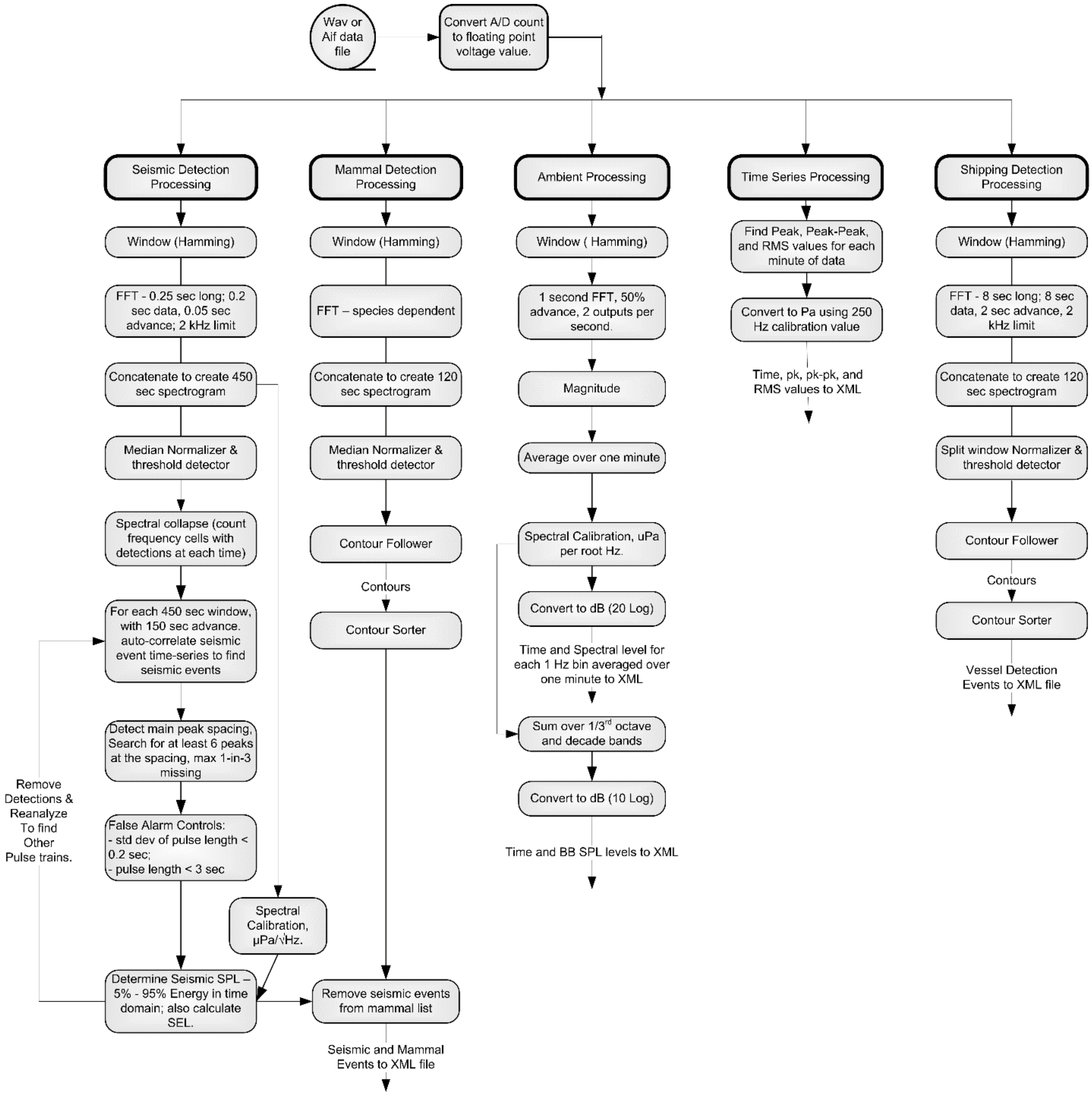


Figure B-1. Major stages of the automated acoustic analysis process performed with JASCO's custom software suite.

B.1. Total Ambient Sound Levels

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 μPa. Because the perceived loudness of sound, especially impulsive noise such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate noise and its effects on marine life. We provide specific definitions of relevant metrics used in this report. Where possible we follow the ANSI and ISO standard definitions and symbols for sound metrics, but these standards are not always consistent.

The zero-to-peak pressure level, or peak pressure level (PK or $L_{p,pk}$; dB re 1 μPa), is the decibel level of the maximum instantaneous sound pressure level in a stated frequency band attained by an acoustic pressure signal, $p(t)$:

$$\mathrm{PK} = L_{p,\mathrm{pk}} = 10\log_{10}\frac{\max|p^2(t)|}{p_0^2} \qquad \text{(B-6)}$$

PK is often included as criterion for assessing whether a sound is potentially injurious; however, because it does not account for the duration of a noise event, it is generally a poor indicator of perceived loudness.

The sound pressure level (SPL or L_p; dB re 1 μPa) is the decibel level of the root-mean-square (rms) pressure in a stated frequency band over a specified time window (T; s) containing the acoustic event of interest. It is important to note that SPL always refers to an rms pressure level and therefore not instantaneous pressure:

$$\mathrm{SPL} = L_p = 10\log_{10}\left[\frac{1}{T}\int_T p^2(t)\,dt \Big/ p_0^2\right] \qquad \text{(B-7)}$$

The SPL represents a nominal effective continuous sound over the duration of an acoustic event, such as the emission of one acoustic pulse, a marine mammal vocalisation, the passage of a vessel, or over a fixed duration. Because the window length, *T*, is the divisor, events with similar sound exposure level (SEL), but more spread out in time have a lower SPL.

The sound exposure level (SEL or L_E, dB re 1 μPa^2·s) is a measure related to the acoustic energy contained in one or more acoustic events (N). The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T):

$$\mathrm{SEL} = L_E = 10\log_{10}\left[\int_T p^2(t)\,dt \Big/ T_0 p_0^2\right] \qquad \text{(B-8)}$$

where T_0 is a reference time interval of 1 s. The SEL continues to increase with time when non-zero pressure signals are present. It therefore can be construed as a dose-type measurement, so the integration time used must be carefully considered in terms of relevance for impact to the exposed recipients.

SEL can be calculated over periods with multiple events or over a fixed duration. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10\log_{10}\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}} \qquad \text{(B-9)}$$

To compute the SPL(T_{90}) and SEL of acoustic events in the presence of high levels of background noise, equations B-6 and B-7 are modified to subtract the background noise contribution:

$$\mathrm{SPL}(T_{90}) = L_{p90} = 10\log_{10}\left[\frac{1}{T_{90}}\int_{T_{90}}\left(p^2(t)-\overline{n^2}\right)dt\Big/p_0^2\right] \tag{B-10}$$

$$L_E = 10\log_{10}\left[\int_T\left(p^2(t)-\overline{n^2}\right)dt\Big/T_0p_0^2\right] \tag{B-11}$$

where $\overline{n^2}$ is the mean square pressure of the background noise, generally computed by averaging the squared pressure of a temporally-proximal segment of the acoustic recording during which acoustic events are absent (e.g., between pulses).

Because the SPL(T_{90}) and SEL are both computed from the integral of square pressure, these metrics are related numerically by the following expression, which depends only on the duration of the time window T:

$$L_p = L_E - 10\log_{10}(T) \tag{B-12}$$

$$L_{p90} = L_E - 10\log_{10}(T_{90}) - 0.458 \tag{B-13}$$

where the 0.458 dB factor accounts for the 10% of SEL missing from the SPL(T_{90}) integration time window.

Energy equivalent SPL (dB re 1 µPa) denotes the SPL of a stationary (constant amplitude) sound that generates the same SEL as the signal being examined, $p(t)$, over the same period of time, T:

$$L_{\mathrm{eq}} = 10\log_{10}\left[\frac{1}{T}\int_T p^2(t)\,dt\Big/p_0^2\right] \tag{B–14}$$

The equations for SPL and the energy-equivalent SPL are numerically identical; conceptually, the difference between the two metrics is that the former is typically computed over short periods (typically of 1 s or less) and tracks the fluctuations of a non-steady acoustic signal, whereas the latter reflects the average SPL of an acoustic signal over times typically of one minute to several hours.

B.2. Decidecade Band Analysis

The distribution of a sound's power with frequency is described by the sound's spectrum. The sound spectrum can be split into a series of adjacent frequency bands. Splitting a spectrum into 1 Hz wide bands, called passbands, yields the power spectral density of the sound. These values directly compare to the Wenz curves, which represent typical deep ocean sound levels (Figure 9) (Wenz 1962). This splitting of the spectrum into passbands of a constant width of 1 Hz, however, does not represent how animals perceive sound.

Because animals perceive exponential increases in frequency rather than linear increases, analysing a sound spectrum with passbands that increase exponentially in size better approximates real-world scenarios. In underwater acoustics, a spectrum is commonly split into decidecade bands, which are one tenth of a decade wide. A decidecade is sometimes referred to as a "1/3-octave" because one tenth of a decade is approximately equal to one third of an octave. Each decade represents a factor 10 in sound frequency. Each octave represents a factor 2 in sound frequency. The centre frequency of the ith band, $f_{\mathrm{c}}(i)$, is defined as:

$$f_{\mathrm{c}}(i) = 10^{\frac{i}{10}}\ \mathrm{kHz} \tag{B-1}$$

and the low (f_{lo}) and high (f_{hi}) frequency limits of the ith decade band are defined as:

$$f_{\mathrm{lo},i} = 10^{\frac{-1}{20}} f_{\mathrm{c}}(i) \quad \text{and} \quad f_{\mathrm{hi},i} = 10^{\frac{1}{20}} f_{\mathrm{c}}(i) \tag{B-2}$$

The decidecade bands become wider with increasing frequency, and on a logarithmic scale the bands appear equally spaced (Figure B-2).

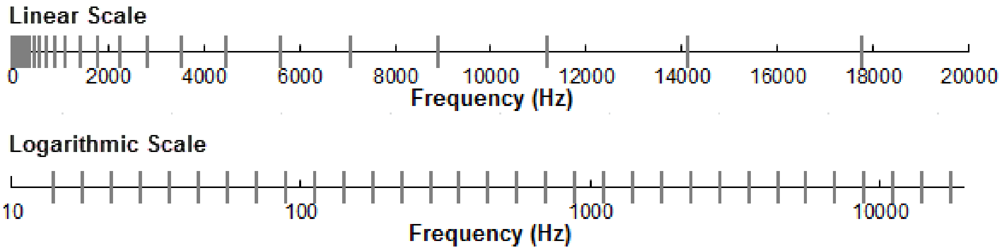


Figure B-2. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale.

The sound pressure level in the ith band ($L_{p,i}$) is computed from the spectrum $S(f)$ between $f_{\mathrm{lo},i}$ and $f_{\mathrm{hi},i}$:

$$L_{p,i} = 10 \log_{10} \int_{f_{\mathrm{lo},i}}^{f_{\mathrm{hi},i}} S(f)\, df \tag{B-3}$$

Summing the sound pressure level of all the bands yields the broadband sound pressure level:

$$\text{Broadband SPL} = 10 \log_{10} \sum_{i} 10^{\frac{L_{p,i}}{10}} \tag{B-4}$$

Figure B-3 shows an example of how the decidecade band sound pressure levels compare to the sound pressure spectral density levels of an ambient noise signal. Because the decidecade bands are wider with increasing frequency, the decidecade band SPL is higher than the spectral levels at higher frequencies. Decidecade band analysis is applied to continuous and impulsive noise sources. For impulsive sources, the decidecade band SEL is typically reported.

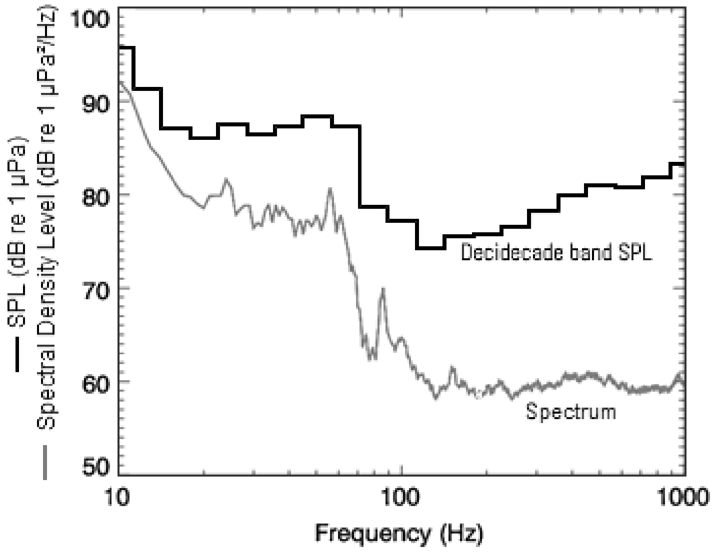


Figure B-3. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale.

Table B-1. Decidecade band frequencies (Hz)

Band	Lower frequency	Nominal centre frequency	Upper frequency
10	8.9	10.0	11.2
11	11.2	12.6	14.1
12	14.1	15.8	17.8
13	17.8	20.0	22.4
14	22.4	25.1	28.2
15	28.2	31.6	35.5
16	35.5	39.8	44.7
17	44.7	50.1	56.2
18	56.2	63.1	70.8
19	70.8	79.4	89.1
20	89.1	100.0	112.2
21	112	126	141
22	141	158	178
23	178	200	224
24	224	251	282
25	282	316	355
26	355	398	447
27	447	501	562
28	562	631	708
29	708	794	891
30	891	1000	1122
31	1122	1259	1413
32	1413	1585	1778
33	1778	1995	2239
34	2239	2512	2818
35	2818	3162	3548
36	3548	3981	4467
37	4467	5012	5623
38	5623	6310	7079
39	7079	7943	8913
40	8913	10000	11220
41	11220	12589	14125
42	14260	16000	17952
43	17825	20000	22440
44	22281	25000	28050
45	28074	31500	35344

Table B-2. Decade-band frequencies (Hz)

Decade band	Lower frequency	Nominal centre frequency	Upper frequency
A	10	50	100
B	100	500	1,000
C	1,000	5,000	10,000

B.3. Millidecade Band Analysis

JASCO Applied Sciences has adopted a hybrid millidecade spectrum system to store and exchange passive acoustic spectral data to optimize data resolution while minimising data size, described in Martin et al. (2021).

Millidecades are logarithmically spaced frequency bands but have a bandwidth equal to 1/1000th of a decade. This frequency resolution is high enough to support many types of analysis, including analysing different types of soundscapes, computing weighted sound exposure levels, and summing the millidecades to find decidecades, 1/3-octave, and other desired frequency bands. The size of the millidecade files greatly compresses the acoustic data compared to 1 Hz resolution, such that data from long-term, multiple-station, high-sampling frequency projects can easily be stored at a single location. For example, there are 1,000 millidecades in each frequency decade, where a decade is an increase in the frequency by a factor of 10. A pure millidecade presentation of a spectrum from 1–100,000 Hz has 5,000 bands rather than 100,000 1 Hz bands, which results in a 20:1 decrease in the amount of data required for storage or exchange. For a 256 kHz spectrum, which is becoming a common size for recorders sampling at 512 kHz, there are 3,206 hybrid millidecades resulting in a compression ratio of 80:1.

The format uses 1-Hz resolution up to 455 Hz and millidecades frequency bands above 455 Hz. The lowest millidecades over-resolve (bin sizes <1 Hz) the space between 1–435 Hz for nearly all soundscape applications. To address this, a hybrid solution was applied that uses 1 Hz bands up to 455 Hz, where the millidecades are 1 Hz wide.

Similar to decidecades, the centre frequency for the ith millidecade (f_{c_i}) is defined as

$$f_{c\_i} = 10^{i/1{,}000}\ (\mathrm{Hz}) \tag{15}$$

and the lower (f_{lo_i}) and upper (f_{hi_i}) bounds for each millidecade are

$$f_{lo\_i} = f_{c\_i} \cdot 10^{-1/2{,}000}\ (\mathrm{Hz}) \tag{16}$$

$$f_{hi\_i} = f_{c\_i} \cdot 10^{1/2{,}000}\ (\mathrm{Hz})\ . \tag{17}$$

Appendix C. Recorder Calibration

The AMAR was calibrated before deployment with a pistonphone type 42AC precision sound source (G.R.A.S. Sound & Vibration A/S; Figure C-1). Due to the unforeseen delay of the retrieval the battery life was exhausted which prevented a calibration after retrieval. The pistonphone calibrator produces a constant tone at 250 Hz at a fixed distance from the hydrophone sensor in an airtight space with known volume. The recorded level of the reference tone on the AMAR yields the system gain for the AMAR and hydrophone. To determine absolute sound pressure levels, this gain was applied during data analysis. Typical calibration variance using this method is less than 0.7 dB absolute pressure.

Figure C-1. Split view of a G.R.A.S. 42AC pistonphone calibrator with an M36 hydrophone.

Appendix D. Marine Mammal Detection Methodology

D.1. Automated Click Detector for Odontocetes

We applied an automated click detector/classifier to the data to detect clicks from odontocetes (Figure D-1.). This detector/classifier is based on the zero-crossings in the acoustic time series. Zero-crossings are the rapid oscillations of a click's pressure waveform above and below the signal's normal level (e.g., Figure D-1.). Clicks are detected by the following steps (Figure D-1.):

1. The raw data is high-pass filtered to remove all energy below 5 kHz. This removes most energy from other sources such as shrimp, vessels, wind, and cetacean tonal calls, yet allows the energy from all marine mammal click types to pass.
2. The filtered samples are summed to create a 0.334 ms rms time series. Most marine mammal clicks have a 0.1–1 ms duration.
3. Possible click events are identified with a split-window normaliser that divides the 'test' bin of the time series by the mean of the 6 'window' bins on either side of the test bin, leaving a 1-bin wide 'notch'.
4. A Teager-Kaiser energy detector identifies possible click events.
5. The high-pass filtered data is searched to find the maximum peak signal within 1 ms of the detected peak.
6. The high-pass filtered data is searched backwards and forwards to find the time span where the local data maxima are within 9 dB of the maximum peak. The algorithm allows for two zero-crossings to occur where the local peak is not within 9 dB of the maximum before stopping the search. This defines the time window of the detected click.
7. The classification parameters are extracted. The number of zero crossings within the click, the median time separation between zero crossings, and the slope of the change in time separation between zero crossings are computed. The slope parameter helps to identify beaked whale clicks, as beaked whales can be identified by the increase in frequency (upsweep) of their clicks.
8. The Mahalanobis distance between the extracted classification parameters and the templates of known click types is computed. The covariance matrices for the known click types, computed from thousands of manually identified clicks for each species, are stored in an external file. Each click is classified as a type with the minimum Mahalanobis distance unless none of them are less than the specified distance threshold.

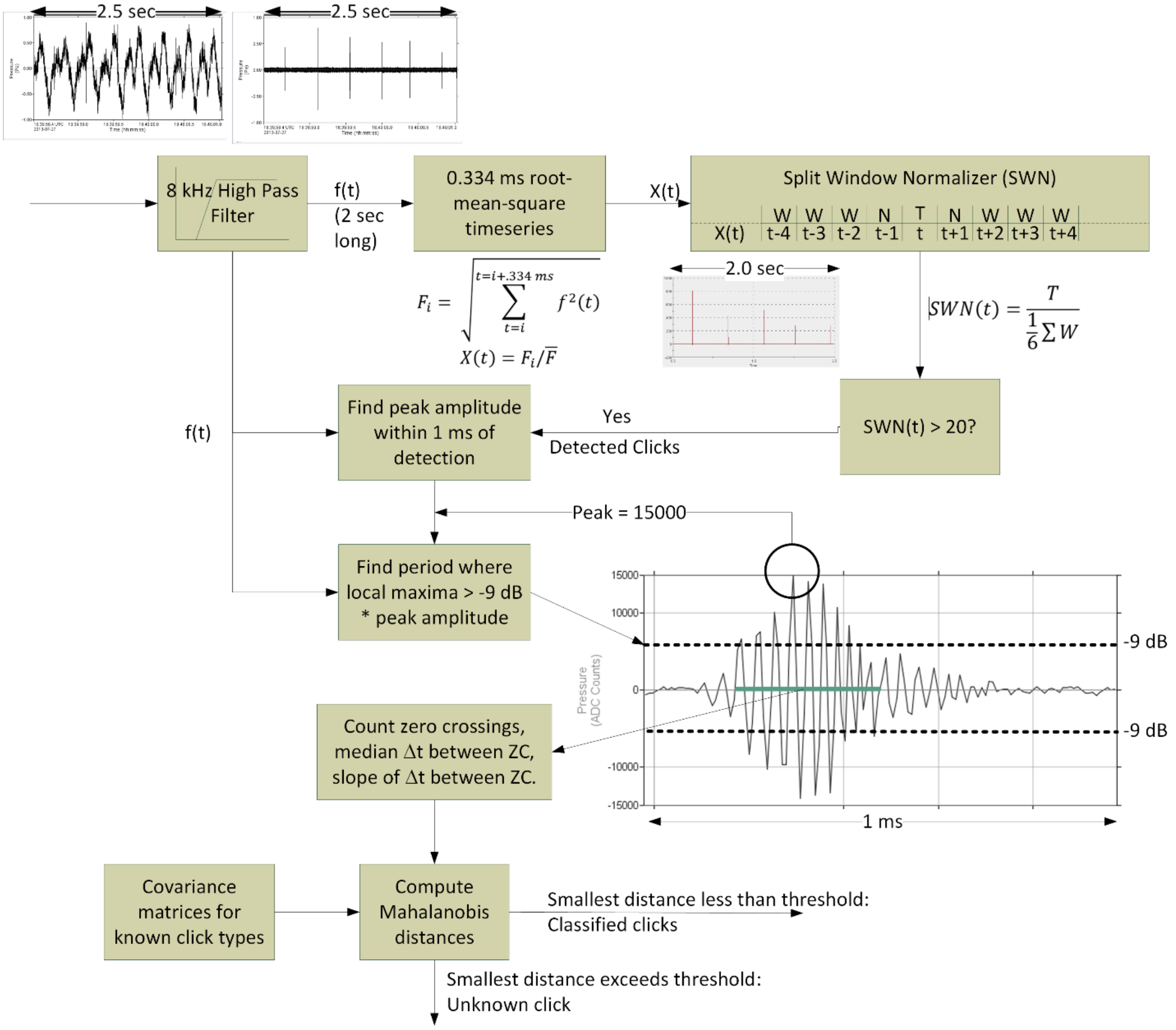


Figure D-1. The automated click detector/classifier block diagram.

Odontocete clicks occur in groups called click trains. Each species has a characteristic inter-click-interval (ICI) and number of clicks per train. The automated click detector includes a second stage that associates individual clicks into trains (Figure D-2). The steps of the click train associator algorithm are:

1. Queue clicks for N seconds, where N is twice the maximum number of clicks per train times the maximum ICI.
2. Search for all clicks within the window that have Mahalanobis distances less than 11 for the species of interest (this gets 99% of all clicks for the species as defined by the template).
3. Create a candidate click train if:
    a. The number of clicks is greater or equal to the minimum number of clicks in a train;
    b. The maximum time between any two clicks is less than twice the maximum ICI, and
    c. The smallest Mahalanobis distance for all clicks in the candidate train is less than 4.1.
4. Create a new ‘time-series’ that has a value of 1 at the time of arrival of each clicks and zeroes everywhere else.
5. Apply a Hann window to the timeseries then compute the cepstrum.

4\. A click train is classified if a peak in the cepstrum with amplitude > 5 times the standard deviation of the cepstrum occurs at a quefrency between the minimum maximum ICI.

5\. Queue clicks for N seconds

6. Search for all clicks within the window that have Mahalanobis distances less than 10 (equal to the extent of the variance in the training data set).
7. If the number of clicks is greater than or equal to 3 and dT is less than 2 * max ICI, make a new time-series at the 0.333 ms rate; where the value is 1 when the clicks occurred and 0 for all other time bins. Perform the following processing on this time series:
   a. Compute cepstrum
   b. ICI is the peak of the cepstrum with amplitude > 5 * stdev and searching for quefrency between minICI and maxICI.
   c. For each click related to the previous Ncepstrum, create a new time series and compute ICI; if we get a good match, extend the click train; find a mean ICI and variance.
8. If the click features, total clicks and mean ICI match the species, output a species_click_train detection.

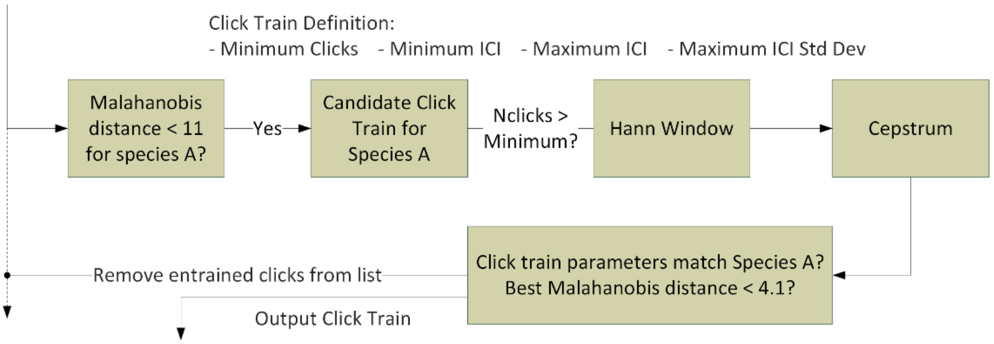


Figure D-2. The click train automated detector/classifier block diagram.

D.2. Automated Tonal Signal Detection

Marine mammal tonal acoustic signals are automatically detected by the following steps:

1. Spectrograms of the appropriate resolution for each mammal vocalisation type that were normalised by the median value in each frequency bin for each detection window Table D-1 were created.
2. Adjacent bins were joined, and contours were created via a contour-following algorithm (Figure D-3).
3. A sorting algorithm determined if the contours match the definition of a marine mammal vocalisation (Table D-2).

Due to the available time, a limited validation of the detections was performed by opening files with detections to check if actual calls were present.

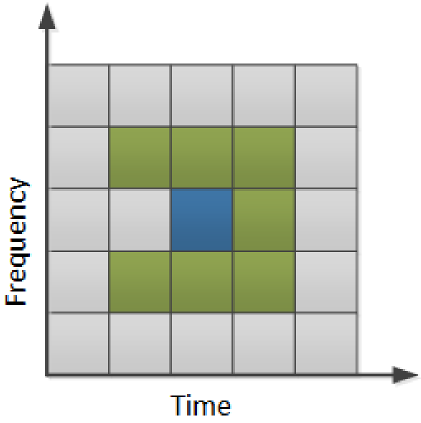


Figure D-3. Illustration of the search area used to connect spectrogram bins. The blue square represents a bin of the binary spectrogram equalling 1 and the green squares represent the potential bins it could be connected to. The algorithm advances from left to right so grey cells left of the test cell need not be checked.

Table D-1. Fast Fourier Transform (FFT) and detection window settings for all automated contour-based detectors used to detect tonal vocalisations of marine mammal species expected in the data. Values are based on JASCO’s experience and empirical evaluation on a variety of data sets.

Automated detector	FFT			Detection window (s)	Detection threshold
	Resolution (Hz)	Frame length (s)	Timestep (s)		
AUS_BW_AH17	0.5	2	0.125	50	2
AUS_BW_AH60	0.5	2	0.125	50	2
AUS_BW_BH20	0.5	2	0.125	40	2
AUS_BW_BH43	0.5	2	0.125	40	2
AUS_BW_BH65	0.5	2	0.125	40	2
BW_H67	0.5	2	0.125	1200	3
BW_DS	0.05	2	0.2	5	3
NPac_BW_D	0.05	2	0.25	10	2
Brydes_DS	0.125	2	0.25	120	3
Brydes_IM_W	0.5	2	0.125	5	4
VLFMoan	2	0.2	0.05	15	4
LFMoan	2	0.25	0.05	10	3
ShortLow	7	0.17	0.025	10	3
MFMoanLow	4	0.2	0.05	5	3
MFMoanHigh	8	0.125	0.05	5	3
Omura_S1	0.25	2	0.25	120	6
Omura_S2	0.25	0.5	0.5	60	4
Omura_W	0.25	2	0.25	120	4
WhistleLow	16	0.03	0.015	5	3
WhistleHigh	64	0.015	0.005	5	3
MF Moan-LowDS-H:M	0.05	4	0.2	5	7
MF Moan-MidT-L	0.05	4	0.2	5	1.5
MF Moan-LowT-L	0.05	4	0.2	5	1.5
MF Moan-LowDS-L	0.05	4	0.2	5	3

Table D-2. A sample of vocalisation sorter definitions for the tonal vocalisations of cetacean species expected in the area.

Automated detector	Target species	Frequency (Hz)	Duration (s)	Bandwidth (B; Hz)	Other detection parameters
AUS_BW_AH17	Blue whale	10–100	6–60	1–50	Peak frequency 17–18.5
AUS_BW_AH60	Blue whale	10–100	6–60	1–50	Peak frequency 59–60.5
AUS_BW_BH20	Blue whale	10–100	6–30	1–3	Peak frequency 21–22.5
AUS_BW_BH43	Blue whale	10–100	6–30	1–3	Peak frequency 43–44.5
AUS_BW_BH65	Blue whale	10–100	6–30	1–3	Peak frequency 64–66.5
BW_H67	Blue whale	60–70	10–30	1–10	n/a
BW_DS	Blue whale	30–100	0.45–1	30–60	n/a
NPac_BW_D	Blue whale	20–100	2–10	15–50	Sweep rate −15 to −5
Brydes_DS	Bryde’s whale	30–200	0.5–3	10–80	n/a
Brydes_IM_W	Bryde’s whale	24–30	2–6	0.5–4	n/a
VLFMoan	Blue/fin/sei whale	10–100	0.30–10.00	>10	minF<40 Hz
LFMoan	Blue/right/sei whale	40–250	0.50–10.00	>15	InstantaneousBandwidth<50 Hz
ShortLow	Fin/baleen whale	30–400	0.08–0.60	>25	n/a
MFMoanLow	Humpback whale	100–700	0.50–5.00	>50	minF<450 Hz InstantaneousBandwidth<200 Hz
MFMoanHigh	Humpback whale	500–2500	0.50–5.00	>150	minF<1500 Hz InstantaneousBandwidth<300 Hz
Omura_S1	Omura’s whale	15–60	5–12	8–40	n/a
Omura_S2	Omura’s whale	10–60	3–15	8–40	n/a
Omura_W	Omura’s whale	24–30	2–6	0.5–4	n/a
WhistleLow	Pilot/killer whale	1000–10000	0.50–5.00	>300	Max Instantaneous Bandwidth = 1000 Hz minF<5000 Hz
WhistleHigh	Other delphinid	4000–20000	0.30–3.00	>700	Max Instantaneous Bandwidth = 5000 Hz
MF Moan-LowDS-H:M	Humpback whale	100–1000	0.35–1.5	200–900	n/a
MF Moan-MidT-L	Humpback whale	500–1500	0.9–2.9	125–500	n/a
MF Moan-LowT-L	Humpback whale	50–950	0.9–2.9	50–500	n/a
MF Moan-LowDS-L	Humpback whale	100–1000	0.35–1.5	200–900	n/a

D.3. Automatic Data Selection for Validation (ADSV)

To standardise the file selection process for the selection of data for manual analysis, we applied our Automated Data Selection for Validation (ADSV) algorithm. Details of the ADSV algorithm are described in Kowarski et al. (2021) and a schematic of the process is provided in Figure D-4. ADSV computes the distribution of three descriptors that describe the automated detections in the full data set: the Diversity (number of automated detectors triggered per file), the Counts (number of automated detections per file for each automated detector), and the Temporal Distribution (spread of detections for each automated detector across the recording period). The algorithm removes files from the temporary data set that have the least impact on the distribution of the three descriptors in the full data set. Files are removed until a pre-determined data set size (*N*) is reached, at which point the temporary data set becomes the subset to be manually reviewed.

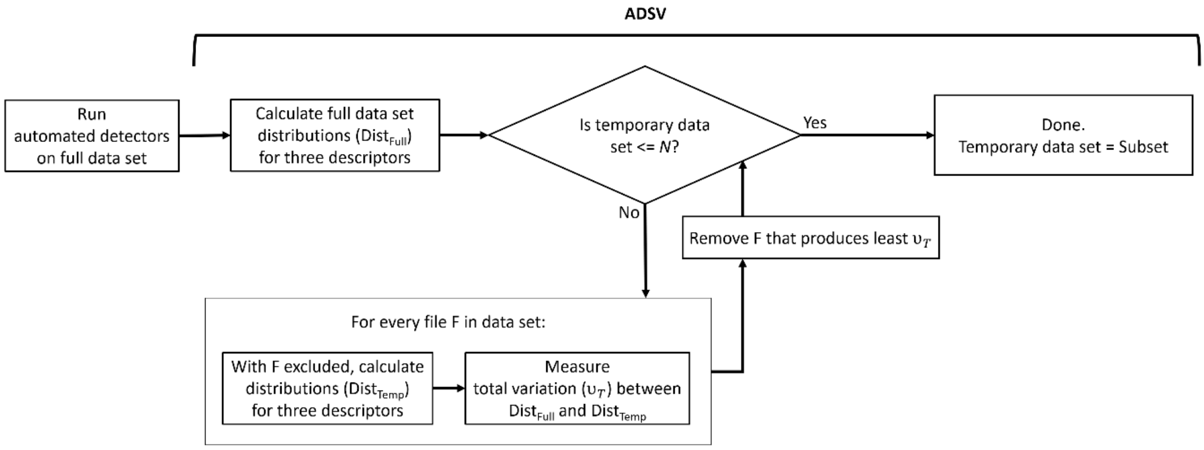


Figure D-4. Automated Data Selection for Validation (ADSV) process Figure 1 from Kowarski et al. (2021).

For the present work, an *N* of 0.5% was selected, largely due to limited scope for this project and marine mammal analysis. Even with limited manual review, the results presented here can be considered reliable, but some caveats should be considered. It is important to note that with such limited data manually reviewed, very rare species may have been missed or their occurrence underestimated. If the 0.5% subset of data manually analysed was not sufficiently large to capture the full range of acoustic environments in the full data set, the resulting automated detector performance metrics may be inaccurate and therefore should be taken as an estimate.

D.4. Automated Detector Performance Calculation and Optimization

All files selected for manual validation were reviewed by one of two experienced analysts using JASCO's PAMlab software to determine the presence or absence of every species, regardless of whether a species was automatically detected in the 5 min file. Although the automated detectors classify specific signals, we validated the presence/absence of species at the file level, not the detection level. Acoustic signals were only assigned to a species if the analyst was confident in their assessment. When unsure, analysts would consult one another, peer reviewed literature, and other experts in the field. If certainty could not be reached, the file of concern would be classified as possibly containing the species in question or containing an unknown acoustic signal. Next, the validated results were compared to the automated detector results in three phases to refine the results and ensure they accurately represent the occurrence of each species in the study area.

In phase 1, the human validated versus automated detector results were plotted as time series and critically reviewed to determine when and where automated detections should be excluded. Questionable detections that overlap with the detection period of other species were scrutinized. By restricting detections spatially and/or temporally where appropriate, we can maximize the reliability of the results. No temporal restrictions were necessary for our automated detector results.

In phase 2, the performance of the automated detectors was calculated and optimized for each species using a threshold, defined as the number of automated detections per file at and above which detections of species were considered valid.

To determine the performance of each automated detector and any necessary thresholds, the automated and validated results (excluding files where an analyst indicated uncertainty in species occurrence) were fed to a maximum likelihood estimation algorithm that maximizes the probability of detection and minimizes the number of false alarms using the Matthews Correlation Coefficient (MCC):

$$MCC = \frac{TPxTN - FPxFN}{\sqrt{(\mathrm{TP}+\mathrm{FP})(\mathrm{TP}+\mathrm{FN})(\mathrm{TN}+\mathrm{FP})(\mathrm{TN}+\mathrm{FN})}}$$

$$P = \frac{TP}{TP+FP}; R = \frac{TP}{TP+FN}$$

where *TP* (true positive) is the number of correctly detected files, *FP* (false positive) is the number of files that are false detections, and *FN* (false negatives) is the number of files with missed detections. No thresholds were necessary for our automated detector results.

In phase 3, detections were further restricted to include only those where *P* was greater than or equal to 0.75. When *P* was less than 0.75, only validated results were used to describe the acoustic occurrence of a species. All species in the present data set had automated detectors that performed sufficiently well. The occurrence of each species was plotted using JASCO's Ark software as time series showing presence/absence by hour over each day.

Appendix E. Auditory Frequency Weighting Functions

The potential for anthropogenic sounds to impact marine mammals is largely dependent on whether the sound occurs at frequencies that an animal can hear well, unless the sound pressure level is so high that it can cause physical tissue damage regardless of frequency. Auditory (frequency) weighting functions reflect an animal's ability to hear a sound (Nedwell and Turnpenny 1998, Nedwell et al. 2007). Houser et al (2017) provide an example illustrating the effect of applying a weighting function to a (hypothetical) sound (Figure E-1).

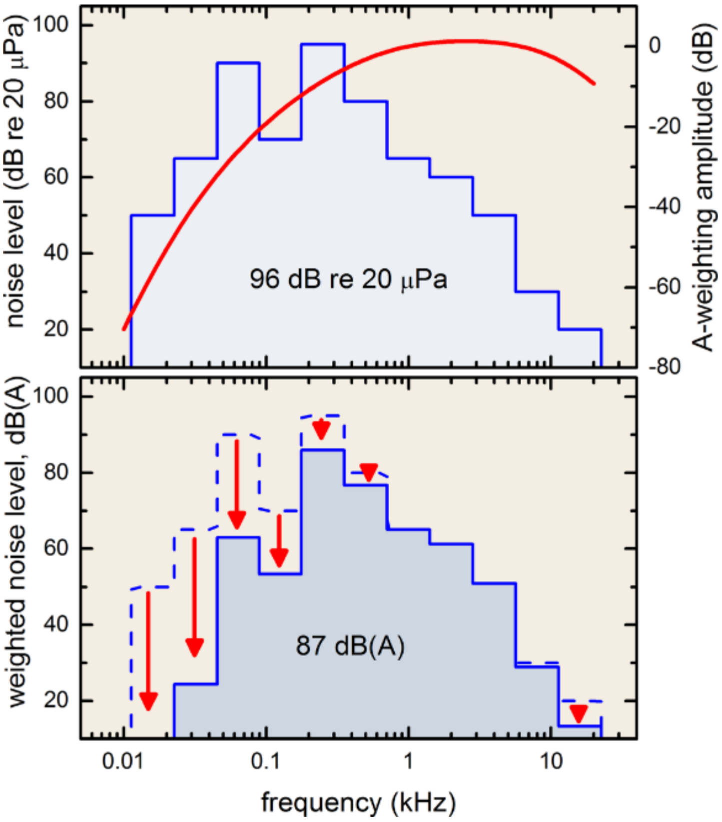


Figure E-1. Application of an auditory weighting function. Blue line shows a hypothetical, octave-band sound pressure spectrum in air, with a total sound pressure level (integrated over all octave-bands) of 96 dB re 20 µPa (This example uses in air-noise levels; therefore, a different reference pressure (20 µPa) applies. The principle is identical to underwater sound where a reference pressure of 1 µPa applies). (Top) Red line shows the human A-weighting function amplitude (A-weighting applies only to human hearing). (Bottom) To determine the weighted exposure level, the A-weighting amplitude at each frequency is added to the sound pressure level at each frequency (red arrows). The weighted spectrum has lower amplitude at the frequencies where the A-weighting function amplitudes are negative. The values from 1–4 kHz do not change substantially, because the weighting function is flat (i.e., the weights are near zero). The weighted SPL is calculated by integrating the weighted spectrum across all octave-bands; the result is 87 dBA, meaning a sound pressure level of 87 dB re 20 µPa after applying the human A-weighting function (Source: Houser et al. 2017).

To better reflect the auditory similarities between phylogenetically closely related species, but also significant differences between species groups among the marine mammals, the extant marine mammal species are assigned to functional hearing groups based on their hearing capabilities and sound production (NMFS 2018) (Table E-1). This division into broad categories is intended to provide a realistic number of categories for which individual noise exposure criteria were developed and the categorisation as such has proven to be a scientifically justified and useful approach in developing auditory frequency weighting functions and deriving noise exposure criteria for marine mammals.

Table E-1. Marine mammal hearing groups (NMFS 2018).

Hearing group	Generalised hearing range*
Low-frequency (LF) cetaceans (mysticetes or baleen whales)	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans (odontocetes: delphinids, beaked whales)	150 Hz to 160 kHz
High-frequency (HF) cetaceans (other odontocetes)	275 Hz to 160 kHz
Phocid pinnipeds (PW) (underwater)	50 Hz to 86 kHz
Otariid pinnipeds (OW) (underwater)	60 Hz to 39 kHz

* The generalised hearing range for all species within a group. Individual hearing will vary.

The potential for noise to affect animals depends on how well the animals can hear it. Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. An exception occurs when the sound pressure is so high that it can physically injure an animal by non-auditory means (i.e., barotrauma). For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

In 2015, a U.S. Navy technical report by Finneran (2015) recommended new auditory weighting functions. The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. The new frequency-weighting function is expressed as:

$$G(f) = K + 10\log_{10}\left[\left(\frac{(f/f_{lo})^{2a}}{\left[1+(f/f_{lo})^2\right]^a\left[1+(f/f_{hi})^2\right]^b}\right)\right] \qquad \text{(E-1)}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid-, and high-frequency cetaceans, phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses noise impacts on marine mammals (NMFS 2016, NMFS 2018). Table E-2 lists the frequency-weighting parameters for each hearing group; Figure E-2 shows the resulting frequency-weighting curves.

Table E-2. Parameters for the auditory weighting functions used in this project as recommended by NMFS (2018).

Hearing group	a	b	f_{lo} (Hz)	f_{hi} (kHz)	K (dB)
Low-frequency cetaceans (baleen whales)	1.0	2	200	19,000	0.13
Mid-frequency cetaceans (dolphins, plus toothed, beaked, and bottlenose whales)	1.6	2	8,800	110,000	1.20
High-frequency cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* and *L. australis*)	1.8	2	12,000	140,000	1.36
Phocid seals in water	1.0	2	1,900	30,000	0.75
Otariid seals in water	2.0	2	940	25,000	0.64

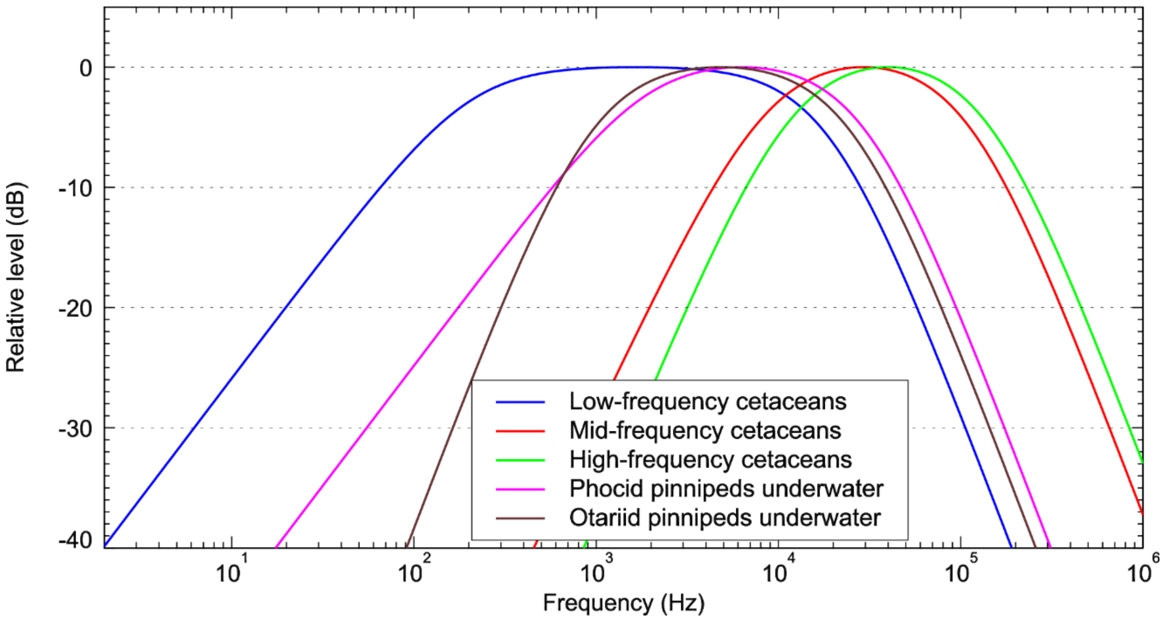


Figure E-2. Auditory weighting functions for functional marine mammal hearing groups as recommended by NMFS (2018).

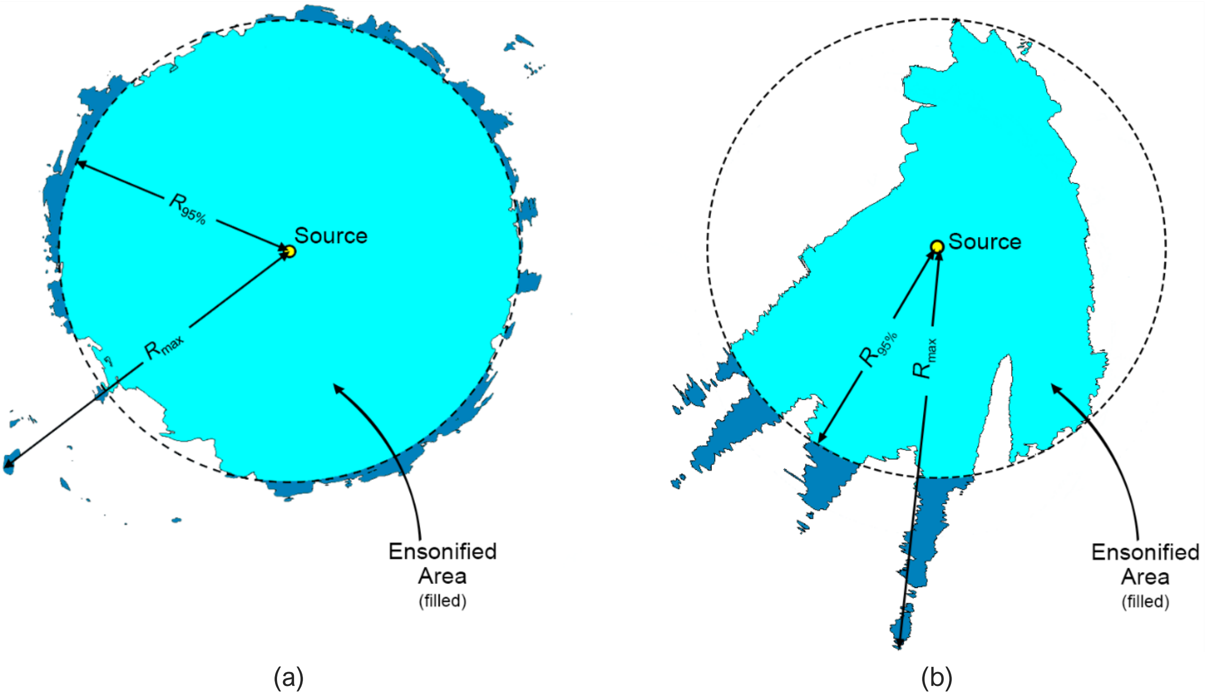
Appendix F. Methods and Parameters

This section describes the specifications of the seismic source that was used at all sites and the environmental parameters used in the propagation models.

F.1. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure F-1).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure F-1(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure F-1(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.



(a) (b)

Figure F-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

F.2. Environmental Parameters

F.2.1. Bathymetry

Water depths throughout the modelled areas were extracted from the Australian Bathymetry and Topography Grid, a 9 arc-second grid rendered for Australian waters (Whiteway 2009). Bathymetry data were re-gridded onto a Map Grid of Australia (MGA) coordinate projection (Zone 54) with a regular grid spacing of 100 × 100 m.

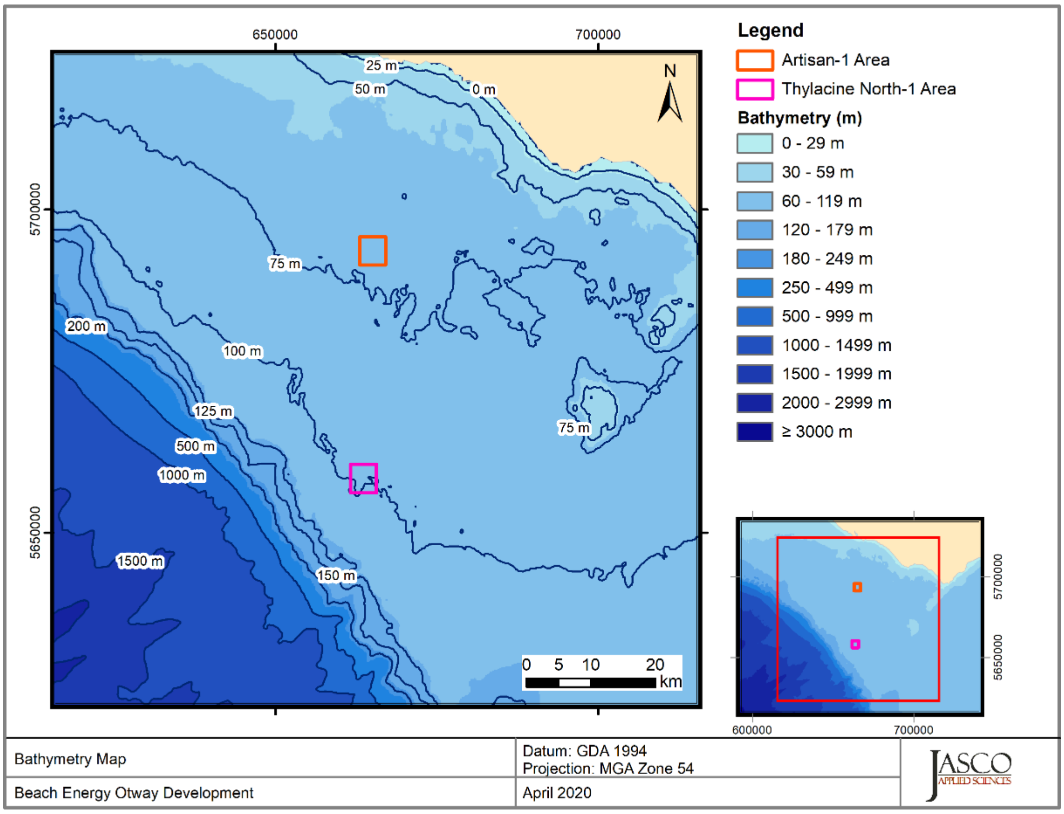


Figure F-2. Bathymetry in the modelled area.

F.2.2. Sound speed profile

Between 0–77 m water depth, mean daily sound speed profiles were derived from the Global Ice Ocean Prediction System (GIOPS) forecasting system for the period when the measurement data was acquired (February 2021 to March 2021 inclusive). A median profile determined to best represent potential propagation conditions over the periods. For deeper water depths below 77 m the sounds speed profile was combined with the sound speed profiles from GDEM (GDEM; Teague et al. 1990, Carnes 2009).

The GIOPS is a data assimilation system that combines satellite and in-situ measurements for ice and ocean analyses and forecasts. Available sea ice analysis products are generated from sea ice concentration data and other satellite measurements from the Canadian Ice Service. For oceanographic variables, GIOPS assimilates a variety of satellite and in-situ observations (Argos profiling floats, ice buoys, moorings, ship observations, and others) to provide a 3-d representation of ocean temperature and salinity, water velocity, sea surface height and mixed layer depth. Meant primarily as a forecasting tool, the daily reported results are not archived long term for general use, but JASCO started caching GIOPS output in 2017 to support Arctic programs.

GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the U.S. Navy's Master Oceanographic Observational Data Set (MOODS). The climatology profiles include 78 fixed depth points to a maximum depth of 6800 m (where the ocean is that deep). The GDEM temperature-salinity profiles were converted to sound speed profiles according to Coppens (1981).

The February and March were selected for sound propagation modelling to ensure to align with the measurement period. Figure F-3 shows the resulting profile, which was used as input for the sound propagation modelling.

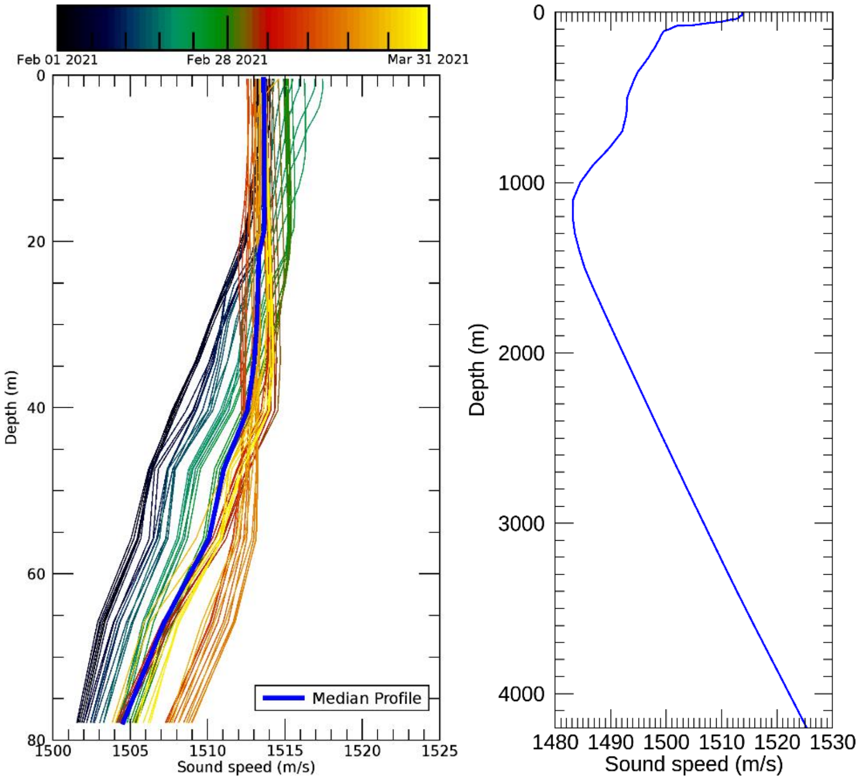


Figure F-3. The sound speed profile used for modelling: The daily and median profiles for the first 77 m from Global Ice Ocean Prediction System (GIOPS) (left) and full depth (right).

F.2.3. Geoacoustics

The propagation model used in this study consider a single geoacoustic profile for the modelled area. These profiles determine how sound is reflected from the seabed, as well as how it is transmitted, reflected, and absorbed into the sediment layers. The seabed in the Artisan-1, located in shallower waters, was characterised by cemented and semi-cemented carbonate rock (calcarenite). semi-cemented carbonate rock with the potential for a thin overlying veneer of coarse sand. This geologic model of the seabed environment is consistent with larger scale geological data and interpretations of the Australian continental shelf environment (James and Bone 2010). Tables F-1 and F-2 present the geoacoustic profiles used modelled sites for each seabed type considered.

Table F-1. *Artisan-1*: Carbonate rock geoacoustic profile. Each parameter varies linearly within the stated range.

Depth below seafloor (m)	Predicted lithology	Density (g/cm^3)	Compressional wave		Shear wave	
			Speed (m/s)	Attenuation (dB/λ)	Speed (m/s)	Attenuation (dB/λ)
0–0.5	Well-cemented carbonate caprock	2.7	2600	0.50	500	0.4
0.5–20	Increasingly cemented calcarenite	2.2	2000	0.30		
20–40		2.3	2120	0.34		
40–60		2.4	2240	0.38		
60–80		2.5	2360	0.42		
80–100		2.6	2480	0.46		
>100	Well-cemented calcarenite	2.7	2600	0.5		

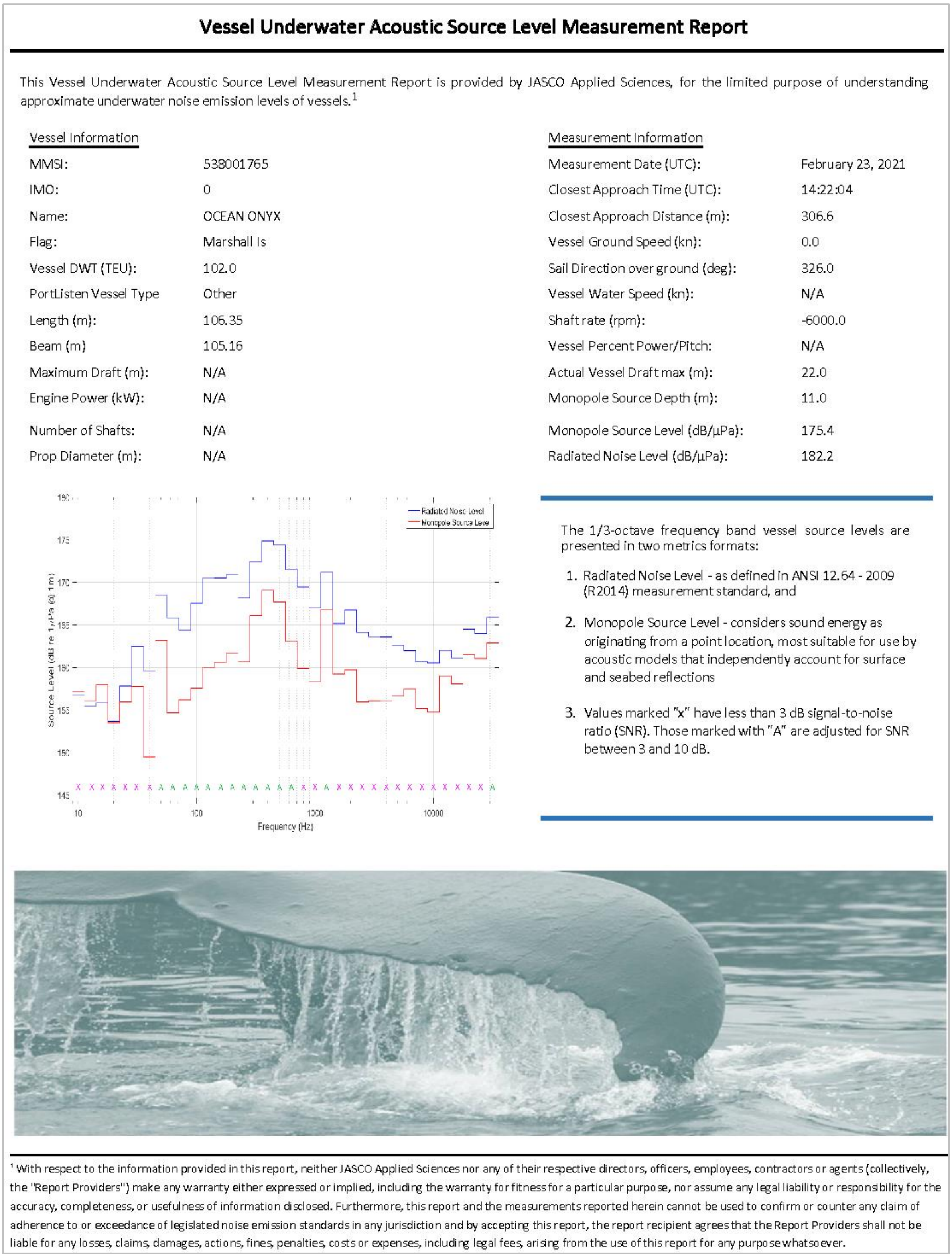
Table F-2. *Artisan-1*: Carbonate rock geoacoustic profile with overlying sand veneer. Each parameter varies linearly within the stated range.

Depth below seafloor (m)	Predicted lithology	Density (g/cm^3)	Compressional wave		Shear wave	
			Speed (m/s)	Attenuation (dB/λ)	Speed (m/s)	Attenuation (dB/λ)
0–1	Coarse carbonate sand	2.03	1800	0.85	300	3.68
1–20	Increasingly cemented calcarenite	2.2	2000	0.30		
20–40		2.3	2120	0.34		
40–60		2.4	2240	0.38		
60–80		2.5	2360	0.42		
80–100		2.6	2480	0.46		
>100	Well-cemented calcarenite	2.7	2600	0.5		

Appendix G. ShipSound Reports

G.1. *Ocean Onyx* Reports

G.1.1. Report 1: 14:22 on 23 Feb 2021



Vessel Underwater Acoustic Source Level Measurement Report

This Vessel Underwater Acoustic Source Level Measurement Report is provided by JASCO Applied Sciences, for the limited purpose of understanding approximate underwater noise emission levels of vessels.[1]

Vessel Information	
MMSI:	538001765
IMO:	0
Name:	OCEAN ONYX
Flag:	Marshall Is
Vessel DWT (TEU):	102.0
PortListen Vessel Type	Other
Length (m):	106.35
Beam (m)	105.16
Maximum Draft (m):	N/A
Engine Power (kW):	N/A
Number of Shafts:	N/A
Prop Diameter (m):	N/A

Measurement Information	
Measurement Date (UTC):	February 23, 2021
Closest Approach Time (UTC):	14:22:04
Closest Approach Distance (m):	306.6
Vessel Ground Speed (kn):	0.0
Sail Direction over ground (deg):	326.0
Vessel Water Speed (kn):	N/A
Shaft rate (rpm):	-6000.0
Vessel Percent Power/Pitch:	N/A
Actual Vessel Draft max (m):	22.0
Monopole Source Depth (m):	11.0
Monopole Source Level (dB/µPa):	175.4
Radiated Noise Level (dB/µPa):	182.2

The 1/3-octave frequency band vessel source levels are presented in two metrics formats:

1. Radiated Noise Level - as defined in ANSI 12.64 - 2009 (R2014) measurement standard, and
2. Monopole Source Level - considers sound energy as originating from a point location, most suitable for use by acoustic models that independently account for surface and seabed reflections
3. Values marked "x" have less than 3 dB signal-to-noise ratio (SNR). Those marked with "A" are adjusted for SNR between 3 and 10 dB.

---

[1] With respect to the information provided in this report, neither JASCO Applied Sciences nor any of their respective directors, officers, employees, contractors or agents (collectively, the "Report Providers") make any warranty either expressed or implied, including the warranty for fitness for a particular purpose, nor assume any legal liability or responsibility for the accuracy, completeness, or usefulness of information disclosed. Furthermore, this report and the measurements reported herein cannot be used to confirm or counter any claim of adherence to or exceedance of legislated noise emission standards in any jurisdiction and by accepting this report, the report recipient agrees that the Report Providers shall not be liable for any losses, claims, damages, actions, fines, penalties, costs or expenses, including legal fees, arising from the use of this report for any purpose whatsoever.

Vessel Underwater Noise Rating - Additional Information

Underwater Noise from vessels has the potential to disturb marine mammals, fish and other marine fauna. JASCO wishes to assist the shipping industry reduce its noise footprint in the marine environment. With this goal in mind, we have developed a vessel noise measurement system and a comparative noise ranking method that allows vessel noise emissions to be characterized relative to those of other vessels of the same class and similar size. The acoustic measurement approach conforms approximately with the protocol defined in ANSI standard 12.64-2009 Grade C, with exceptions as outlined below.

Vessel underwater noise emissions vary with vessel class, size, tonnage, speed, loading and other parameters. The system implements frequency weighting that considers that different marine species have different hearing acuities. For example, humpback whales are believed to be more sensitive to low-frequency sounds than killer whales. To account for these differences, the system calculates frequency-weighted noise metrics based on functions adopted by U.S. National Oceanic and Atmospheric Administration (NOAA) and published in their Marine Mammal Acoustic Technical Guidance[2]. The listening station calculates frequency-weighted noise levels for: Low Frequency Cetaceans (LFC), Mid-Frequency Cetaceans (MFC), and High-Frequency Cetaceans (HFC), Phocid Pinnipeds (PPW) and Otariid Pinnipeds (OPW). The actual rating value is the percentile of the vessel's adjusted and frequency-weighted noise level relative to all vessels of the same class.

RNL with Marine Mammal Weightings (NOAA 2016):

Low Frequency Cetaceans (LFC):	180.4	LFC Rank:	N/A
Mid-Frequency Cetaceans (MFC):	165.9	MFC Rank:	N/A
High-Frequency Cetaceans (HFC):	165.8	HFC Rank:	N/A

Additional Information for this Vessel Measurement:

Name of Vessel:	OCEAN ONYX
Measurement ID:	BEACHOTWAY-stn1-2021-02-538001765202102231422
Date of Measurement:	February 23, 2021

Environmental Information:

Closest Point of Approach location (WGS 84):	-38°53'029"S, 142°52'056"E		
Hydrophone location (WGS-84):	-38°53'024"S, 142°53'008"E		
Water Depth (m):	70.0		
Hydrophone Depth (m):	68.5	Wind Speed (kn):	9.0
Speed of Current (kn):	N/A	Wind Direction (deg):	184.0
Current Direction (deg):	N/A	Sea State Code (WMO):	N/A

Conformance with Standard

The vessel source measurements reported here were acquired using procedures conforming approximately with Grade C - Survey Method - ANSI 12.64-2009 (R2014) Quantities and Procedures for Description and Measurement of Underwater Sound from Ships - Part 1: General Requirements. Notable conformance exceptions are:

1. The standard requires 4 vessel passes, while this measurement is of a single pass.
2. The standard requires vessel Closest Point of Approach (CPA) of the greater of 100 m or one vessel length. This system may admit measurements at other distances.
3. The standard requires the hydrophone subtend depression angles relative to the ship of 20° ± 5° below horizontal, while this system permits angles from 10° to 60°.

Vessel name and dimension information is obtained from Automatic Identification System (AIS) records sent from the vessel at time of measurement and from MarineTraffic.com. Fields not transmitted by these services are marked as N/A in the report. Frequency bands marked with "X" or "A" in the source level graphs are respectively invalid or adjusted, due to being insufficiently above background noise levels as described in the standard.

---

[2] Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0), NOAA Technical Memorandum NMFS-OPR-59 April 2018. https://www.fisheries.noaa.gov/webdam/download/75962998

G.1.2. Report 2: 17:52 on 8 Mar 2021

Vessel Underwater Acoustic Source Level Measurement Report

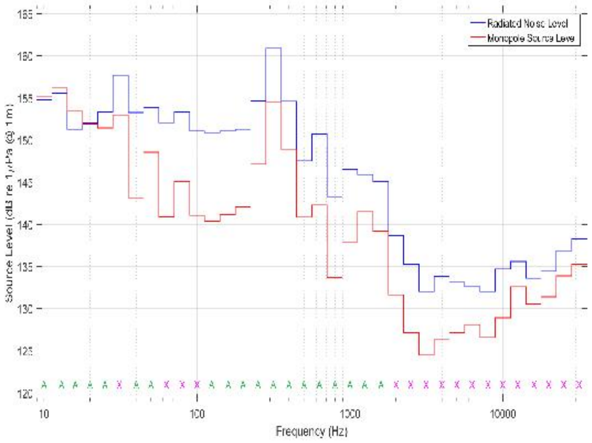
This Vessel Underwater Acoustic Source Level Measurement Report is provided by JASCO Applied Sciences, for the limited purpose of understanding approximate underwater noise emission levels of vessels.[1]

Vessel Information

MMSI:	538001765
IMO:	0
Name:	OCEAN ONYX
Flag:	Marshall Is
Vessel DWT (TEU):	102.0
PortListen Vessel Type	Other
Length (m):	106.35
Beam (m)	105.16
Maximum Draft (m):	N/A
Engine Power (kW):	N/A
Number of Shafts:	N/A
Prop Diameter (m):	N/A

Measurement Information

Measurement Date (UTC):	March 08, 2021
Closest Approach Time (UTC):	17:52:04
Closest Approach Distance (m):	306.6
Vessel Ground Speed (kn):	0.0
Sail Direction over ground (deg):	326.0
Vessel Water Speed (kn):	N/A
Shaft rate (rpm):	-6000.0
Vessel Percent Power/Pitch:	N/A
Actual Vessel Draft max (m):	22.0
Monopole Source Depth (m):	11.0
Monopole Source Level (dB/µPa):	159.6
Radiated Noise Level (dB/µPa):	165.3



The 1/3-octave frequency band vessel source levels are presented in two metrics formats:

1. Radiated Noise Level - as defined in ANSI 12.64 - 2009 (R2014) measurement standard, and
2. Monopole Source Level - considers sound energy as originating from a point location, most suitable for use by acoustic models that independently account for surface and seabed reflections
3. Values marked "x" have less than 3 dB signal-to-noise ratio (SNR). Those marked with "A" are adjusted for SNR between 3 and 10 dB.

---

[1] With respect to the information provided in this report, neither JASCO Applied Sciences nor any of their respective directors, officers, employees, contractors or agents (collectively, the "Report Providers") make any warranty either expressed or implied, including the warranty for fitness for a particular purpose, nor assume any legal liability or responsibility for the accuracy, completeness, or usefulness of information disclosed. Furthermore, this report and the measurements reported herein cannot be used to confirm or counter any claim of adherence to or exceedance of legislated noise emission standards in any jurisdiction and by accepting this report, the report recipient agrees that the Report Providers shall not be liable for any losses, claims, damages, actions, fines, penalties, costs or expenses, including legal fees, arising from the use of this report for any purpose whatsoever.

Vessel Underwater Noise Rating - Additional Information

Underwater Noise from vessels has the potential to disturb marine mammals, fish and other marine fauna. JASCO wishes to assist the shipping industry reduce its noise footprint in the marine environment. With this goal in mind, we have developed a vessel noise measurement system and a comparative noise ranking method that allows vessel noise emissions to be characterized relative to those of other vessels of the same class and similar size. The acoustic measurement approach conforms approximately with the protocol defined in ANSI standard 12.64-2009 Grade C, with exceptions as outlined below.

Vessel underwater noise emissions vary with vessel class, size, tonnage, speed, loading and other parameters. The system implements frequency weighting that considers that different marine species have different hearing acuities. For example, humpback whales are believed to be more sensitive to low-frequency sounds than killer whales. To account for these differences, the system calculates frequency-weighted noise metrics based on functions adopted by U.S. National Oceanic and Atmospheric Administration (NOAA) and published in their Marine Mammal Acoustic Technical Guidance². The listening station calculates frequency-weighted noise levels for: Low Frequency Cetaceans (LFC), Mid-Frequency Cetaceans (MFC), and High-Frequency Cetaceans (HFC), Phocid Pinnipeds (PPW) and Otariid Pinnipeds (OPW). The actual rating value is the percentile of the vessel's adjusted and frequency-weighted noise level relative to all vessels of the same class.

RNL with Marine Mammal Weightings (NOAA 2016):

Low Frequency Cetaceans (LFC):	162.6	LFC Rank:	N/A
Mid-Frequency Cetaceans (MFC):	126.5	MFC Rank:	N/A
High-Frequency Cetaceans (HFC):	118.2	HFC Rank:	N/A

Additional Information for this Vessel Measurement:

Name of Vessel:	OCEAN ONYX
Measurement ID:	BEACHOTWAY-stn1-2021-02-538001765202103081752
Date of Measurement:	March 08, 2021

Environmental Information:

Closest Point of Approach location (WGS 84):	-38°53'029"S, 142°52'056"E		
Hydrophone location (WGS-84):	-38°53'024"S, 142°53'008"E		
Water Depth (m):	70.0		
Hydrophone Depth (m):	68.5	Wind Speed (kn):	9.0
Speed of Current (kn):	N/A	Wind Direction (deg):	231.0
Current Direction (deg):	N/A	Sea State Code (WMO):	N/A

Conformance with Standard

The vessel source measurements reported here were acquired using procedures conforming approximately with Grade C - Survey Method - ANSI 12.64-2009 (R2014) Quantities and Procedures for Description and Measurement of Underwater Sound from Ships - Part 1: General Requirements. Notable conformance exceptions are:

1. The standard requires 4 vessel passes, while this measurement is of a single pass.
2. The standard requires vessel Closest Point of Approach (CPA) of the greater of 100 m or one vessel length. This system may admit measurements at other distances.
3. The standard requires the hydrophone subtend depression angles relative to the ship of 20° ± 5° below horizontal, while this system permits angles from 10° to 60°.

Vessel name and dimension information is obtained from Automatic Identification System (AIS) records sent from the vessel at time of measurement and from MarineTraffic.com. Fields not transmitted by these services are marked as N/A in the report. Frequency bands marked with "X" or "A" in the source level graphs are respectively invalid or adjusted, due to being insufficiently above background noise levels as described in the standard.

---

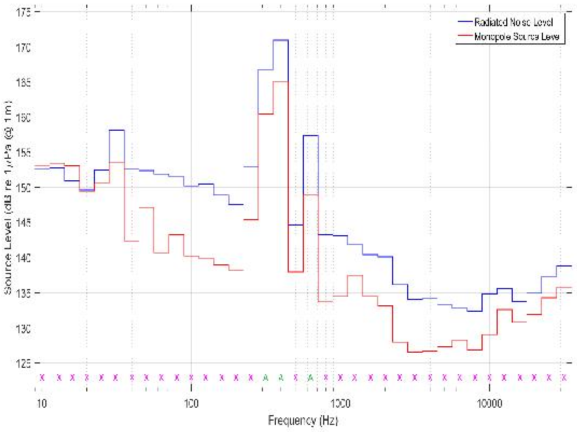
[2] Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0), NOAA Technical Memorandum NMFS-OPR-59 April 2018. https://www.fisheries.noaa.gov/webdam/download/75962998

G.1.3. Report 3: 18:22 on 8 Mar 2021

Vessel Underwater Acoustic Source Level Measurement Report

This Vessel Underwater Acoustic Source Level Measurement Report is provided by JASCO Applied Sciences, for the limited purpose of understanding approximate underwater noise emission levels of vessels.[1]

Vessel Information		Measurement Information	
MMSI:	538001765	Measurement Date (UTC):	March 08, 2021
IMO:	0	Closest Approach Time (UTC):	18:22:05
Name:	OCEAN ONYX	Closest Approach Distance (m):	306.6
Flag:	Marshall Is	Vessel Ground Speed (kn):	0.0
Vessel DWT (TEU):	102.0	Sail Direction over ground (deg):	326.0
PortListen Vessel Type	Other	Vessel Water Speed (kn):	N/A
Length (m):	106.35	Shaft rate (rpm):	-6000.0
Beam (m)	105.16	Vessel Percent Power/Pitch:	N/A
Maximum Draft (m):	N/A	Actual Vessel Draft max (m):	22.0
Engine Power (kW):	N/A	Monopole Source Depth (m):	11.0
Number of Shafts:	N/A	Monopole Source Level (dB/µPa):	166.5
Prop Diameter (m):	N/A	Radiated Noise Level (dB/µPa):	172.5



The 1/3-octave frequency band vessel source levels are presented in two metrics formats:

1. Radiated Noise Level - as defined in ANSI 12.64 - 2009 (R2014) measurement standard, and
2. Monopole Source Level - considers sound energy as originating from a point location, most suitable for use by acoustic models that independently account for surface and seabed reflections
3. Values marked "x" have less than 3 dB signal-to-noise ratio (SNR). Those marked with "A" are adjusted for SNR between 3 and 10 dB.

---

[1] With respect to the information provided in this report, neither JASCO Applied Sciences nor any of their respective directors, officers, employees, contractors or agents (collectively, the "Report Providers") make any warranty either expressed or implied, including the warranty for fitness for a particular purpose, nor assume any legal liability or responsibility for the accuracy, completeness, or usefulness of information disclosed. Furthermore, this report and the measurements reported herein cannot be used to confirm or counter any claim of adherence to or exceedance of legislated noise emission standards in any jurisdiction and by accepting this report, the report recipient agrees that the Report Providers shall not be liable for any losses, claims, damages, actions, fines, penalties, costs or expenses, including legal fees, arising from the use of this report for any purpose whatsoever.

Vessel Underwater Noise Rating - Additional Information

Underwater Noise from vessels has the potential to disturb marine mammals, fish and other marine fauna. JASCO wishes to assist the shipping industry reduce its noise footprint in the marine environment. With this goal in mind, we have developed a vessel noise measurement system and a comparative noise ranking method that allows vessel noise emissions to be characterized relative to those of other vessels of the same class and similar size. The acoustic measurement approach conforms approximately with the protocol defined in ANSI standard 12.64-2009 Grade C, with exceptions as outlined below.

Vessel underwater noise emissions vary with vessel class, size, tonnage, speed, loading and other parameters. The system implements frequency weighting that considers that different marine species have different hearing acuities. For example, humpback whales are believed to be more sensitive to low-frequency sounds than killer whales. To account for these differences, the system calculates frequency-weighted noise metrics based on functions adopted by U.S. National Oceanic and Atmospheric Administration (NOAA) and published in their Marine Mammal Acoustic Technical Guidance[2]. The listening station calculates frequency-weighted noise levels for: Low Frequency Cetaceans (LFC), Mid-Frequency Cetaceans (MFC), and High-Frequency Cetaceans (HFC), Phocid Pinnipeds (PPW) and Otariid Pinnipeds (OPW). The actual rating value is the percentile of the vessel's adjusted and frequency-weighted noise level relative to all vessels of the same class.

RNL with Marine Mammal Weightings (NOAA 2016):

Low Frequency Cetaceans (LFC):	171.5	LFC Rank:	N/A
Mid-Frequency Cetaceans (MFC):	130.5	MFC Rank:	N/A
High-Frequency Cetaceans (HFC):	120.5	HFC Rank:	N/A

Additional Information for this Vessel Measurement:

Name of Vessel:	OCEAN ONYX
Measurement ID:	BEACHOTWAY-stn1-2021-02-538001765202103081822
Date of Measurement:	March 08, 2021

Environmental Information:

Closest Point of Approach location (WGS 84):	-38°53'029"S, 142°52'056"E		
Hydrophone location (WGS-84):	-38°53'024"S, 142°53'008"E		
Water Depth (m):	70.0		
Hydrophone Depth (m):	68.5	Wind Speed (kn):	9.0
Speed of Current (kn):	N/A	Wind Direction (deg):	231.0
Current Direction (deg):	N/A	Sea State Code (WMO):	N/A

Conformance with Standard

The vessel source measurements reported here were acquired using procedures conforming approximately with Grade C - Survey Method - ANSI 12.64-2009 (R2014) Quantities and Procedures for Description and Measurement of Underwater Sound from Ships - Part 1: General Requirements. Notable conformance exceptions are:

1. The standard requires 4 vessel passes, while this measurement is of a single pass.
2. The standard requires vessel Closest Point of Approach (CPA) of the greater of 100 m or one vessel length. This system may admit measurements at other distances.
3. The standard requires the hydrophone subtend depression angles relative to the ship of 20° ± 5° below horizontal, while this system permits angles from 10° to 60°.

Vessel name and dimension information is obtained from Automatic Identification System (AIS) records sent from the vessel at time of measurement and from MarineTraffic.com. Fields not transmitted by these services are marked as N/A in the report. Frequency bands marked with "X" or "A" in the source level graphs are respectively invalid or adjusted, due to being insufficiently above background noise levels as described in the standard.

---

[2] Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0), NOAA Technical Memorandum NMFS-OPR-59 April 2018. https://www.fisheries.noaa.gov/webdam/download/75962998

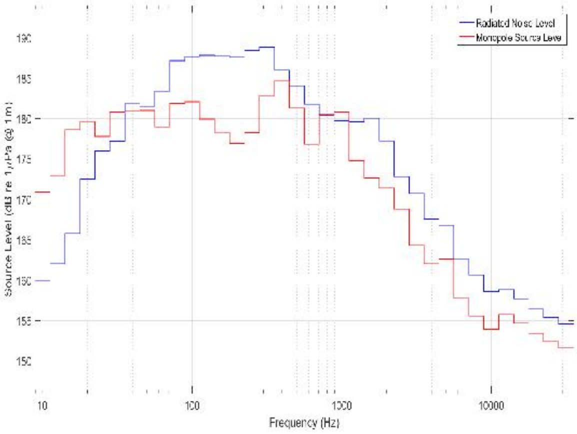
G.2. Vessel DP Trial Report: 01:48 on 4 Feb 2021

Vessel Underwater Acoustic Source Level Measurement Report

This Vessel Underwater Acoustic Source Level Measurement Report is provided by JASCO Applied Sciences, for the limited purpose of understanding approximate underwater noise emission levels of vessels.[1]

Vessel Information	
MMSI:	257544000
IMO:	0
Name:	SIEM SAPPHIRE
Flag:	Norway
Vessel DWT (TEU):	4250.0
PortListen Vessel Type	Other
Length (m):	91.0
Beam (m)	22.04
Maximum Draft (m):	N/A
Engine Power (kW):	N/A
Number of Shafts:	N/A
Prop Diameter (m):	N/A

Measurement Information	
Measurement Date (UTC):	February 04, 2021
Closest Approach Time (UTC):	1:48:00
Closest Approach Distance (m):	182.6
Vessel Ground Speed (kn):	0.6
Sail Direction over ground (deg):	152.4
Vessel Water Speed (kn):	N/A
Shaft rate (rpm):	-6000.0
Vessel Percent Power/Pitch:	N/A
Actual Vessel Draft max (m):	7.0
Monopole Source Depth (m):	4.9
Monopole Source Level (dB/µPa):	193.4
Radiated Noise Level (dB/µPa):	198.0



The 1/3-octave frequency band vessel source levels are presented in two metrics formats:

1. Radiated Noise Level - as defined in ANSI 12.64 - 2009 (R2014) measurement standard, and
2. Monopole Source Level - considers sound energy as originating from a point location, most suitable for use by acoustic models that independently account for surface and seabed reflections
3. Values marked "x" have less than 3 dB signal-to-noise ratio (SNR). Those marked with "A" are adjusted for SNR between 3 and 10 dB.

---

[1] With respect to the information provided in this report, neither JASCO Applied Sciences nor any of their respective directors, officers, employees, contractors or agents (collectively, the "Report Providers") make any warranty either expressed or implied, including the warranty for fitness for a particular purpose, nor assume any legal liability or responsibility for the accuracy, completeness, or usefulness of information disclosed. Furthermore, this report and the measurements reported herein cannot be used to confirm or counter any claim of adherence to or exceedance of legislated noise emission standards in any jurisdiction and by accepting this report, the report recipient agrees that the Report Providers shall not be liable for any losses, claims, damages, actions, fines, penalties, costs or expenses, including legal fees, arising from the use of this report for any purpose whatsoever.

Vessel Underwater Noise Rating - Additional Information

Underwater Noise from vessels has the potential to disturb marine mammals, fish and other marine fauna. JASCO wishes to assist the shipping industry reduce its noise footprint in the marine environment. With this goal in mind, we have developed a vessel noise measurement system and a comparative noise ranking method that allows vessel noise emissions to be characterized relative to those of other vessels of the same class and similar size. The acoustic measurement approach conforms approximately with the protocol defined in ANSI standard 12.64-2009 Grade C, with exceptions as outlined below.

Vessel underwater noise emissions vary with vessel class, size, tonnage, speed, loading and other parameters. The system implements frequency weighting that considers that different marine species have different hearing acuities. For example, humpback whales are believed to be more sensitive to low-frequency sounds than killer whales. To account for these differences, the system calculates frequency-weighted noise metrics based on functions adopted by U.S. National Oceanic and Atmospheric Administration (NOAA) and published in their Marine Mammal Acoustic Technical Guidance[2]. The listening station calculates frequency-weighted noise levels for: Low Frequency Cetaceans (LFC), Mid-Frequency Cetaceans (MFC), and High-Frequency Cetaceans (HFC), Phocid Pinnipeds (PPW) and Otariid Pinnipeds (OPW). The actual rating value is the percentile of the vessel's adjusted and frequency-weighted noise level relative to all vessels of the same class.

RNL with Marine Mammal Weightings (NOAA 2016):

Low Frequency Cetaceans (LFC):	195.0	LFC Rank:	N/A
Mid-Frequency Cetaceans (MFC):	168.4	MFC Rank:	N/A
High-Frequency Cetaceans (HFC):	164.7	HFC Rank:	N/A

Additional Information for this Vessel Measurement:

Name of Vessel:	SIEM SAPPHIRE
Measurement ID:	BEACHOTWAY-stn2-2021-02-257544000202102040148
Date of Measurement:	February 04, 2021

Environmental Information:

Closest Point of Approach location (WGS 84):	-38°53'010"S, 142°53'044"E		
Hydrophone location (WGS-84):	-38°53'011"S, 142°53'036"E		
Water Depth (m):	70.0		
Hydrophone Depth (m):	68.5	Wind Speed (kn):	13.0
Speed of Current (kn):	N/A	Wind Direction (deg):	89.0
Current Direction (deg):	N/A	Sea State Code (WMO):	N/A

Conformance with Standard

The vessel source measurements reported here were acquired using procedures conforming approximately with Grade C - Survey Method - ANSI 12.64-2009 (R2014) Quantities and Procedures for Description and Measurement of Underwater Sound from Ships - Part 1: General Requirements. Notable conformance exceptions are:

1. The standard requires 4 vessel passes, while this measurement is of a single pass.
2. The standard requires vessel Closest Point of Approach (CPA) of the greater of 100 m or one vessel length. This system may admit measurements at other distances.
3. The standard requires the hydrophone subtend depression angles relative to the ship of 20° ± 5° below horizontal, while this system permits angles from 10° to 60°.

Vessel name and dimension information is obtained from Automatic Identification System (AIS) records sent from the vessel at time of measurement and from MarineTraffic.com. Fields not transmitted by these services are marked as N/A in the report. Frequency bands marked with "X" or "A" in the source level graphs are respectively invalid or adjusted, due to being insufficiently above background noise levels as described in the standard.

---

[2] Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0), NOAA Technical Memorandum NMFS-OPR-59 April 2018. https://www.fisheries.noaa.gov/webdam/download/75962998

G.3. Vessel Transit Report: 21:56 on 10 Mar 2021

Vessel Underwater Acoustic Source Level Measurement Report

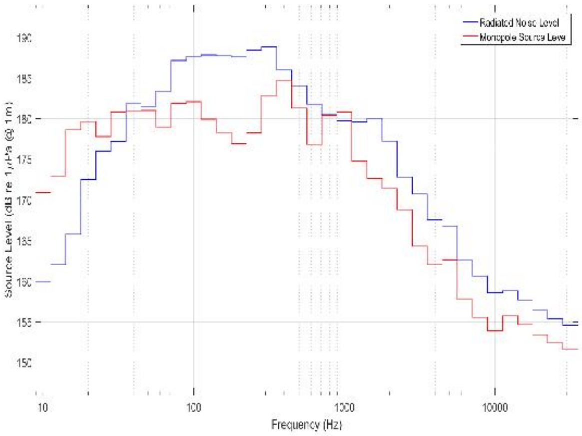
This Vessel Underwater Acoustic Source Level Measurement Report is provided by JASCO Applied Sciences, for the limited purpose of understanding approximate underwater noise emission levels of vessels.[1]

Vessel Information

MMSI:	257544000
IMO:	0
Name:	SIEM SAPPHIRE
Flag:	Norway
Vessel DWT (TEU):	4250.0
PortListen Vessel Type	Other
Length (m):	91.0
Beam (m)	22.04
Maximum Draft (m):	N/A
Engine Power (kW):	N/A
Number of Shafts:	N/A
Prop Diameter (m):	N/A

Measurement Information

Measurement Date (UTC):	February 04, 2021
Closest Approach Time (UTC):	1:48:00
Closest Approach Distance (m):	182.6
Vessel Ground Speed (kn):	0.6
Sail Direction over ground (deg):	152.4
Vessel Water Speed (kn):	N/A
Shaft rate (rpm):	-6000.0
Vessel Percent Power/Pitch:	N/A
Actual Vessel Draft max (m):	7.0
Monopole Source Depth (m):	4.9
Monopole Source Level (dB/µPa):	193.4
Radiated Noise Level (dB/µPa):	198.0



The 1/3-octave frequency band vessel source levels are presented in two metrics formats:

1. Radiated Noise Level - as defined in ANSI 12.64 - 2009 (R2014) measurement standard, and
2. Monopole Source Level - considers sound energy as originating from a point location, most suitable for use by acoustic models that independently account for surface and seabed reflections
3. Values marked "x" have less than 3 dB signal-to-noise ratio (SNR). Those marked with "A" are adjusted for SNR between 3 and 10 dB.

---

[1] With respect to the information provided in this report, neither JASCO Applied Sciences nor any of their respective directors, officers, employees, contractors or agents (collectively, the "Report Providers") make any warranty either expressed or implied, including the warranty for fitness for a particular purpose, nor assume any legal liability or responsibility for the accuracy, completeness, or usefulness of information disclosed. Furthermore, this report and the measurements reported herein cannot be used to confirm or counter any claim of adherence to or exceedance of legislated noise emission standards in any jurisdiction and by accepting this report, the report recipient agrees that the Report Providers shall not be liable for any losses, claims, damages, actions, fines, penalties, costs or expenses, including legal fees, arising from the use of this report for any purpose whatsoever.

Vessel Underwater Noise Rating - Additional Information

Underwater Noise from vessels has the potential to disturb marine mammals, fish and other marine fauna. JASCO wishes to assist the shipping industry reduce its noise footprint in the marine environment. With this goal in mind, we have developed a vessel noise measurement system and a comparative noise ranking method that allows vessel noise emissions to be characterized relative to those of other vessels of the same class and similar size. The acoustic measurement approach conforms approximately with the protocol defined in ANSI standard 12.64-2009 Grade C, with exceptions as outlined below.

Vessel underwater noise emissions vary with vessel class, size, tonnage, speed, loading and other parameters. The system implements frequency weighting that considers that different marine species have different hearing acuities. For example, humpback whales are believed to be more sensitive to low-frequency sounds than killer whales. To account for these differences, the system calculates frequency-weighted noise metrics based on functions adopted by U.S. National Oceanic and Atmospheric Administration (NOAA) and published in their Marine Mammal Acoustic Technical Guidance[2]. The listening station calculates frequency-weighted noise levels for: Low Frequency Cetaceans (LFC), Mid-Frequency Cetaceans (MFC), and High-Frequency Cetaceans (HFC), Phocid Pinnipeds (PPW) and Otariid Pinnipeds (OPW). The actual rating value is the percentile of the vessel's adjusted and frequency-weighted noise level relative to all vessels of the same class.

RNL with Marine Mammal Weightings (NOAA 2016):

Low Frequency Cetaceans (LFC):	195.0	LFC Rank:	N/A
Mid-Frequency Cetaceans (MFC):	168.4	MFC Rank:	N/A
High-Frequency Cetaceans (HFC):	164.7	HFC Rank:	N/A

Additional Information for this Vessel Measurement:

Name of Vessel:	SIEM SAPPHIRE
Measurement ID:	BEACHOTWAY-stn2-2021-02-257544000202102040148
Date of Measurement:	February 04, 2021

Environmental Information:

Closest Point of Approach location (WGS 84):	-38°53'010"S, 142°53'044"E		
Hydrophone location (WGS-84):	-38°53'011"S, 142°53'036"E		
Water Depth (m):	70.0		
Hydrophone Depth (m):	68.5	Wind Speed (kn):	13.0
Speed of Current (kn):	N/A	Wind Direction (deg):	89.0
Current Direction (deg):	N/A	Sea State Code (WMO):	N/A

Conformance with Standard

The vessel source measurements reported here were acquired using procedures conforming approximately with Grade C - Survey Method - ANSI 12.64-2009 (R2014) Quantities and Procedures for Description and Measurement of Underwater Sound from Ships - Part 1: General Requirements. Notable conformance exceptions are:

1. The standard requires 4 vessel passes, while this measurement is of a single pass.
2. The standard requires vessel Closest Point of Approach (CPA) of the greater of 100 m or one vessel length. This system may admit measurements at other distances.
3. The standard requires the hydrophone subtend depression angles relative to the ship of 20° ± 5° below horizontal, while this system permits angles from 10° to 60°.

Vessel name and dimension information is obtained from Automatic Identification System (AIS) records sent from the vessel at time of measurement and from MarineTraffic.com. Fields not transmitted by these services are marked as N/A in the report. Frequency bands marked with "X" or "A" in the source level graphs are respectively invalid or adjusted, due to being insufficiently above background noise levels as described in the standard.

---

[2] Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0), NOAA Technical Memorandum NMFS-OPR-59 April 2018. https://www.fisheries.noaa.gov/webdam/download/75962998

Appendix I Sound Modelling Report – McPherson and Wood 2017

Otway Basin Geophysical Operations Acoustic Modelling

Acoustic Modelling for Assessing Marine Fauna Sound Exposures

Submitted to:
Lattice Energy

Authors:
Craig McPherson
Michael Wood

10 May 2019

P001359-001
Document 01473
Version 1.0

JASCO Applied Sciences (Australia) Pty Ltd
Unit 1, 14 Hook Street
Capalaba, Queensland, 4157
Tel: +61 7 3823 2620
Mob: +61 4 3812 8179
www.jasco.com

Document Version Control

Version	Date	Name	Change
1.0	2017 November 02	C. McPherson	Final submitted to client

Suggested citation:

McPherson, C., M. Wood. 2017. *Otway Basin Geophysical Operations Acoustic Modelling: Acoustic Modelling for Assessing Marine Fauna Sound Exposures*. Document 01473, Version 1.0. Technical report by JASCO Applied Sciences for Lattice Energy.

Disclaimer:

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

Contents

Figures

Tables

Executive Summary

Sound models were used to assess underwater noise levels during the proposed Otway Basin Geophysical Survey by Lattice Energy. The modelling approach accounted for the acoustic emission characteristics of a representative boomer and sub-bottom profiler (SBP) both towed at 3 m depth, along with a 450 in^3 vertical seismic profiler (VSP) array operated at a centroid depth of 6 m. The boomer and SBP geophysical survey sources planned for use had not been decided at the time of the modelling study, therefore JASCO chose commonly-used representative systems for each source, with levels derived from previous JASCO field measurement campaigns of such sources. The modelled per-pulse in-beam SEL and SPL source levels of the boomer were 180.0 dB re 1 µPa^2·s @ 1 m and 200.5 dB re 1 µPa @ 1 m respectively, and for the sub-bottom profiler they were 171.4 dB re 1 µPa^2·s @ 1 m and 191.7 dB re 1 µPa @ 1 m. The modelling considered source directivity and the area's range-dependent environmental properties.

The modelling study assessed six sites for the representative boomer and sub-bottom profiler, and one site for the VSP operations, focusing on the metrics relevant to benthic invertebrates. Accumulated SEL was modelled for four full surveys of the boomer and SBP operating in tandem. The scenarios considered operational periods of either 51 or 40.2 hours, including turn times.

The analysis considered the maximum distances away from a given source or survey lines at which several effects criteria were reached. The results are summarised below for representative single pulse sites and for accumulated sound exposure level (SEL) scenarios.

Benthic Invertebrates and Fish

- Sound fields from the representative boomer and SBP do not reach any of the assessed thresholds for benthic crustaceans or fish at the seafloor for either single pulse or accumulated SEL scenarios. The sound level drops below the lowest relevant peak-to-peak pressure level (PK-PK) isopleth of 202 dB re 1 µPa at a vertical distance of 11 m below the source, and below the lowest relevant peak pressure level (PK) of 207 dB re 1 µPa within 1.6 m, while the maximum per-pulse SEL isopleth predicted to occur at the seafloor is 155 dB re 1 µPa^2·s at a maximum horizontal distance of 1 m from the source.
- The SBP is a higher-frequency, more directional, and lower energy source than the boomer; consequently, the ranges are consistently lower. The PK-PK isopleth of 202 dB re 1 µPa is predicted to occur at 1.4 m vertically below the source, while the maximum per-pulse SEL isopleth predicted to occur at the seafloor is 130 dB re 1 µPa^2·s at a maximum horizontal distance of 6 m.
- The maximum accumulated SEL from the combined operations of the boomer and SBP at the seafloor is not predicted to exceed 170 dB re 1 µPa^2·s for any single survey. This is below any of the relevant isopleths for benthic invertebrates, including the 183 dB re 1 µPa^2·s 'no effect' accumulated SEL (McCauley and Duncan 2016). It is also below the threshold for temporary hearing impairment (TTS) in fish. The predicted ranges for the four surveys modelled at similar, due to the identical sources, sound speed profiles, similar depths and geoacoustics.
- The VSP source was modelled with models capable of accounting for all environmental parameters and high propagation angles. The results show that the lowest PK-PK isopleths of interest derived from Day et al. (2016b), 209 dB re 1 µPa, is not reached at the seafloor; and the horizontal range along the seafloor to the 202 dB re 1 µPa PK-PK level from Payne et al. (2007) is 185 m. PK metrics relevant to the Popper et al. (2014) criteria for fish and turtles are also not reached at the seafloor. The maximum per-pulse SEL on the seafloor below the array is 181 dB re 1 µPa^2·s, below the lowest level from Day et al. (2016b) of 186 dB re 1 µPa^2·s.

Marine Mammals and Turtle Behaviour

- Considering the United States (US) National Marine Fisheries Service (NMFS; 2013) acoustic threshold for behavioural effects in marine mammals of 160 dB re 1 µPa (SPL), the boomer could potentially disturb marine mammals at horizontal distances of up to 145 m, and the SBP at 2 m.
- Considering the US NMFS criterion for behavioural effects in turtles of 166 dB re 1 µPa (SPL), the boomer could potentially disturb turtles are horizontal distances of up to 36 m, while this level is not reached for the SBP.

- For the VSP array, sounds exceeded the unweighted per-pulse SEL criterion for the 1 km low-power zone of 160 dB re 1 µPa^2·s (DEWHA 2008) within 1.03 km of the 450 in^3 array ($R_{95\%}$ distance). The maximum ranges to the marine mammal and turtle behavioural thresholds of 160 and 166 dB re 1 µPa SPL are 2.56 and 1.55 km respectively.

1. Introduction

JASCO Applied Sciences (JASCO) performed a numerical estimation study of underwater sound levels associated with the Otway Basin Geotechnical Operations proposed by Lattice Energy in the Otway Basin. The acoustic modelling evaluated the effects of sounds produced by three sources on marine fauna, with a specific focus on benthic invertebrates. The three sources considered in the modelling were a representative boomer and sub-bottom profiler (SBP) both towed at 3 m, along with a 450 in^3 vertical seismic profiler (VSP) array operated at a centroid depth of 6 m. The boomer and SBP geophysical survey sources planned for use had not been decided at the time of the modelling study, therefore JASCO proposed a commonly used representative for each source, with levels derived from a previous JASCO measurement campaign of such sources. The results are presented as sound pressure levels (SPL), zero-to-peak pressure levels (PK), peak-to-peak pressure levels (PK-PK) and either per-pulse (i.e., per-pulse) or accumulated sound exposure levels (SEL), as appropriate to each scenario.

Single pulse sound fields for each source were modelled at six representative locations (Table 1, Figure 1), although it is likely that the boomer and SBP will not operate at Site 5. The VSP will only be operated at Site 5. Accumulated SEL was modelled for four full surveys of the boomer and SBP operating in tandem, using the single pulse modelling results from Sites 1, 3, 4 and 6.

Table 1. Location details for modelled sites (UTM zone 54S).

Site #	Site Name	Site Name Acronym	Water depth (m)	Latitude	Longitude	Easting	Northing
1	Thylacine Midpoint	THY MID	100.5	-39.2168	142.8665	661137	5657503
2	Murchinson Downdip	MURCH DDIP	129.5	-39.2249	142.7614	652042	5656787
3	Geographe 3	G3	85	-39.1082	142.9517	668752	5669398
4	Artisan	ARTISAN	71.6	-38.8909	142.8829	663300	5693640
5	Block VICP69, North	VICP69 NTH	72.8	-38.8829	143.1359	685264	5694052
6	Block VICP69, Meeki	VICP69 MEEKI	79.1	-38.9881	143.051	677633	5682538

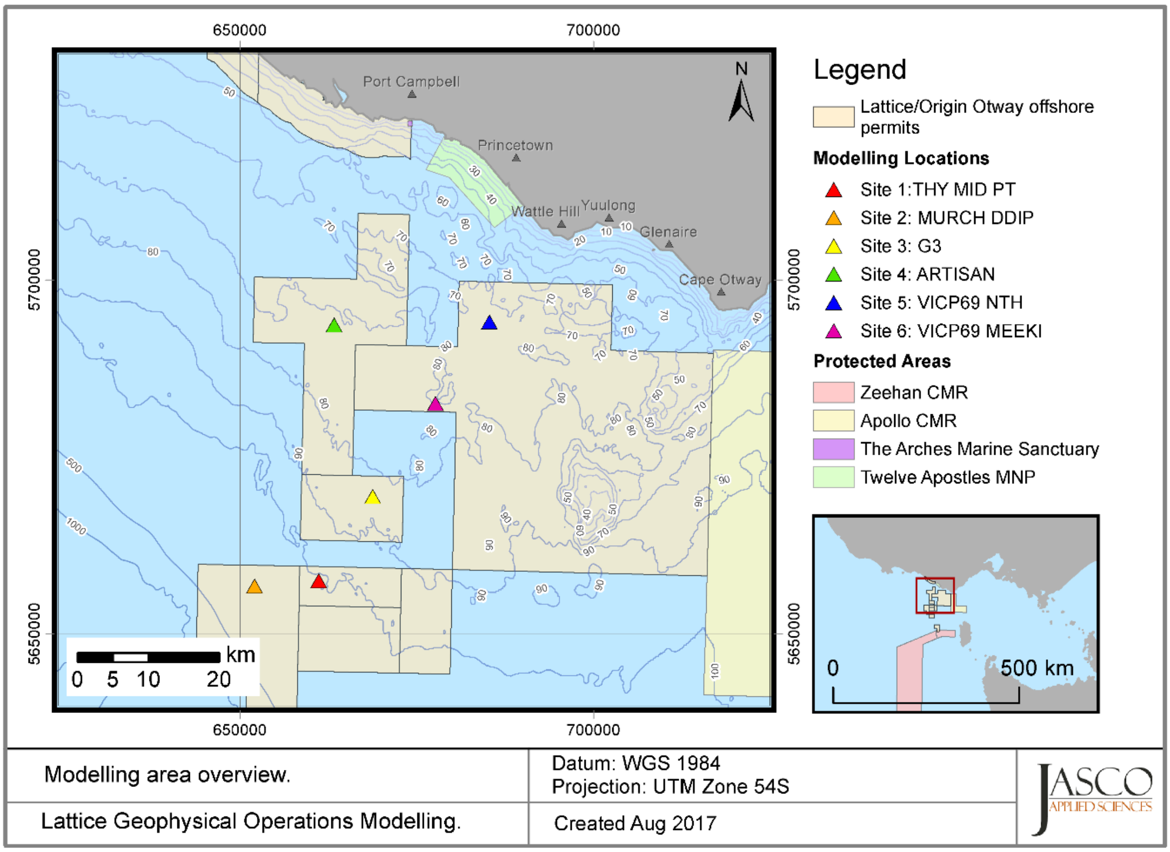


Figure 1. Single pulse modelling site locations and relevant features, including Commonwealth Marine Reserves (CMR), and Marine National Parks (MNP)

2. Noise Effects Criteria

The perceived loudness of sound, especially impulsive noise such as from seismic airguns, is not generally proportional to the instantaneous acoustic pressure. Rather, perceived loudness depends on the time over which the pulse rises, how long this occurs for, and its frequency content. Thus, several sound level metrics are commonly used to evaluate noise and its effects on marine life. The metrics applied in this report, including peak pressure level (PK), peak-peak pressure (PK-PK), sound pressure level (SPL), and sound exposure level (SEL), are defined in Appendix A. Appropriate subscripts indicate any applied frequency weighting; unweighted SEL is defined as required. The acoustic metrics in this report reflect the updated ANSI and ISO standards for acoustic terminology, ANSI-ASA S1.1 (R2013) and ISO/DIS 18405.2:2017 (2016).

Whether acoustic exposure levels might injure or disturb marine fauna is an active research topic. Since 2007, several expert groups have investigated an SEL-based assessment approach for injury in marine mammals, with a handful of key papers published on the topic. The number of studies that investigated the level of disturbance to marine animals by underwater noise has also increased substantially.

We chose the following noise criteria for this study because they include requested thresholds, standard thresholds, thresholds suggested by the best available science (Sections 2.1, 2.2 and 2.3):

1. For comparison to results in Payne et al. (2008), and Day et al. (2016a), the following metrics are reported for benthic crustaceans:
    - Seafloor per-pulse SEL: 186–190 dB re 1 µPa^2.s
    - Seafloor SEL$_{24h}$: 192–199 dB re 1 µPa^2.s
    - Peak-peak pressure: 202, 209–212 dB re 1 µPa
2. ‘No effect on lobster’ accumulated SEL for the Crowes Foot MSS of 183 dB re 1 µPa^2.s (McCauley and Duncan 2016).
3. Per-pulse threshold for cetaceans (unweighted per-pulse SEL of 160 dB re 1 µPa^2·s) outlined in the Australian Environment Protection and Biodiversity Conservation (EPBC) Act Policy Statement 2.1, Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008).
4. Marine mammal behavioural threshold based on the current interim U.S. National Marine Fisheries Service (NMFS) criterion (NMFS 2013) for marine mammals of 160 dB re 1 µPa SPL for impulsive sound sources.
5. Sound exposure guidelines for fish, fish eggs and larvae, and turtles (Popper et al. 2014).
6. Threshold for turtle behavioural response 166 dB re 1 µPa (SPL) (NSF 2011), applied by the US NMFS.

2.1. Benthic Invertebrates (Crustaceans)

Research is ongoing into the relationship between sound and its effects on crustaceans, including the relevant metrics for both effect and impact. Available literature suggests particle motion, rather than sound pressure, is a more important factor for crustacean and bivalve hearing. Water depth and airgun array size are related to the particle motion levels at the seafloor, with larger arrays and shallower water being related to higher particle motion levels, more likely relevant to effects on bivalves. Although some impact assessments have estimated areas of potential impacts from seismic surveys based on the results in Day et al. (2016b), current literature does not clearly define an appropriate metric or identify relevant sound levels for an assessment. This includes the consideration of what particle motion levels lead to a behavioural response, or mortality.

At the seafloor interface bivalves are subject to particle motion stimuli from several acoustic or acoustically-induced waves. These include the particle motion associated with an impinging sound pressure wave in the water column (the incident, reflected, and transmitted portions), substrate acoustic waves, and interface waves of the Scholte type. However, it is unclear which aspect(s) of these waves is/are most relevant to the animals, either when they normally sense the environment or their physiological responses to loud sounds so there is not enough information to establish similar criteria and thresholds as done for marine mammals and fish. Therefore, at this stage, JASCO is not able to define thresholds to inform the impact assessment. Additionally, prediction of particle motion from sources such as low-energy geophysical sources including boomers and sub-bottom profilers is not possible currently due to the lack of source models.

Despite this, the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) has publicly stated that the seafloor levels, sound levels at the seafloor derived from Day et al. (2016b) should be used to assist in the assessment of impacts on scallops and lobster. Therefore, JASCO has used the following metrics in its evaluation:

- Per-pulse SEL: 186–190 dB re 1 µPa^{2}.s
- Accumulated SEL: 192–199 dB re 1 µPa^{2}.s
- Peak-peak pressure: 209–212 dB re 1 µPa

Additionally a PK-PK of 202 dB re 1 µPa from Payne et al. (2007) has been included along with an accumulated SEL of 183 dB re 1 µPa^{2}.s as specified by Lattice Energy based on McCauley and Duncan (2016).

2.2. Marine Mammals

The criteria applied in this study to assess possible effects of impulsive noise on marine mammals are summarised in Table 2 and detailed in Sections 2.2.1 and 2.2.2.

Table 2. The SPL and per-pulse SEL thresholds for acoustic effects on marine mammals.

Hearing group	DEWHA (2008)	NMFS (2013)
	Unweighted per-pulse SEL (dB re 1 µPa^{2}·s)	Behaviour
		SPL (dB re 1 µPa)
Low-frequency cetaceans	160	160
Mid-frequency cetaceans		
High-frequency cetaceans		
Phocid pinnipeds in water	Not Applicable	
Otariid pinnipeds in water	Not Applicable	

2.2.1. Injury and Hearing Sensitivity Changes

There are two categories of auditory threshold shifts representing reduced hearing ability: permanent threshold shift (PTS), considered a physical injury to an animal's hearing organs, and temporary threshold shift (TTS), a temporary reduction in an animal's hearing sensitivity, understood to be partly a result of receptor hair cells in the cochlea becoming fatigued.

For seismic surveys in Australian waters, the EPBC Act Policy Statement 2.1 determines suitable exclusion zones with an unweighted per-pulse SEL threshold of 160 dB re 1 µPa^{2}·s (DEWHA 2008). This threshold minimises the likelihood of TTS in mysticetes and large odontocetes. The Policy Statement does not apply to smaller dolphins and porpoises as DEWHA assessed these cetaceans as having relatively low hearing sensitivity to the low frequencies produced by seismic airgun arrays.

2.2.2. Behavioural Response

Southall et al. (2007) extensively reviewed marine mammal behavioural responses to sounds. Their review found that most marine mammals exhibited varying responses between 140 and

180 dB re 1 µPa SPL, but inconsistent results between studies makes choosing a single behavioural threshold difficult. Studies varied in their lack of control groups, imprecise measurements, inconsistent metrics, and that animal responses depended on study context, which included the animal's activity state. To create meaningful quantitative data from the collected information, Southall et al. (2007) proposed a severity scale that increased with increasing sound levels.

NMFS has historically used a relatively simple sound level criterion for potentially disturbing a marine mammal. For impulsive sounds, this threshold is 160 dB re 1 µPa SPL for pinnipeds and cetaceans (NMFS 2013).

2.3. Fish, Turtles, Fish Eggs, and Fish Larvae

In 2006, the Working Group on the Effects of Sound on Fish and Turtles was formed to continue developing noise exposure criteria for fish and turtles, work begun by a NOAA panel two years earlier. The resulting guidelines included specific thresholds for different levels of effects and for different groups of species (Popper et al. 2014). These guidelines defined quantitative thresholds for three types of immediate effects:

- Mortality, including injury leading to death.
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma.
- TTS

Masking and behavioural effects can be assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds. These effects are not assessed in this report. Because the presence or absence of a swim bladder has a role in hearing, fish's susceptibility to injury from noise exposure varies depending on the species and the presence and possible role of a swim bladder in hearing. Thus, different thresholds were proposed for fish without a swim bladder (also appropriate for sharks and applied to whale sharks in the absence of other information), fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing. Turtles, fish eggs, and fish larvae are considered separately.

Table 3 lists relevant effects thresholds from Popper et al. (2014). In general, any adverse effects of seismic sound on fish behaviour depends on the species, the state of the individuals exposed, and other factors. We note that, despite mortality being a possibility for fish exposed to airgun sounds, Popper et al. (2014) do not reference an actual occurrence of this effect. Since the publication of that work, newer studies have further examined the question of possible mortality. Popper et al. (2016) adds further information to the possible levels of impulsive seismic airgun sound to which adult fish can be exposed without immediate mortality. They found that the two fish species in their study, with body masses in the range 200–400 g, exposed to a per-pulse of a maximum received level of either 231 dB re 1 µPa (PK) or 205 dB re 1 µPa^2·s (SEL), remained alive for 7 days after exposure and that the probability of mortal injury did not differ between exposed and control fish.

The SEL metric integrates noise intensity over some period of exposure. Because the period of integration for regulatory assessments is not well defined for sounds that do not have a clear start or end time, or for very long-lasting exposures, it is required to define a time period. This is done for marine mammals in the Southall et al. (2007) criteria, where it is 24 h or the duration of the activity, whichever longer. Popper et al. (2014) recommend a standard period of time should be applied, where this is either defined as a justified fixed period or the duration of the activity, however also include caveats about how long the fish will be exposed because they can move (or remain in location) and so can the source. In the discussion of the criteria, Popper et al. (2014) discuss the complications in determining a relevant period of mobile seismic surveys, as the received levels at the fish change between impulses due to the mobile source, and that in reality a revised guideline based on the closest PK or the per-pulse SEL might be more useful than one based on accumulated SEL. This is because exposures at the closest point of approach are the primary exposures contributing to a receiver's accumulated level (Gedamke et al. 2011). Additionally, several important factors determine the likelihood and duration a receiver is expected to be in close proximity to a sound source (i.e., overlap in space and time between the source and receiver). For example, accumulation time for fast moving (relative to the receiver) mobile sources is driven primarily by the characteristics of source (i.e., speed, duty cycle) (NMFS 2016).

Popper et al. (2014) summaries that in all TTS studies considered, fish that showed TTS recovered to normal hearing levels within 18–24 hours. However in this study the full period of operations has been considered as the accumulation period for SEL.

Table 3. Criteria for seismic noise exposure for fish and turtles, adapted from Popper et al. (2014).

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	> 219 dB SEL_{24h} or > 213 dB PK	> 216 dB SEL_{24h} or > 213 dB PK	>> 186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	210 dB SEL_{24h} or > 207 dB PK	203 dB SEL_{24h} or > 207 dB PK	>> 186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24h} or > 207 dB PK	203 dB SEL_{24h} or > 207 dB PK	186 dB SEL_{24h}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Turtles	210 dB SEL_{24h} or > 207 dB PK	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish eggs and fish larvae	> 210 dB SEL_{24h} or > 207 dB PK	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Notes: Peak sound pressure level dB re 1 µPa; SEL_{24h} dB re 1µPa^2·s. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

2.3.1. Turtle Behavioural Response

There is a paucity of data regarding responses of turtles to acoustic exposure, and no studies of hearing loss due to exposure to loud sounds. McCauley et al. (2000) observed the behavioural response of caged turtles—green (*Chelonia mydas*) and loggerhead (*Caretta caretta*)—to an approaching seismic airgun. For received levels above 166 dB re 1 µPa (SPL), the turtles increased their swimming activity and above 175 dB re 1 µPa they began to behave erratically, which was interpreted as an agitated state. The 166 dB re 1 µPa level has been used as the threshold level for a behavioural disturbance response by NMFS and applied in the Arctic Programmatic Environment Impact Statement (PEIS) (NSF 2011). At that time, and in the absence of any data from which to determine the sound levels that could injure an animal, TTS or PTS onset were considered possible at an SPL of 180 dB re 1 µPa (NSF 2011). Some additional data suggest that behavioural responses occur closer to an SPL of 175 dB re 1 µPa, and TTS or PTS at even higher levels (Moein et al. 1995), but the received levels were unknown and the NSF (2011) PEIS maintained the earlier NMFS criteria levels of 166 and 180 dB re 1 µPa (SPL) for behavioural response and injury, respectively. Popper et al. (2014) suggested injury to turtles could occur for sound exposures above 207 dB re 1 µPa (PK) or above 210 dB re 1 µPa^2·s (SEL_{24h}) (Table 3). Sound levels defined by Popper et al. (2014) show that animals are very likely to exhibit a behavioural response when they are near an airgun (tens of metres), a moderate response if they encounter the source at intermediate ranges (hundreds of metres), and a low response if they are far (thousands of meters) from the airgun. Both the NMFS criteria for behavioural disturbance (SPL of 166 dB re 1 µPa) and the Popper et al. (2014) injury criteria were included in this analysis, although the analysis did not consider the ranges at which an animal could suffer impairment, as defined by Popper et al. (2014).

3. Methods

This section details the methodology for predicting source levels, modelling sound propagation, and assessing distances to the selected impact criteria.

The environmental parameters used in the propagation models are described in detail in Appendix D. A single sound speed profile that provided the greatest propagation across the year was applied, which occurs during the month of September.

3.1. Acoustic Sources

3.1.1. Boomer: AP3000 Dual-Plate Boomer

The representative boomer system for geophysical survey operations is the AP3000 triple-plate boomer (manufactured by Subsea Systems, Inc.). To estimate the sound field for the boomer source, the specifications of the Applied Acoustics AA202 boomer plate (Applied Acoustics Engineering 2013), a suitable approximation, were taken to represent a single plate, three of which comprise the full system. The boomer plate is 38 cm wide by 38 cm long with a circular baffle. Because the boomer source is a circular piston surrounded by a rigid baffle, it cannot be considered a point-like source (Verbeek and McGee 1995). The beam pattern of a boomer plate shows some directivity for frequencies above 1 kHz. Above this frequency, the acoustic wave's emitted length becomes comparable (of the same order of magnitude) with the baffle size (< 150 cm vs. 35 cm).

The input energy for the AP3000 system is up to 600 J per pulse per plate, or up to 1800 J per pulse from all three plates. The width of the pulse calculated based on the 90% SPL (T_{90}) is 8.1 ms.

JASCO performed a source verification study on an AP3000 system (Martin et al. 2012) with a double-plate configuration operating at maximum input energy of 1000 J. During the study, the acoustic data were collected as close as 8 m to the source and directly below it (Figure 2). By assuming a reduction in pressure in line with spherical spreading laws the data showed that the broadband source level for the system was 197.9 dB 1 µPa @ 1 m SPL and 177.4 dB re 1 µPa^2·s @ 1 m SEL.

The increase in the source level of an AP3000 boomer when in triple-plate configuration, instead of double-plate configuration, was estimated at 2.6 dB because a triple-plate configuration could be used with a higher energy input per pulse (up to 1800 J vs. up to 1000 J for double plate configuration). For modelling, the source level of the AP3000 triple-plated boomer operating at 1800 J per pulse energy was calculated to be 200.5 dB 1 µPa @ 1 m SPL and 180.0 dB re 1 µPa^2·s @ 1 m SEL (Table 4). The power spectrum of the boomer signal was determined directly from the measurement of the boomer signal having compensated the signal for geometric spreading and the change in energy (Figure 3). The 1/3-octave frequency boomer source spectra are shown in Figure 4.

The beamwidth of a boomer plate at each 1/3-octave frequency was calculated based on the standard formula for the beam pattern of a circular transducer (Equation 1). Figure 5 shows a vertical slice for the calculated beam pattern at (a) 1.25 and (b) 16.0 kHz. In order to simplify the acoustic propagation calculations, the beam pattern from the triple-plate system was considered to be equal to the beam pattern from a single plate.

Table 4. Specifications of the AP3000 triple-plate boomer system towed at a depth of 2 m used for the modelling

Specification	Specification	Source
Operating frequency (broad band):	200 Hz–16 kHz;	Estimated from field measurements; Martin et al. (2012)
Beam width	omnidirectional –8°	
Beams	1	

Specification	Specification	Source
Tilt angle (below horizontal plane)	90°	System specification document
Maximum energy input (per pulse):	1800 J	
Peak pressure source level	210.8 dB re 1 µPa @ 1 m	Estimated from field measurements; Martin et al. (2012).
Peak-Peak pressure source level	222.7 dB re 1 µPa @ 1 m	
SPL source level	200.5 dB re 1 µPa @ 1 m	
Pulse length (*T*₉₀)	8.1 ms	
Per-pulse SEL source level	180.0 dB re 1 µPa²•s @ 1 m	

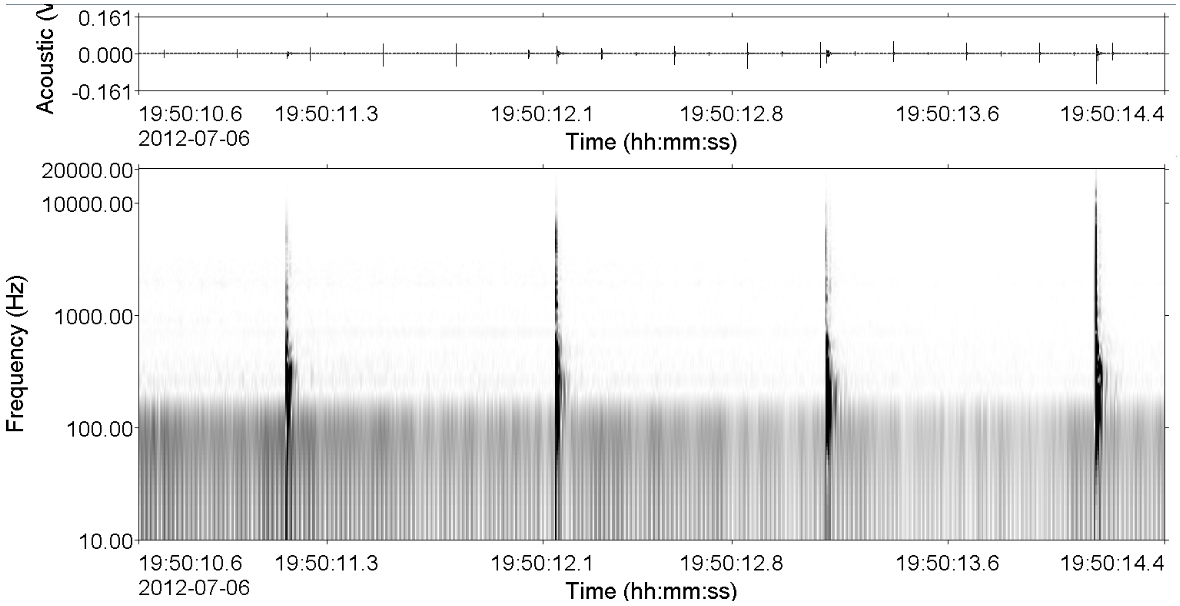


Figure 2. Spectrogram of dual-plate boomer (1000 J) pulses at the closest point of approach. Majority of energy is between 100 and 1000 Hz, with some energy at up to 10 kHz. (131,072 point FFT, 7000 data points, 3500 point overlap, Figure 15 in Martin et al. (2012)).

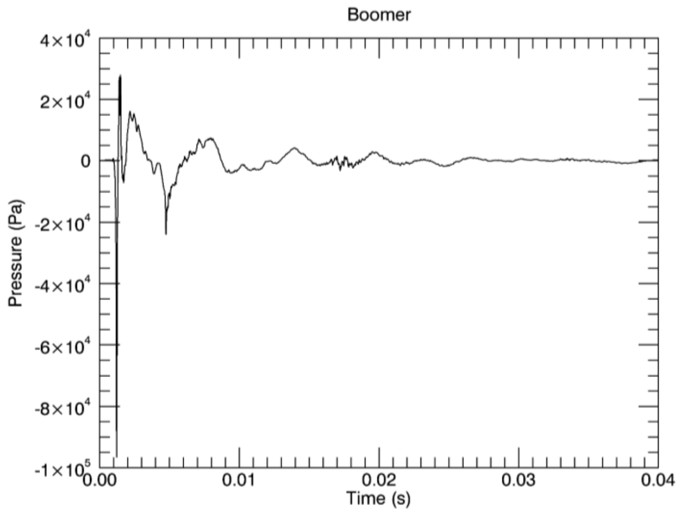


Figure 3. Back-propagated and scaled boomer source signature calculated from measurements (Martin et al. 2012).

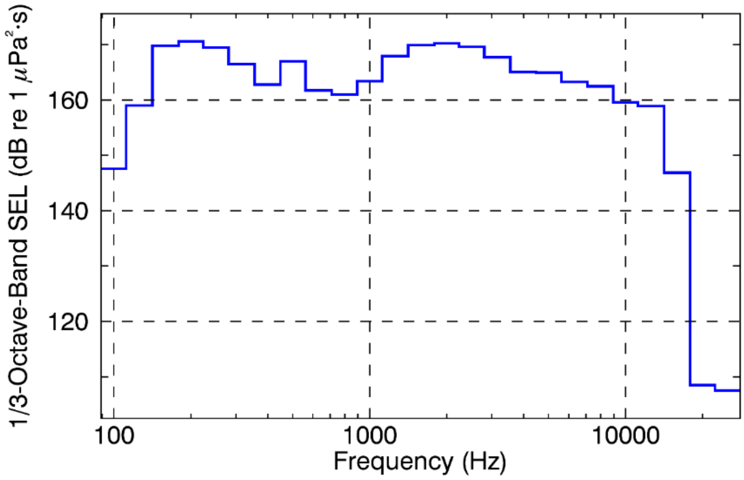


Figure 4. Boomer source spectra calculated from measurements (Martin et al. 2012).

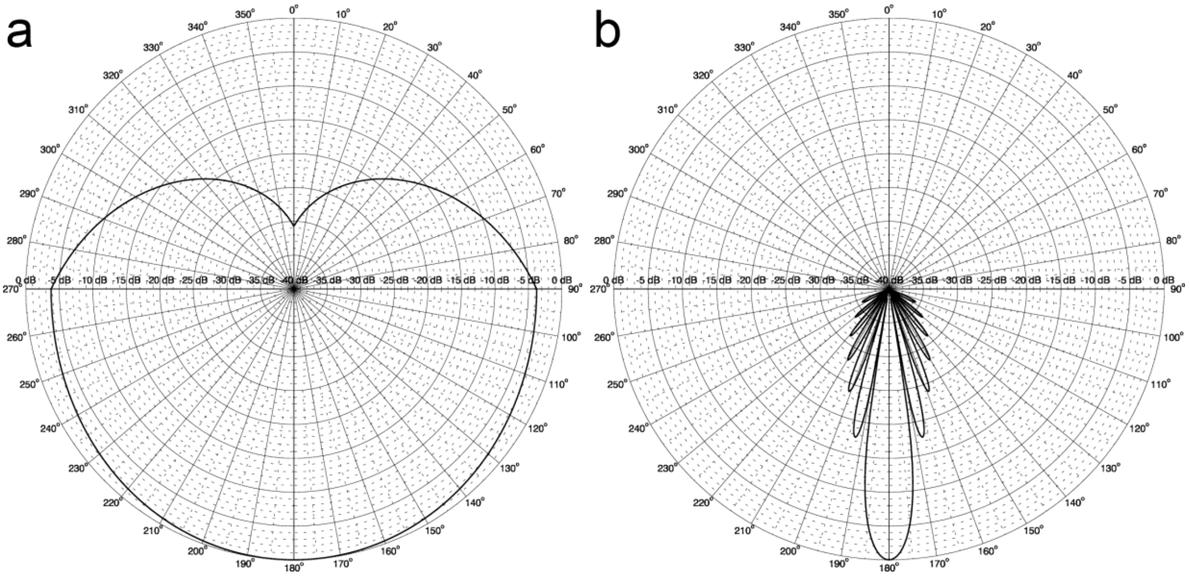


Figure 5. Calculated beam pattern vertical slice for the AA202 boomer plate at (a) 1.25 and (b) 16.0 kHz; across-track direction.

3.1.2. Sub-bottom Profiler: EdgeTech X-Star

The representative sub-bottom profiler system for geophysical survey operations is the EdgeTech X-Star (manufactured by EdgeTech). The system is equipped with a SBP-216 tow-fish. The transducer installed on the SBP-216 tow-fish transmits a chirp pulse that spans an operator-selectable frequency band. The lower and upper limits of the sonar's frequency band are 2 and 16 kHz, respectively. The system projects a single beam directed vertically down. The projected beamwidth depends on the operating frequency, and it can vary in range from 10° to 20°.

The source function was determined by using data obtained from the same measurement campaign as the boomer (Martin et al. (2012).To determine a source function usable for modelling the signal underwent a degree of post-processing. A clip from the recording measured at the closest point of approach was selected for processing (Figure 6). By assuming a point-like source and with no significant reflections or pulse dilation, the source level was determined by back-propagation methods assuming spherical spreading (Figure 7). The SEL band levels were determined from the back-propagated signal and are shown in Figure 8. The calculated source specifications are provided in Table 5. The width of the pulse encompassing 90% of the energy (T_{90}) was 8.1 ms, providing a SPL of 191.7 dB re 1 µPa @ 1 m.

For the purposes of modelling a source depth of 3 m was used, based on the assumed tow depth of a tow-fish. Since the echosounder's transducer projects a circular beam that is aimed vertically down, the source is effectively omnidirectional in the horizontal plane.

Table 5. Specifications of the Edgetech X-Star sub-bottom profiling system towed at a depth of 3 m used for the modelling

Specification	Specification	Source
Operating frequency:	2-16 kHz	System specification document
Beam width	10-20°	
Tilt angle (below horizontal plane)	90°	
Peak pressure source level	197.6 dB re 1 µPa @ 1 m	Estimated from field measurements; Martin et al. (2012).
Peak-Peak pressure source level	204.7 dB re 1 µPa @ 1 m	
SPL source level	191.7 dB re 1 µPa @ 1 m	
Pulse length (T_{90})	8.1 ms	
Per-pulse SEL source level	171.4 dB re 1 µPa^2·s @ 1 m	

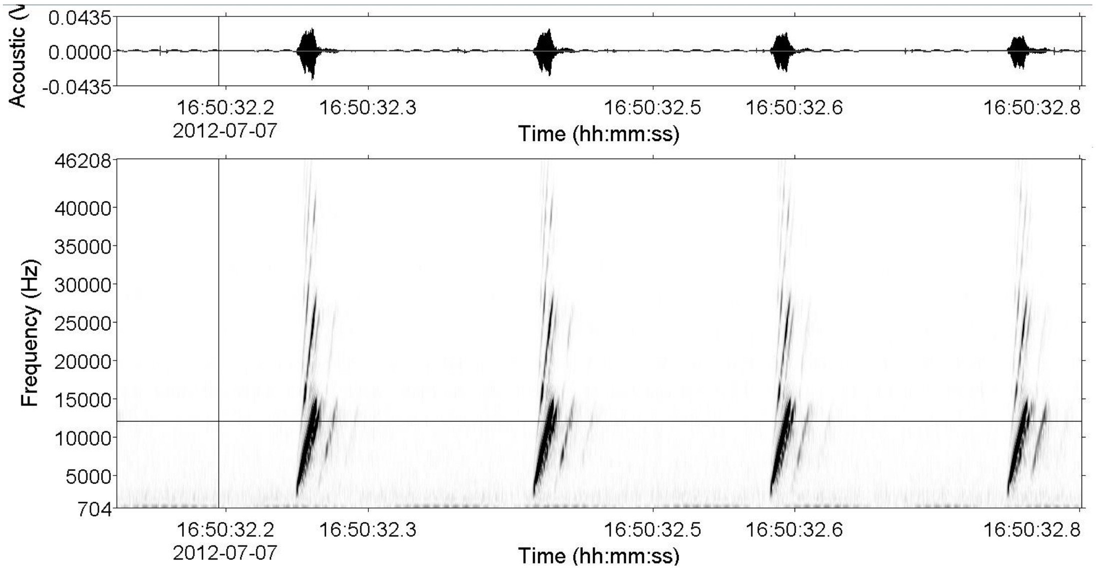


Figure 6. Spectrogram of X-Star SB-216S Sub-Bottom Profiler at closest-point of approach. The centroid frequency of the pulses was approximately 10 kHz, with 90% of the energy between 6 and 13 kHz. Aliased energy is visible above the main pulse. The bottom reflection is visible about 15 ms after the main pulse. (131,072 point FFT, 690 real data points, 345 point overlap.)

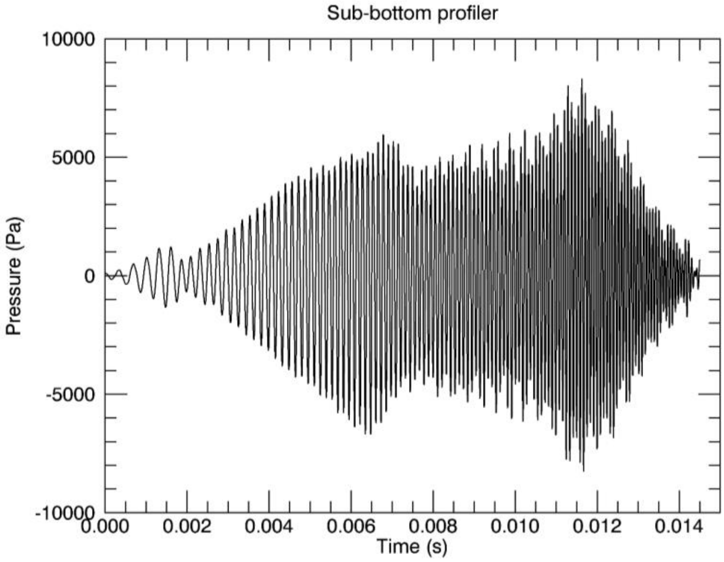


Figure 7. Back-propagated and scaled sub-bottom profiler source signature calculated from measurements (Martin et al. 2012).

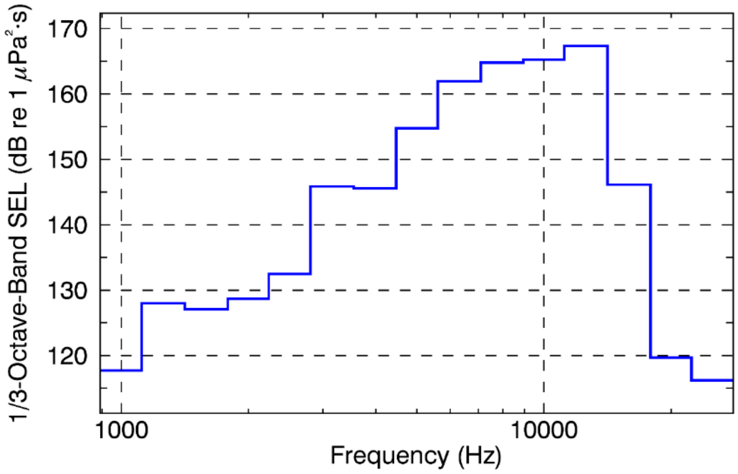


Figure 8. Sub-bottom profiler source spectra calculated from measurements (Martin et al. 2012).

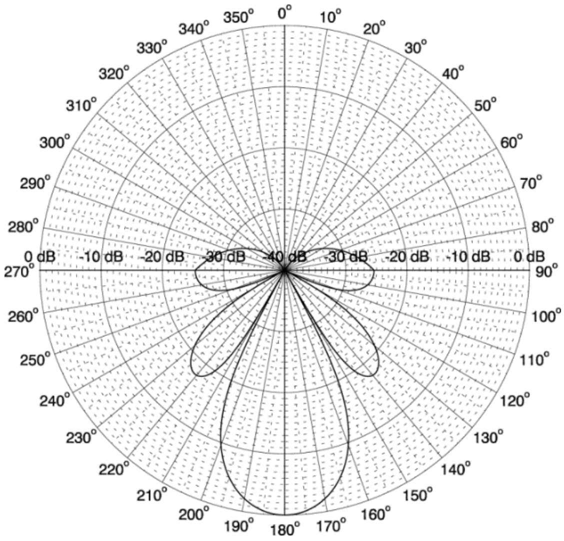


Figure 9. Calculated beam pattern vertical slice for the EdgeTech X-Star sub-bottom profiler at central frequency of 9 kHz.

3.1.3. VSP

The VSP airgun array under consideration is a 450 in^3 array consisting of 3 150 in^3 airguns operated at a centroid depth of 6 m, Figure 10 and Table 6.

The source levels and directivity of the airgun array were predicted with JASCO's Airgun Array Source Model (AASM), which accounts for:

- Array layout
- Volume, tow depth, and firing pressure of each airgun
- Interactions between different airguns in the array

The array was modelled over AASM's full frequency range, up to 25 kHz. Details of the model are described in Appendix B.

The model considered the following specifications:

- A 450 in^3 firing volume seismic airgun array for VSP.
- Airguns operated at a firing pressure of 2000 psi. The type was not specified, however Bolt 1900 LLX were used for the modelling.

- An array layout consisting of three 150 in³ airguns with a centroid depth of 6.0 m.

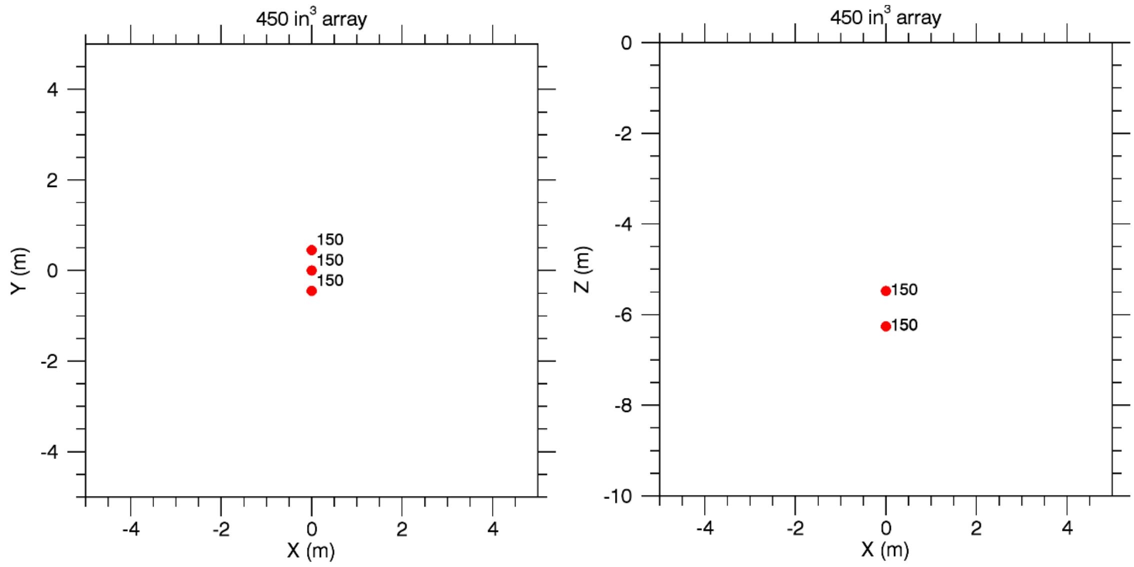


Figure 10. Layout of the modelled 450 in³ VSP array, plan view (left) and side view (right). Centroid operating depth is 6 m. The labels indicate the firing volume (in cubic inches) for each airgun. The convention is that the array is towed in the positive x direction. Also see Table 6.

Table 6. Layout of the modelled 450 in³ VSP array.Centroid operating depth is 6 m. Firing pressure for all guns is 2000 psi. The tow direction is assumed to be in the positive *x* direction.

Gun	*x* (m)	*y* (m)	*z* (m)	Volume (in³)
1	0.0	0	5.48	150
2	0.0	0.45	6.26	150
3	0.0	- 0.45	6.26	150

3.2. Sound Propagation Models

3.2.1. Boomer

The boomer source can be treated as an omnidirectional source for the frequencies of 1000 Hz and lower. For frequencies higher than 1000 Hz, the directionality of the boomer was taken into account. Due The acoustic field projected by the boomer source in 1/3-octave-bands was modelled using two propagation models: for frequencies of 1000 Hz and below MONM-RAM was used, while frequencies above 1000 Hz were modelled using MONM-BELLHOP. These were combined in post processing to determine the acoustic field across the entire frequency range. To determine the maximum range to PK, and PK-PK thresholds, spherical spreading laws were applied to the source level in the downward direction; these are usable due to the short ranges associated with the identified threshold levels within which no appreciable pulse dilation will occur nor reflections.

The acoustic propagation modelling was conducted in terms of PK, PK-PK and SEL units. The conversion to the SPL units was done based on Equation A-5 considering the T_{90} equal to 0.2 ms for the distances from the source less than 20 m, and 10 ms for the distances greater than 20 m from the source.

3.2.2. Sub-bottom Profiler

As the sub-bottom profiler was found only to have significant energy above 1 kHz it was assumed to be directional throughout its operational range. Consequently, MONM-BELLHOP was employed to model the entire frequency range of the SEL acoustic field in terms of 1/3-octave-bands. The ranges to PK and PK-PK levels were determined using spherical spreading laws.

The conversion to the SPL units was done based on Equation A-5 considering the T_{90} equal to 8 ms as determined by the measurement study.

3.2.3. VSP

Four sound propagation models (Appendix C) were used to predict the acoustic field around the VSP array for frequencies from 5 Hz to 25 kHz:

- Range-dependent parabolic equation model (Marine Operations Noise Model, MONM)
- Range-dependent ray tracing model (BELLHOP)
- Full Waveform Range-dependent Acoustic Model (FWRAM)
- Wavenumber integration model (VSTACK).

The models were used in combination to characterise the acoustic fields at short and long ranges in terms of SEL, SPL, PK, and PK-PK.

3.3. Accumulated SEL

3.3.1. Method overview

During a geophysical survey, a new portion of sound energy is introduced into the environment with each pulse from the survey equipment. An accurate assessment of the cumulative acoustic field depends not only on the parameters of each impulse, but also on the number of impulses delivered over a period and the relative position of the impulses. Consideration of the total acoustic energy marine fauna is subjected to over the survey operations is required for comparison to the relevant effect criteria (Section 2).

When there are many pulses, it becomes computationally prohibitive to perform sound propagation modelling for every single event. The offset between the consecutive pulses is small enough, however, that the environmental parameters that influence sound propagation are virtually the same for many impulse points. The acoustic fields can, therefore, be modelled for a subset of pulses and estimated at several adjacent ones. After sound fields from representative impulse locations are calculated, they are adjusted to account for the source position for nearby impulses.

Although estimating the cumulative sound field with the described approach is not as precise as modelling sound propagation at every impulse location, small-scale, site-specific sound propagation features tend to blur and become less relevant when sound fields from adjacent impulses are summed. Larger scale sound propagation features, primarily dependent on water depth, dominate the cumulative field. The accuracy of the present method acceptably reflects those large-scale features, thus providing a meaningful estimate of a wide area SEL field in a computationally feasible framework.

3.3.2. Scenario definition

Four regions were identified for the cumulative study, each requiring many thousands of individual impulses. In each region a representative single pulse noise field for the relevant source is shifted in space and noise fields summed to provide a composite field. For the Thylacine location, two possible surveys were combined into a single scenario, referred to as Thylacine Combined. This scenario included a total of 38 lines each being 7.025 km in length (total estimated time of 51 h including turns). The other three scenarios, Geographe 3 (G3), Artisan (ARTISAN) and VICP69 Meeki (MEEKI), each featured 41 lines, of 4.0 km length (total estimated time of 40.2 h. Along each line the operating sequence was to alternate between the sub-bottom profiler and the boomer with the vessel travelling at 4.5 knots and a turn time of 30 minutes during which no source would be operated. The proposed areas are shown in Figure 11.

To produce maps of cumulative received sound level distribution and calculate distances to specified sound level thresholds at the seafloor, the sound level was calculated at a subset of points within the modelled region. The radial grids of sound levels of the modelled sites at each point were then resampled (by linear triangulation) to produce a regular Cartesian grid. These grids were transposed geographically to each impulse location along the survey lines. The sound field grids from all impulses were summed, using Equation A-4, to produce the cumulative sound field grid. The produced grids had a cell size of 5 m. The contours and threshold ranges were calculated from these flat Cartesian projections of the modelled acoustic fields.

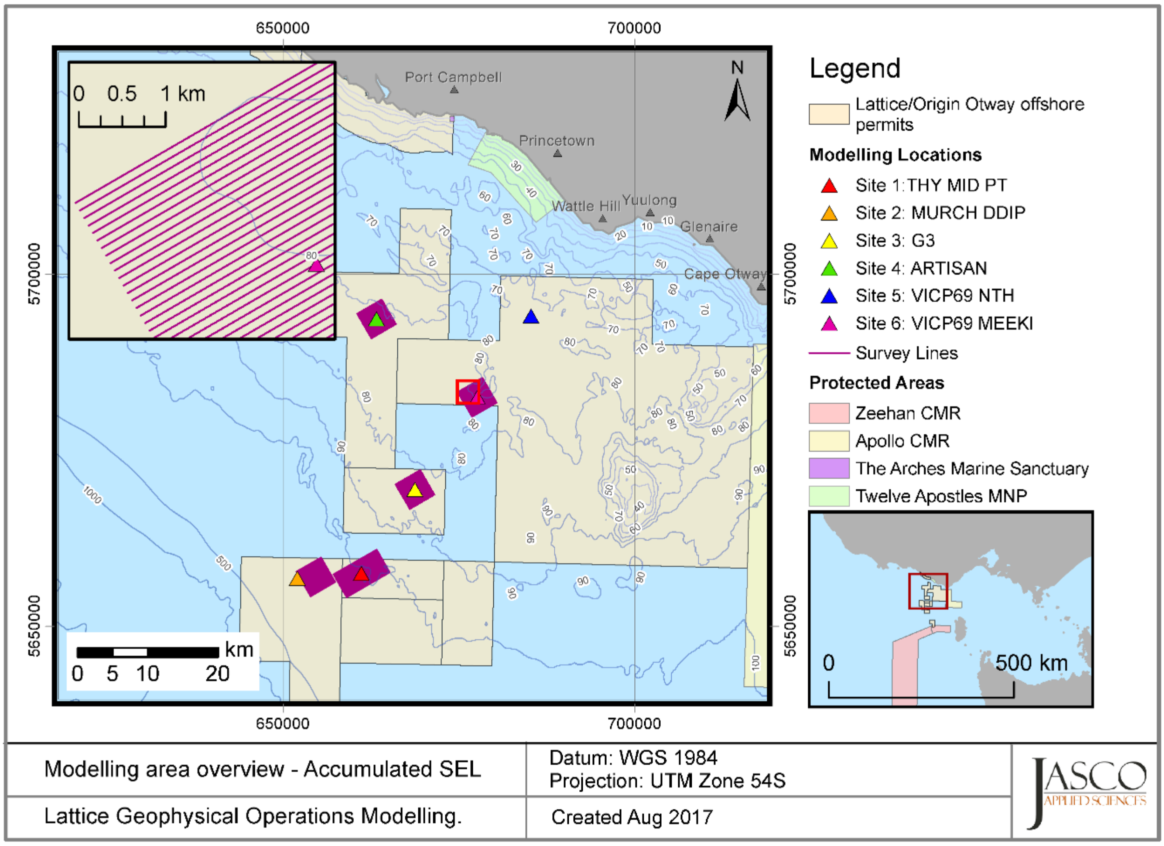


Figure 11. Overview of site surveys (and survey lines) under consideration. The site surveys are referred to by the name of the modelling location located at the same site.

3.4. Geometry and Modelled Regions

The modelled regions were defined based on the anticipated noise footprint of each of the sources. The VSP is significantly louder than either the boomer or the sub-bottom profiler, as well as having greater energy at lower frequencies that would typically propagate further than higher frequencies. The VSP, therefore was modelled in MONM in a series of radial slices with a maximum length of 56 km; the radial slices were 2.5° apart providing a total of 144 individual two-dimensional sound fields that were interpolated onto a regular three-dimensional grid to determine the output metrics. The range step in MONM was 10 m, used across the entire frequency range of 10 to 2000 Hz.

To determine the conversion factor from SEL to SPL, FWRAM was used with four transects modelled (cardinal directions). The Full Waveform Range-dependent Acoustic Model (FWRAM) employs a frequency dependent range step varying from 50 m at 10 Hz to 10 m at 1000 Hz. To calculate the near-field results the VSP was modelled in VSTACK, a wavenumber integration model; results were generated up to a frequency of 1 kHz up to 500 m away. Only a single range-independent transect was modelled using VSTACK.

The boomer and the sub-bottom profiler sources are more strongly directional than the VSP and operate at higher frequencies; consequently, the modelling was principally performed using BELLHOP, the beam-tracing model. The field was modelled in radial slices each 10° apart to provide 36 modelled transects, up to a maximum range of 3.5 km, with a range step of 1 m to provide high-resolution outputs. Where the boomer was omnidirectional (at 1 kHz), MONM was used to generate the contribution; otherwise, BELLHOP was used throughout. These modelling runs were performed separately for each of the six identified single pulse sites.

4. Results

This section presents the model results as distances to sound level thresholds and as sound field contour maps.

4.1. Acoustic Source Levels and Directivity

4.1.1. VSP Array

The pressure signatures of the individual airguns and the composite 1/3-octave-band point-source equivalent directional levels of the arrays were modelled with AASM (Section 3.1). Although AASM accounts for the effects of surface-reflected signals on bubble oscillations and inter-bubble interactions in the notional pressure signatures of each airgun, the signal reflected off the water surface (known as surface ghost) is not included in the far-field source signatures; however, the acoustic propagation models account for those surface reflections because they are a property of the propagating medium rather than the source.

The horizontal and vertical overpressure signatures, corresponding power spectrum levels, and the horizontal directivity plots for array is provided in Appendix B.4.

To help compare these results to the outputs of other airgun array source models, Table 7 presents the vertical source level that accounts for the surface ghost, and lists the broadband PK, and per-pulse SEL source levels of the array in the endfire, broadside, and vertical directions.

Table 7. Source level specifications in the horizontal plane for the 450 in^3 VSP array, for a 6 m centroid depth.

Direction	PK (dB re 1 µPa @ 1 m)	SEL (dB re 1 µPa^2·s @ 1 m)	
		10–2000 Hz	2000–25000 Hz
Broadside	237.6	213.6	167.7
Endfire	237.8	213.7	173.4
Vertical (no ghost)	237.6	213.6	171.1
Vertical (with ghost)	237.6	215.7	174.1

4.2. Single Pulse Sound Fields

4.2.1. Tabulated Results

4.2.1.1. Boomer

The single pulse sound fields for the representative boomer (an AP3000 triple plate boomer) are presented in terms of maximum-over depth SPL for marine mammal and turtle behavioural thresholds (Table 8), maximum-over-depth and seafloor per-pulse SEL (Tables 9 and 10), and water column PK-PK and PK (Tables 11 and 12). Water column PK-PK and PK are included as the levels referenced for benthic invertebrates in Section 2.1 are not reached at the seafloor.

Table 8. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the boomer to modelled maximum-over-depth marine mammal and turtle behavioural response thresholds.

	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
Marine mammal behaviour SPL: 160 dB re 1 µPa	142	139	75	72	140	136	138	134	136	132	145	134
Turtle behaviour, SPL: 166 dB re 1 µPa	36	35	36	35	36	35	36	35	36	35	36	35

Table 9. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the boomer to modelled maximum-over-depth per-pulse SEL isopleths.

Per-pulse SEL (dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}
160	7	7	7	7	6	6	7	6	7	7	6	6
155	13	12	12	12	13	12	12	12	12	12	12	12
150	21	21	21	21	21	21	22	21	21	21	22	21
145	38	37	38	37	38	37	39	38	38	37	38	37
140	84	77	70	67	136	134	131	127	134	129	135	129
135	233	226	244	229	226	208	288	208	303	215	253	216
130	768	609	604	504	738	559	868	725	908	671	762	628
125	2070	1500	1810	1220	1900	1380	1740	1490	1810	1520	1880	1310
120	3260	2660	3250	2480	3210	2480	3000	2460	3070	2460	3100	2440

Table 10. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the boomer to modelled seafloor per-pulse SEL isopleths. A dash indicates the level is not reached.

Per-pulse SEL (dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}
160	—	—	—	—	—	—	—	—	—	—	—	—
155	1	1	—	—	—	—	—	—	—	—	—	—

Per-pulse SEL (dB re 1 µPa^2·s)	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}
150	3	3	2	2	1	1	1	1	1	1	1	1
145	6	5	5	5	4	4	3	3	4	4	4	4
140	62	60	13	12	136	135	131	127	134	130	135	130
135	232	226	243	229	226	208	288	208	303	213	253	209
130	668	607	602	504	634	547	868	636	908	661	762	651
125	1960	1500	1810	1170	1690	1310	1740	1510	1810	1540	1880	1280
120	3240	2580	3230	2410	3060	2380	3000	2330	3070	2390	2920	2370

Table 11. Maximum (R_{max}) vertical distances down (in m) from the boomer to modelled PK-PK isopleths in the water column. The source is operated at 2 m depth, the results are site independent.

PK-PK (dB re 1 µPa)	Vertical Distance from source (m)
215	2.4
212	3.4
210	4.3
209	4.8
205	7.6
202	10.8

Table 12. Maximum (R_{max}) vertical distances down (in m) from the boomer to modelled PK isopleths in the water column. The source is operated at 2 m depth, the results are site independent.

PK (dB re 1 µPa)	Vertical Distance from source (m)
213	0.6
210	0.8
207	1.6

4.2.1.2. Sub-bottom Profiler

The single pulse sound fields for the representative sub-bottom profiler (an EdgeTech X-Star SBP-216) are presented in terms of maximum-over depth SPL for marine mammal and turtle behavioural thresholds (Table 13), maximum-over-depth and seafloor per-pulse SEL (Tables 14 and 15), and water column PK-PK and PK (Tables 16 and 17). Water column PK-PK and PK are included as the levels referenced for benthic invertebrates in Section 2.1 are not reached at the seafloor.

Table 13. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the sub-bottom profiler to modelled maximum-over-depth applied marine mammal and turtle behavioural response thresholds. A dash indicates the threshold is not reached.

Per-pulse SEL (dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
Marine mammal behaviour SPL: 160 dB re 1 µPa	2	2	2	2	2	2	2	2	2	2	2	2
Turtle behaviour, SPL: 166 dB re 1 µPa	—	—	—	—	—	—	—	—	—	—	—	—

Table 14. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the sub-bottom profiler to modelled maximum-over-depth per-pulse SEL isopleths. A dash indicates the level is not reached.

Per-pulse SEL (dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
145	—	—	—	—	—	—	—	—	—	—	—	—
140	1	1	1	1	1	1	1	1	1	1	1	1
135	4	4	4	4	4	4	4	4	4	4	4	4
130	8	8	8	7	7	7	7	7	7	7	7	7
125	13	12	13	13	11	11	10	10	10	10	11	10
120	16	16	19	18	14	13	13	12	13	13	13	13

Table 15. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the sub-bottom profiler to modelled seafloor per-pulse SEL isopleths. A dash indicates the level is not reached.

Per-pulse SEL (dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
135	—	—	—	—	—	—	—	—	—	—	—	—
130	—	—	—	—	—	—	5	5	6	6	6	6
125	10	10	13	13	9	9	8	8	8	8	10	9
120	15	14	19	18	13	12	12	12	13	12	13	13

Table 16. Maximum (R_{max}) vertical distances down (in m) from the boomer to modelled PK-PK isopleths in the water column. The source is operated at 3 m depth, the results are site independent.

PK-PK (dB re 1 µPa)	Vertical Distance from source (m)
215	0.3
212	0.4
210	0.5
209	0.6
205	1.0

PK-PK (dB re 1 µPa)	Vertical Distance from source (m)
202	1.4

Table 17. Maximum (R_{max}) vertical distances down (in m) from the boomer to modelled PK isopleths in the water column. The source is operated at 3 m depth, the results are site independent.

PK (dB re 1 µPa)	Vertical Distance from source (m)
213	0.1
210	0.2
207	0.3

4.2.1.3. VSP

The single pulse results for the 450 in^3 VSP array operating in 72 m of water at Site 5 are presented in terms of maximum-over-depth per-pulse SEL and SPL (Tables 18 and 19), and seafloor per-pulse SEL, PK-PK and PK (Tables 20–22).

Table 18. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 450 in^3 VSP array to modelled maximum-over-depth per-pulse SEL isopleths at Site 5. The 160 dB re 1 µPa²·s isopleth (bold values) is associated with the DEWHA (2008) criterion.

Per-pulse SEL (dB re 1 µPa²·s)	Distance (km)	
	R_{max}	$R_{95\%}$
190	<0.02	<0.02
180	0.04	0.04
170	0.23	0.22
160	**1.06**	**1.03**
150	3.55	3.10
140	8.76	7.80
130	>23.0	>19.0

Table 19. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 450 in^3 VSP array to modelled maximum-over-depth SPL isopleths at Site 5 The 166 and 160 dB re 1 µPa isopleths (bold values) are associated with the turtle and marine mammal behavioural response thresholds.

SPL (dB re 1 µPa)	Distance (km)	
	R_{max}	$R_{95\%}$
190	<0.04	<0.04
180	0.22	0.21
170	0.89	0.86
166	**1.55**	**1.45**
160	**2.56**	**2.44**
150	6.96	6.24

SPL (dB re 1 µPa)	Distance (km)	
	*R*max	*R*95%
140	19.9	16.8
130	>48.0	>42.0

Table 20. Maximum (R_{max}) horizontal distances (in m) from the 450 in^3 VSP array to modelled seafloor per-pulse SEL isopleths at Site 5 using VSTACK. A dash indicates the level is not reached.

Per-pulse SEL (dB re 1 µPa²·s)	Distance (m)
185	-
180	35
178	65
176	105
174	145
172	180
170	210

Table 21. Maximum (R_{max}) horizontal distances (in m) from the VSP array at Site 5 to modelled seafloor PK-PK isopleths. A dash indicates the level is not reached.

PK-PK (dB re 1 µPa)	Distance (m)
212	–
210	–
209	–
208	30
207	55
206	75
205	100
202	185

Table 22. Maximum (R_{max}) horizontal distances (in m) from the VSP array at Site 5 to modelled seafloor PK isopleths. A dash indicates the level is not reached.

PK (dB re 1 µPa)	Distance (m)
213	–
207	–
204	20
202	60
200	110

PK (dB re 1 µPa)	Distance (m)
198	165

4.2.2. Maps and Graphs

4.2.2.1. Boomer

Maps of the per-pulse SEL at the seafloor along with vertical slices for the representative boomer are shown for two representative sites, Site 1 (Thylacine Midpoint: Figures 12 and 13) and Site 4 (Artisan: Figures 14 and 15). The shape of the footprint at all six modelled sites (Table 1) is almost identical.

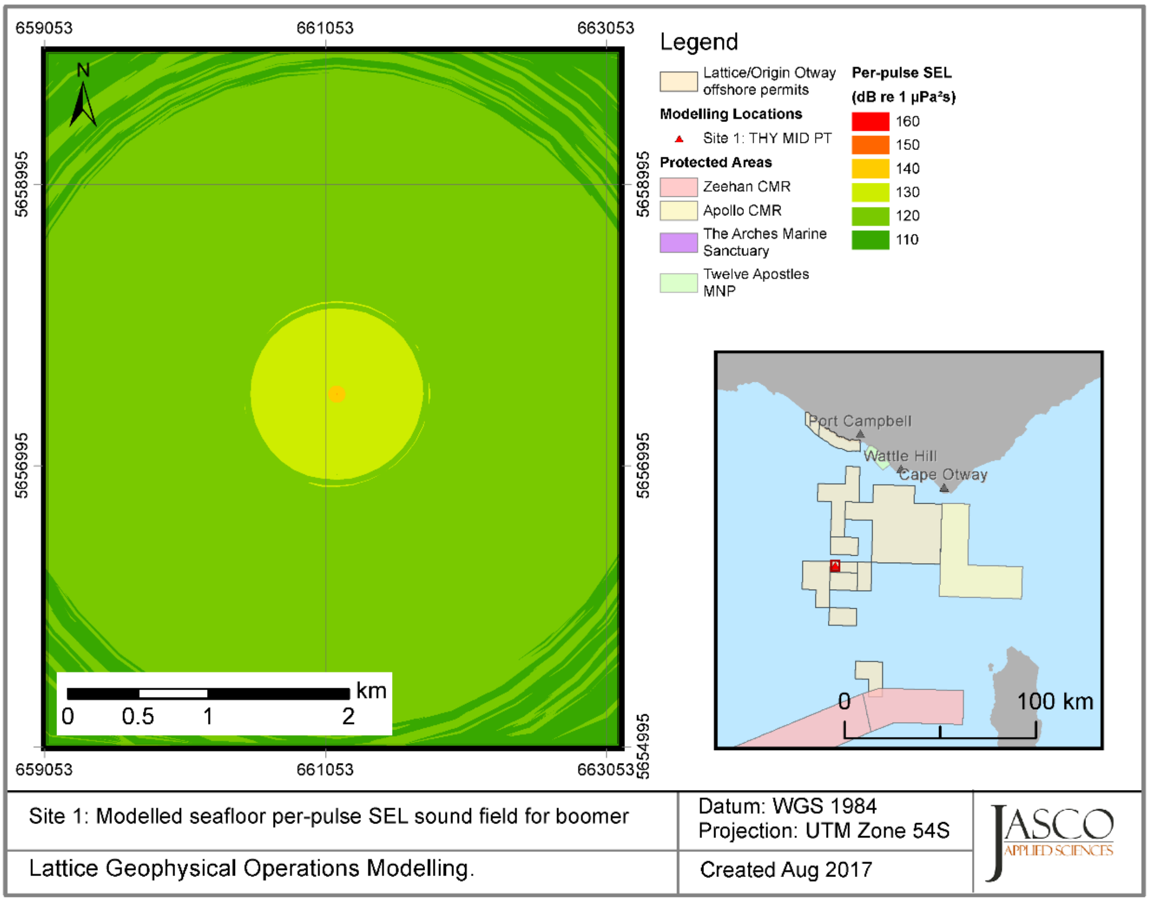


Figure 12. Boomer, Site 1: Sound level contour map showing unweighted seafloor per-pulse SEL results for the boomer towed at 2 m depth.

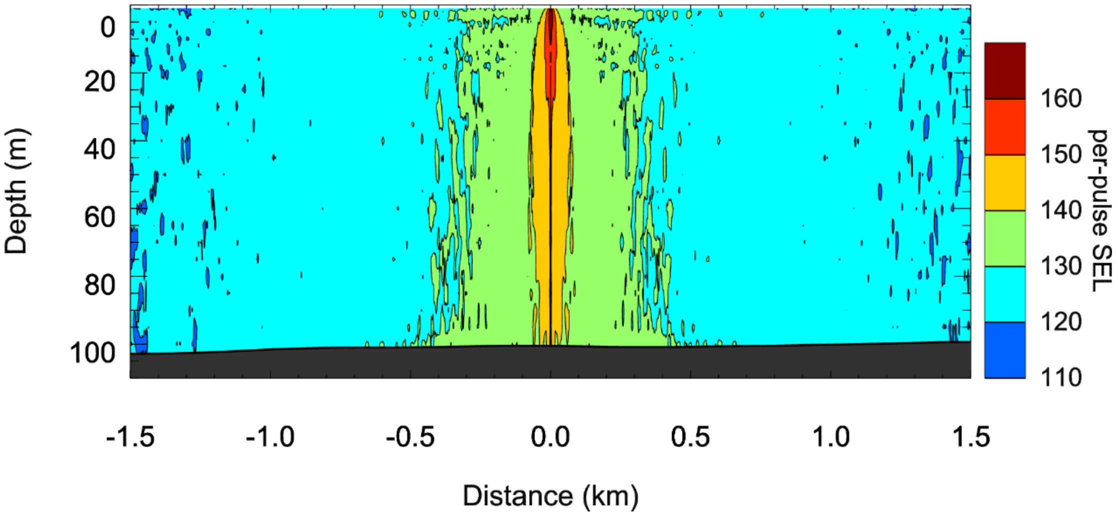


Figure 13. Boomer, Site 1: Predicted unweighted per-pulse SEL for the boomer towed at 2 m depth as vertical slices. Levels are shown from south to north.

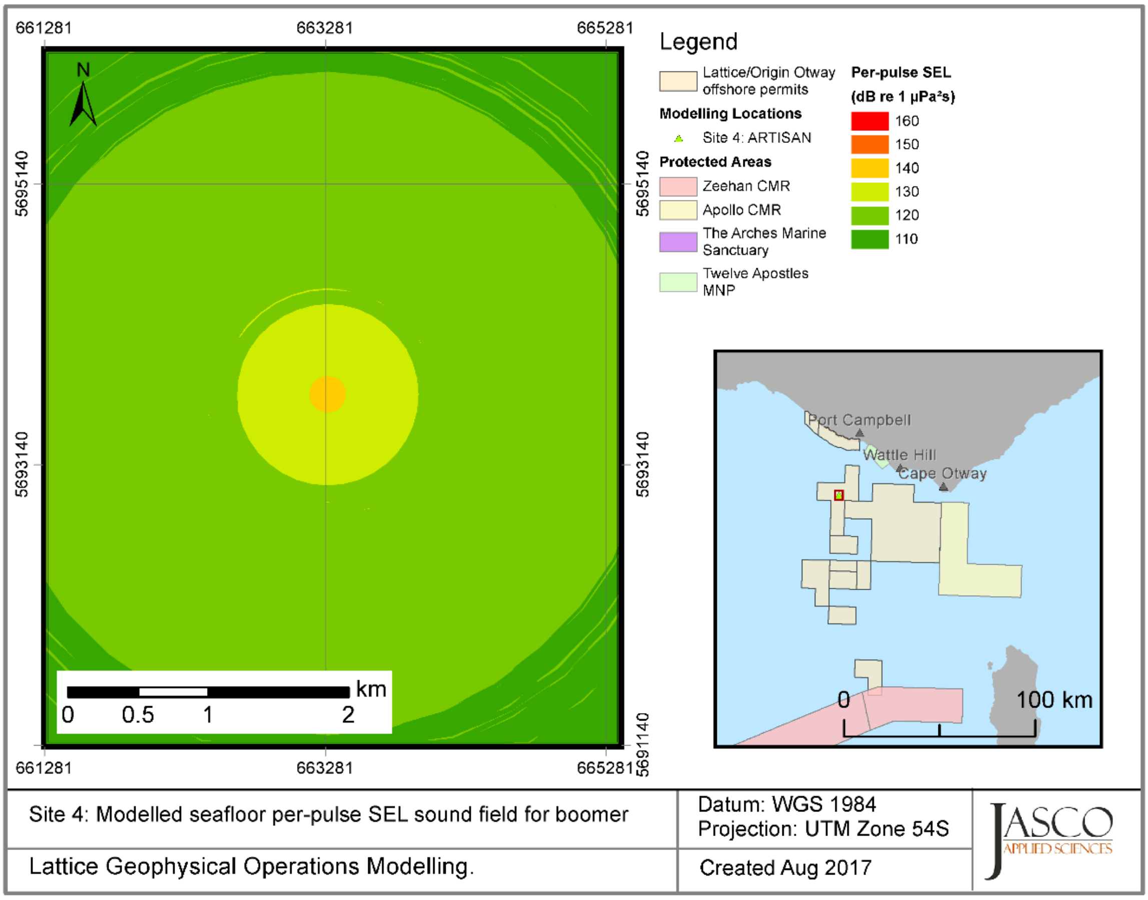


Figure 14. Boomer, Site 4: Sound level contour map showing unweighted seafloor per-pulse SEL results for the boomer towed at 2 m depth.

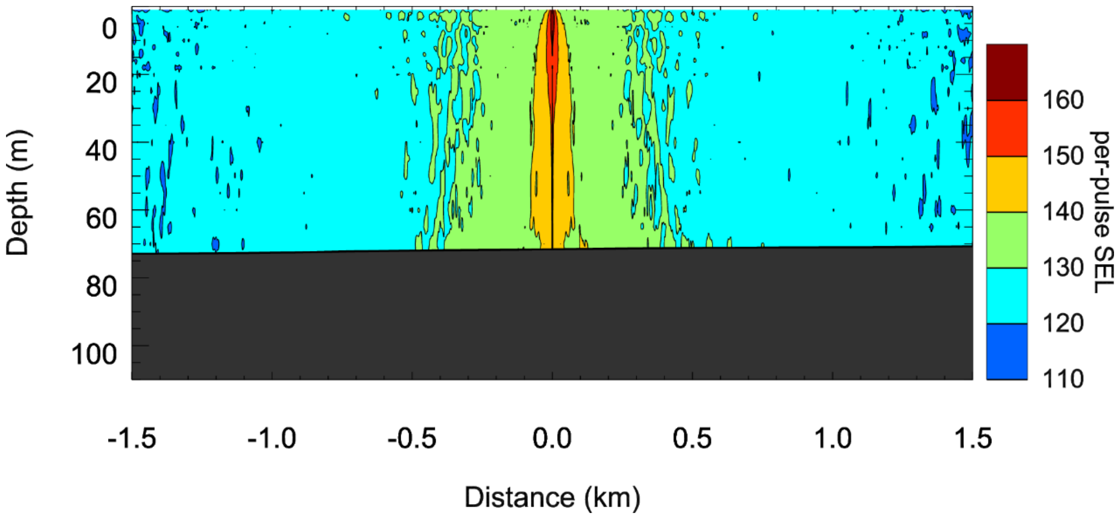


Figure 15. Boomer, Site 4: Predicted unweighted per-pulse SEL for the boomer towed at 2 m depth as vertical slices. Levels are shown from south to north.

4.2.2.2. Sub-bottom Profiler

Maps of the per-pulse SEL at the seafloor along with vertical slices for the representative SBP is shown for two representative sites, Site 1 (Thylacine Midpoint: Figures 16 and 17) and Site 4 (Artisan: Figures 18 and 19). The shape of the footprint at all six modelled sites (Table 1) is almost identical.

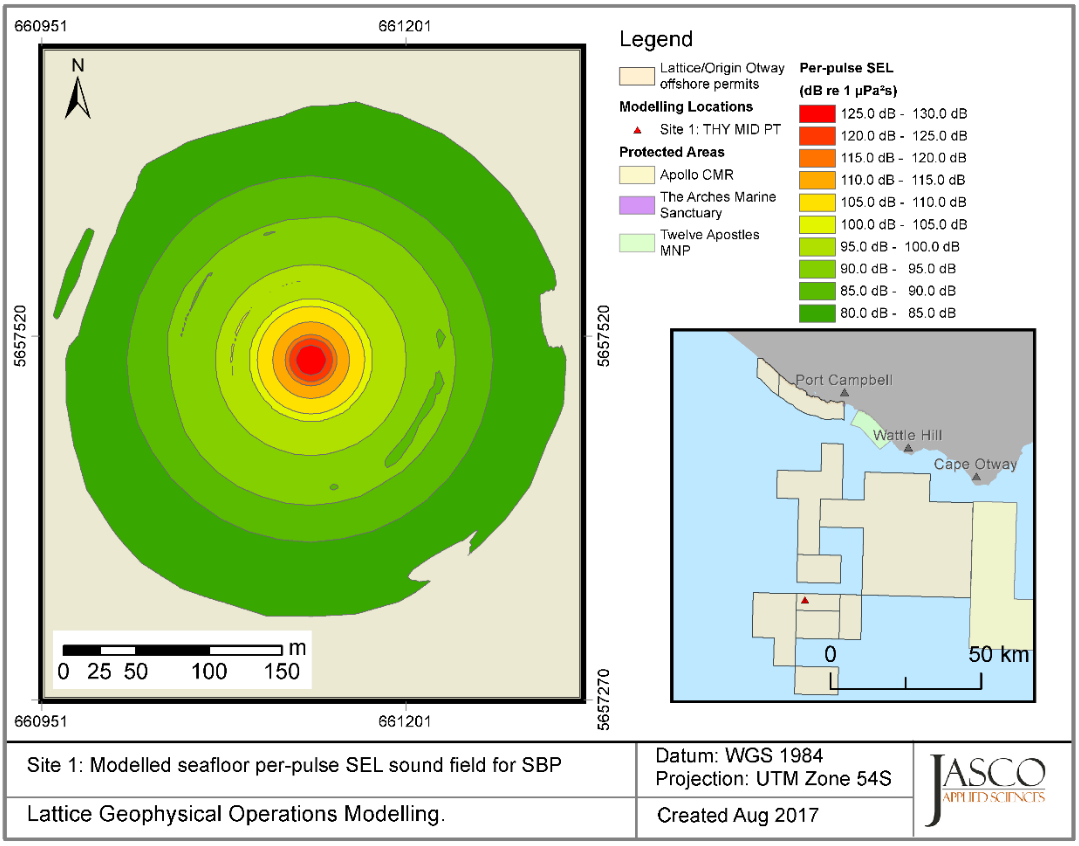


Figure 16. SBP, Site 1: Sound level contour map showing unweighted seafloor per-pulse SEL results for the SBP towed at 3 m depth.

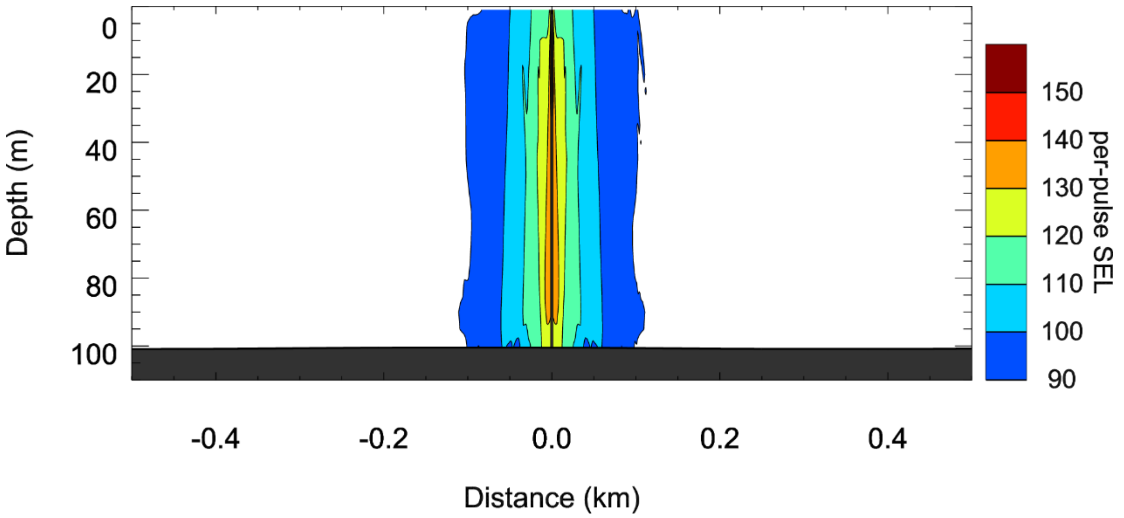


Figure 17. SBP, Site 1: Predicted unweighted per-pulse SEL for the SBP towed at 3 m depth as a vertical slice. Levels are shown from south to north.

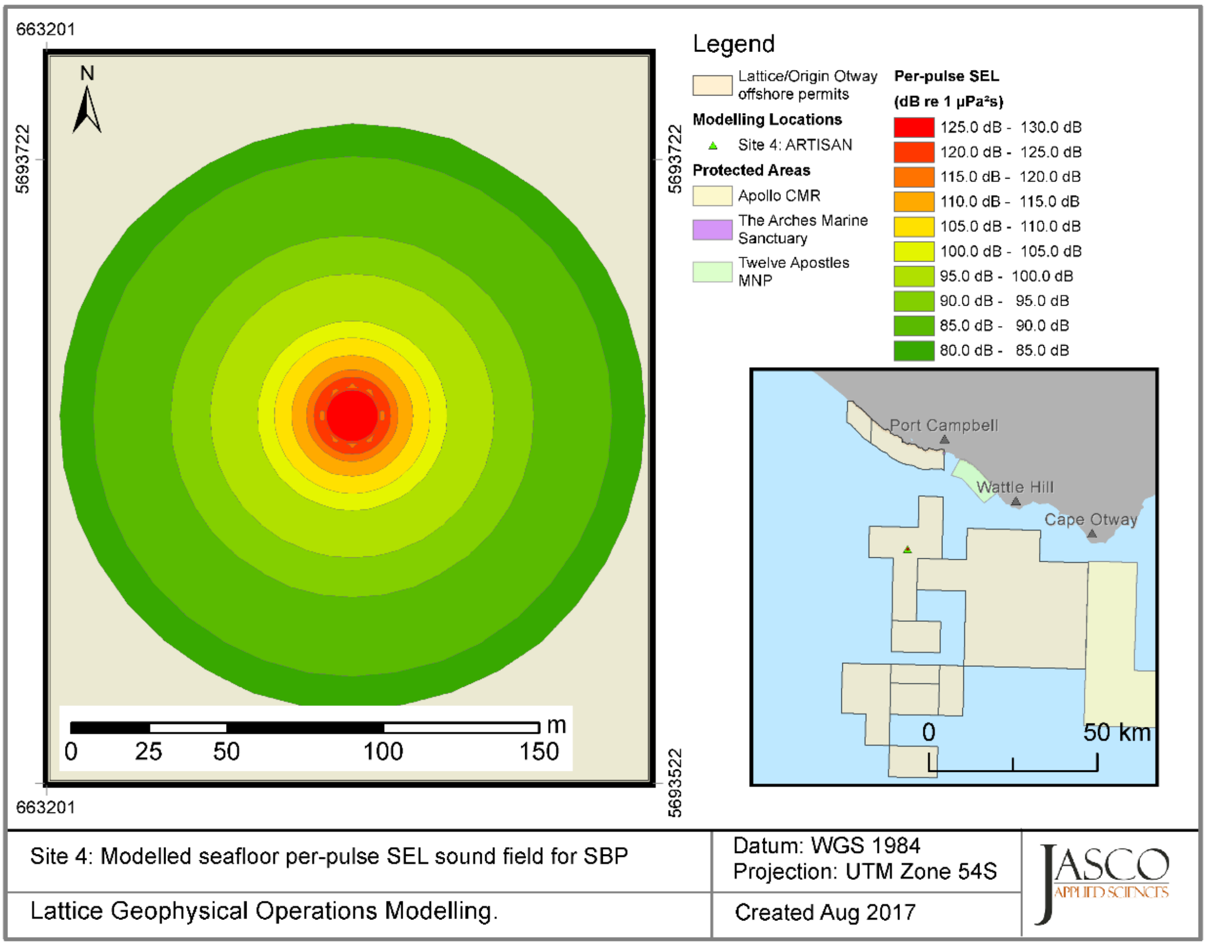


Figure 18. SBP, Site 4: Sound level contour map showing unweighted seafloor per-pulse SEL results for the SBP towed at 3 m depth.

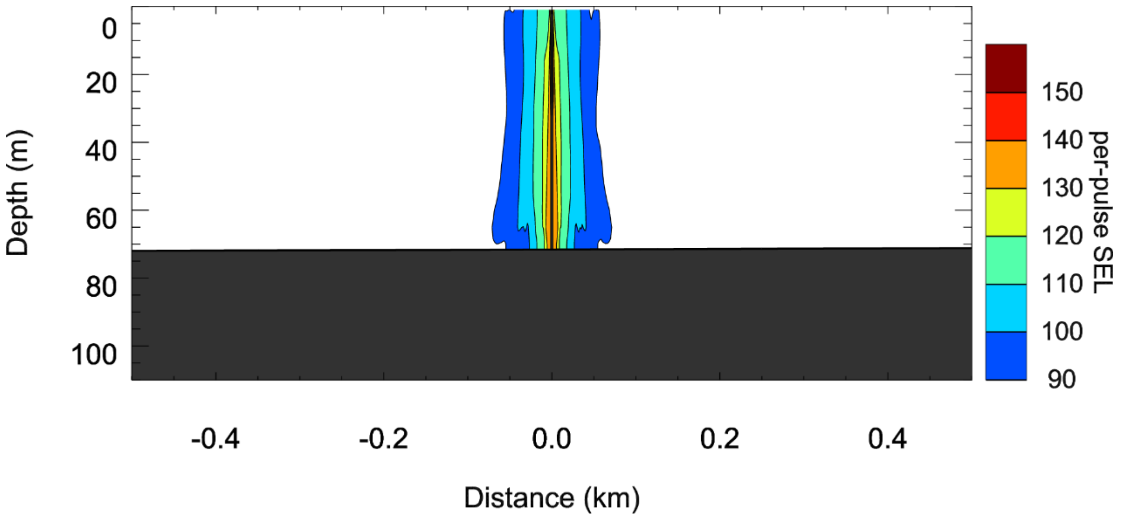


Figure 19. SBP, Site 4: Predicted unweighted per-pulse SEL for the SBP towed at 3 m depth as a vertical slice. Levels are shown from south to north.

4.2.2.3. VSP

Maps of the per-pulse SEL as maximum-over-depth along with vertical slices for the VSP is shown at Site 5, Block VICP69, North (Figures 20 and 21). Additionally, the PK and PK-PK at the seafloor out to 300 m is shown in Figure 22.

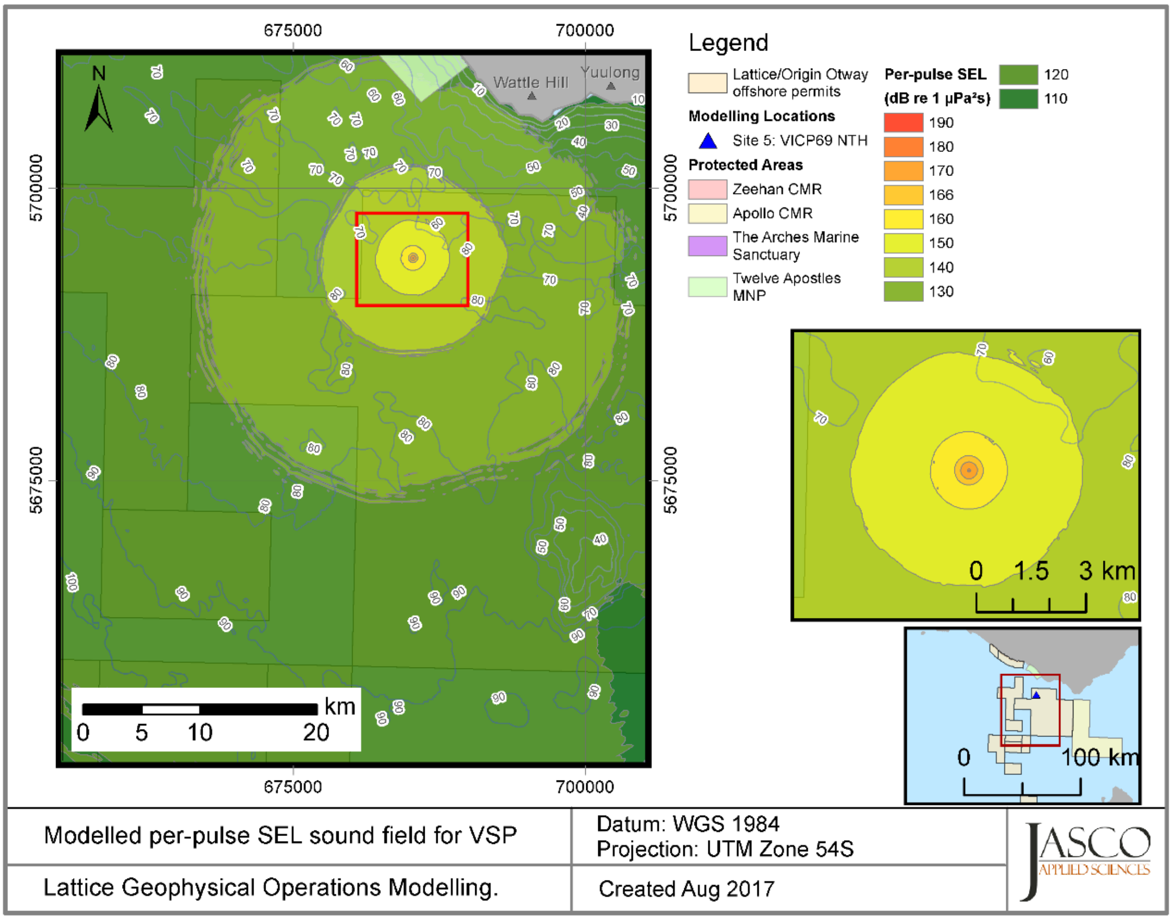


Figure 20. Sound level contour map showing unweighted maximum-over-depth per-pulse SEL results for the 450 in³ VSP array operated at 6 m depth at Site 5.

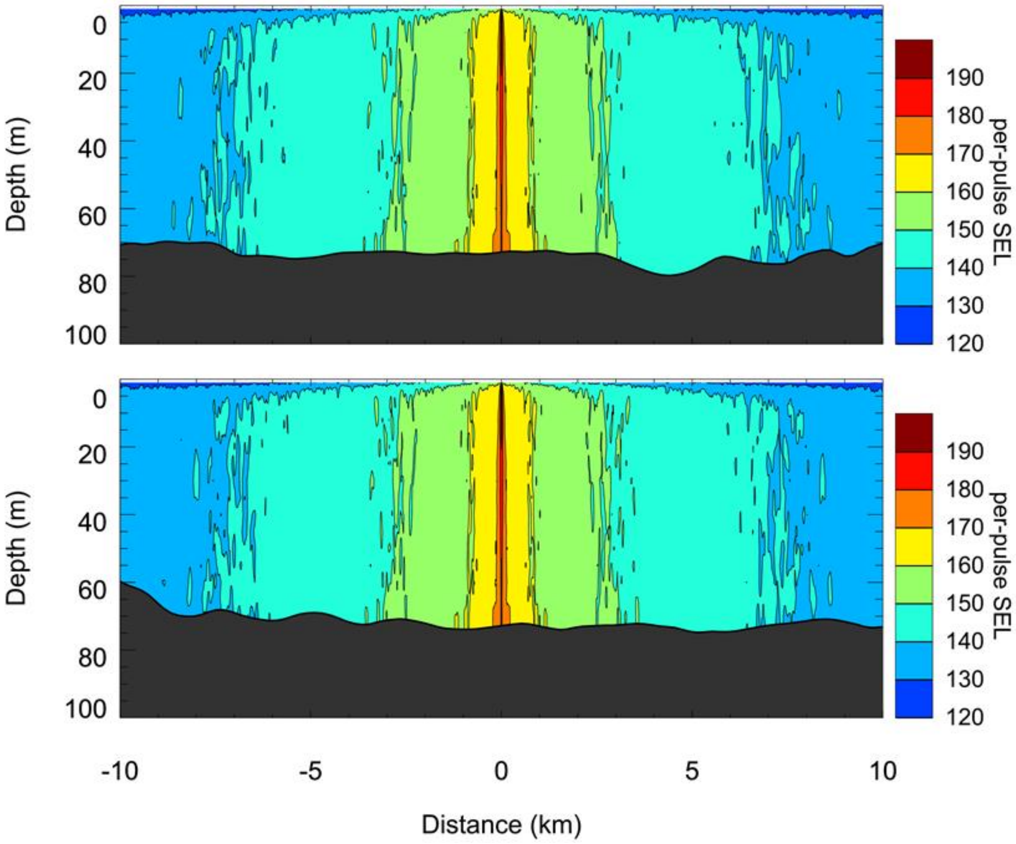


Figure 21. Predicted unweighted per-pulse SEL as vertical slices. Levels are shown in the broadside (top) and endfire directions (bottom). The source depth is 6 m.

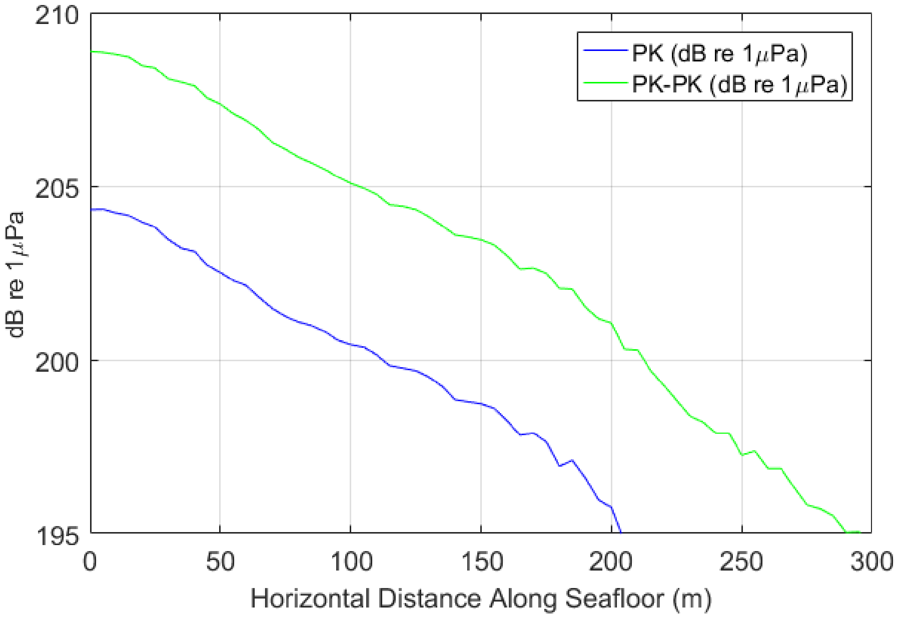


Figure 22. Predicted maximum PK and PK-PK in the endfire direction at the seafloor at Site 5, 72.8 m depth. The source depth is 6 m.

4.3. Accumulated Sound Exposure Levels

4.3.1. Tabulated Results

A cumulative noise study was performed for the four regions, Thylacine Combined, Geographe 3, Artisan, and Block VICP69 Meeki, as indicated in Figure 11. The study involved multiple survey lines with alternating pulses of the boomer and the sub-bottom profiler. Table 23 shows the distances to cumulative SEL thresholds at the seafloor where the accumulation period covers the entire survey.

Table 23. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the survey areas to modelled seafloor cumulative SEL isopleths, and the ensonified area to the specified threshold (in km^2). A dash indicates that the level was not exceeded at the seafloor.

SEL (dB re 1 µPa^2·s)	Thylacine Combined			Geographe 3			Artisan			Block VICP69, Meeki		
	R_{max} (km)	$R_{95\%}$ (km)	*Area* (km^2)	R_{max} (km)	R_{max} (km)	*Area* (km^2)	R_{max} (km)	R_{max} (km)	*Area* (km^2)	R_{max} (km)	R_{max} (km)	*Area* (km^2)
170	—	—	—	—	—	—	—	—	—	—	—	—
165	0.11	0.05	12.52	0.05	0.05	8.86	0.09	0.05	9.46	0.05	0.05	9.08
160	1.7	1.2	38.9	1.1	0.8	22.7	1.2	0.8	22.7	1.1	0.8	22.7
155	6.9	5.3	189	4.8	4.1	107	4.8	3.9	106	5.5	4.2	114
150	9.6	6.9	287	8.2	6.4	221	8.1	6.4	220	8.3	6.4	221
145	>10	>10	NA	>10	>10	NA	>10	>10	NA	>10	>10	NA

4.3.2. Sound Level Contour Maps

Maps of the accumulated SEL at the seafloor for the combined operations of the boomer and the SBP over the duration of the surveys (described in Section 3.3.2) are shown for the four considered surveys. These are at the Thylacine Combined (Figure 23), Geographe 3 (Figure 24), Artisan (Figure 25) and Block VICP69, Meeki (Figure 26) locations.

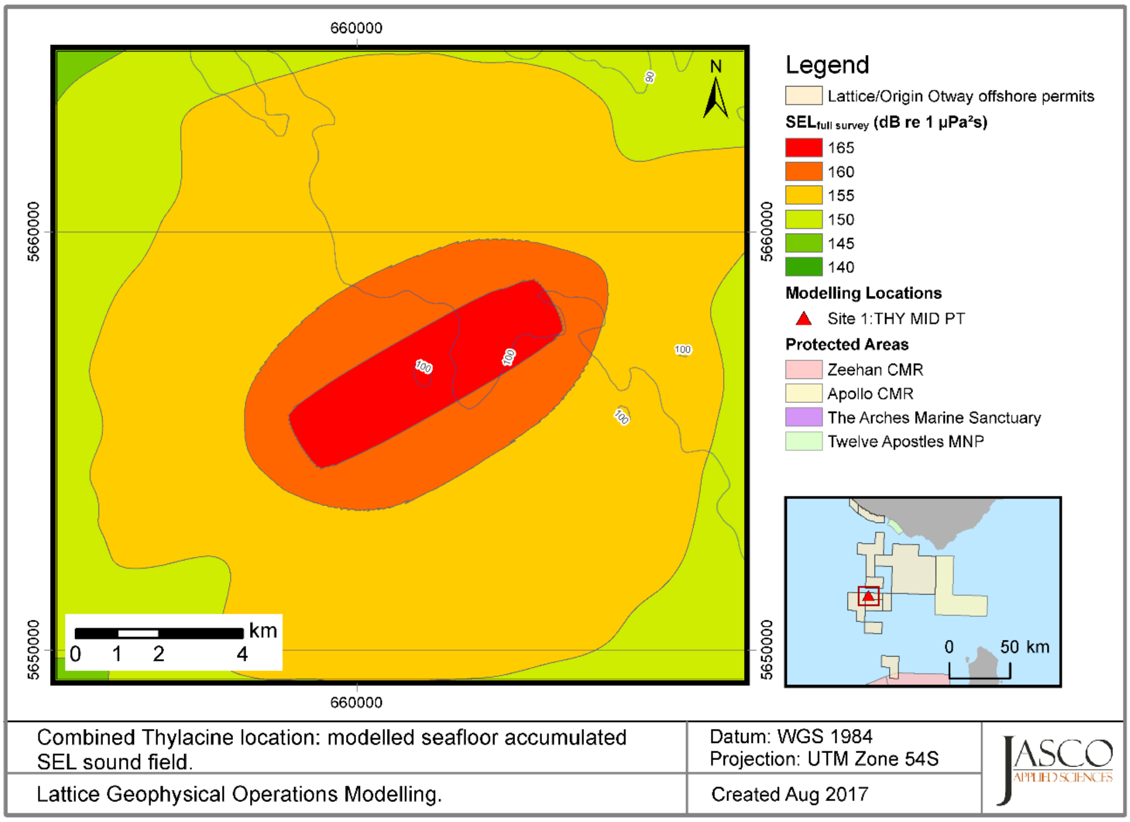


Figure 23. Thylacine Combined location: Sound level contour map of seafloor accumulated SEL over the full survey for the boomer and SBP operations.

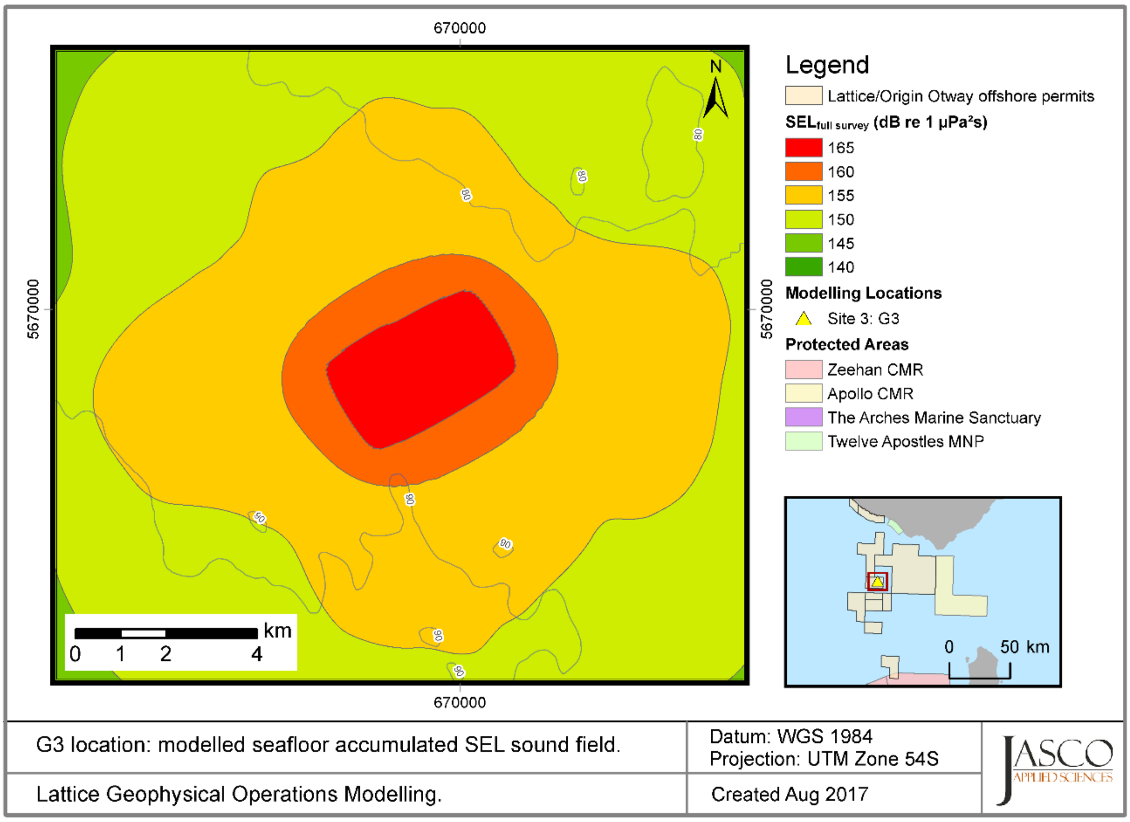


Figure 24. G3 location: Sound level contour map of seafloor accumulated SEL over the full survey for the boomer and SBP operations.

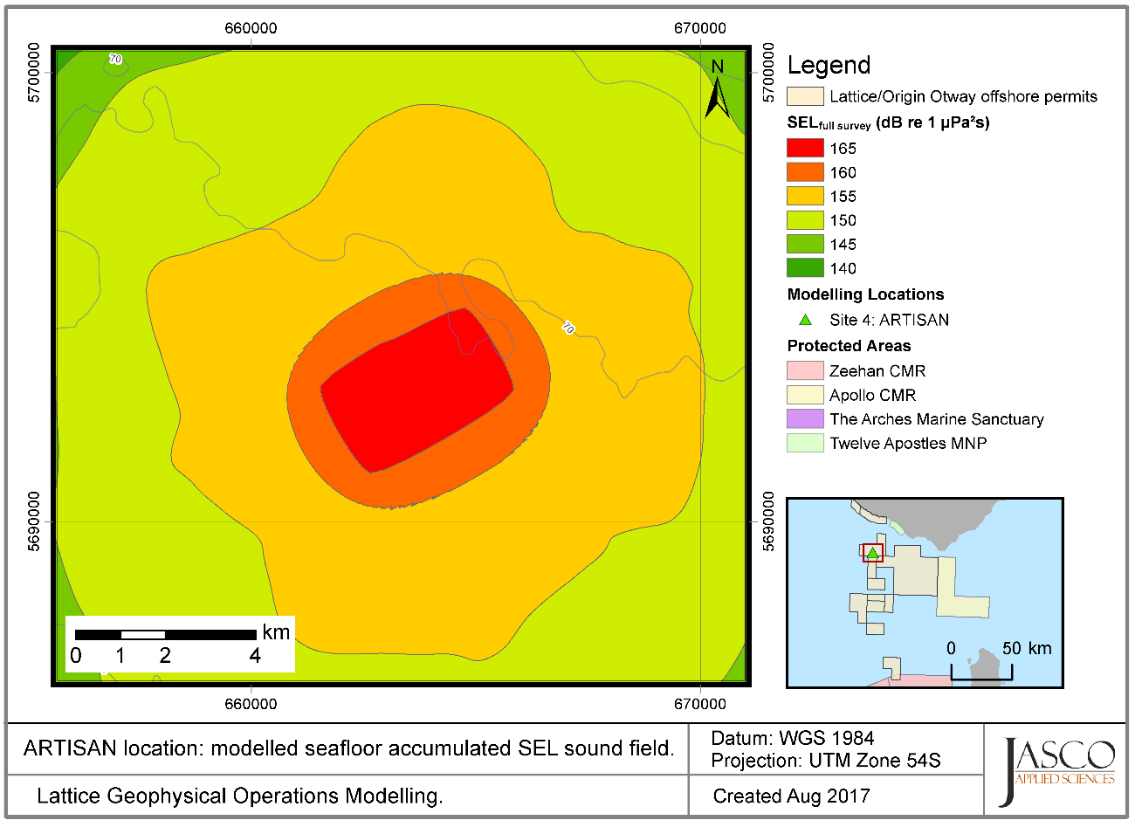


Figure 25. ARTISAN location: Sound level contour map of seafloor accumulated SEL over the full survey for the boomer and SBP operations.

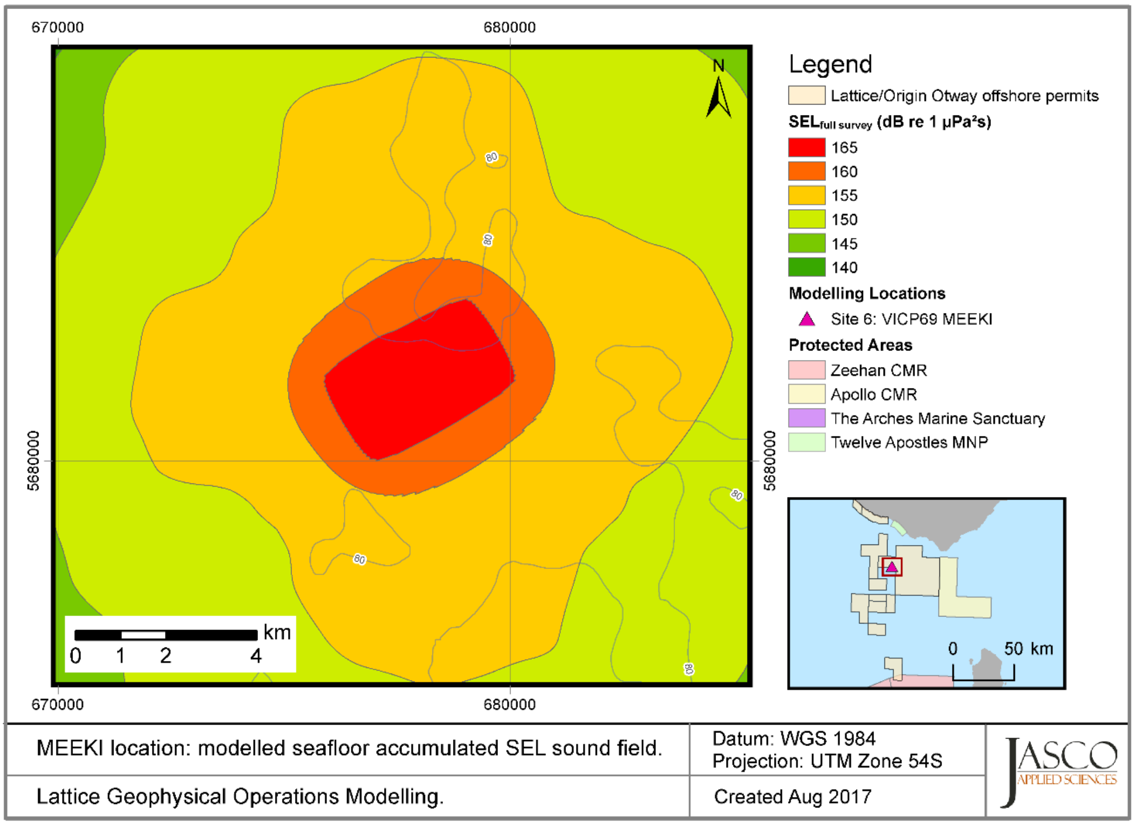


Figure 26. MEEKI location: Sound level contour map of seafloor accumulated SEL over the full survey for the boomer and SBP operations.

5. Discussion and Conclusion

5.1. Overview and source levels

This modelling study predicted underwater sound levels associated with the specified geophysical operations of the VSP, and surveys including boomer and sub-bottom profiler sources. Due to a lack of available literature on source functions for the high-frequency sources, the boomer and the sub-bottom profiler source inputs were determined from a previous JASCO measurement campaign (Sections 3.1.1 and 3.1.2). It was determined that the per-pulse SEL source level of the boomer was 180.0 dB re 1 µPa²·s @ 1 m, and for the sub-bottom profiler it was 171.4 dB re 1 µPa²·s @ 1 m; further metrics for the back propagated source levels are shown in Tables 4 and 5 respectively. The boomer was found to be a relatively broadband source with appreciable energy across the range of 160 Hz to 12.5 kHz (Figure 4). The sub-bottom profiler had the majority of energy at higher frequencies, between 5 kHz and 12.5 kHz.

The 450 in³ VSP was modelled using AASM at a centroid depth of 6 m (Section 3.1.3). The SEL source level of the VSP was 213.7 dB re 1 µPa²·s @ 1 m in the endfire direction, and 213.6 dB re 1 µPa²·s @ 1 m in the broadside direction; further source metrics are shown in Table 7. Most of the acoustic energy is output at lower frequencies, in the tens to hundreds of hertz. Due to the geometry of the array, the VSP is practically an omnidirectional source.

The modelling was performed using a typical September sound speed profile, as the setting most likely to achieve the greatest transmission, such that a precautionary estimation of distances can be made for the surveys (Section D.3.2). The lithography of the regions place Sites 1 & 2 in a region typified by a hard caprock, Sites 3, 4, and 6 in a region with a shallow sand layer over increasingly consolidated calcarenite, and Site 5 with a deeper sand layer over the calcarenite; this is detailed in Section D.3.3. The modelling also accounted for variations in site-specific bathymetry (Section D.3.1)

5.2. Single pulse sound fields

The results for the single pulse sound fields are presented in Section 4.2.

Across all sites, the maximum range for the boomer to exceed the marine mammal behavioural threshold (SPL of 160 dB re 1 µPa) is 145 m (Site 6), and to exceed the turtle behavioural threshold (SPL of 166 dB re 1 µPa) is 36 m, which is consistent across all sites (Table 8). The consistency for the turtle behavioural threshold is due to the levels being reached before influences from the site-dependent environment factors (bathymetry and geoacoustics). The range to the marine mammal behavioural threshold level at Site 2 is significantly shorter than at the other sites; this is due to the greater water depth and consequent lack of constructive noise fields within 150 m horizontally from the source.

The PK-PK ranges for the boomer are shown in Table 11. Due to the high threshold levels, the ranges were calculated assuming an acoustic field that is initially spherically spreading. This is valid where the source can be considered a point source, and there is no influence from reflecting surfaces. Due also to the directionality of the source, the ranges to the thresholds on-axis are going to be significantly greater than those off-axis and thus the vertical ranges from the sources are presented. It is shown that for the triple-plate boomer, the level drops below all relevant isopleths within 11 m of the source. Similar principles apply for PK levels in Table 12; the greatest range to a specified threshold is 1.6 m.

The SBP is a higher-frequency, more directional, and lower energy source than the boomer; consequently, the ranges are consistently lower. Using the generated source levels, the threshold for turtle behaviour is not reached at any horizontal distance from the source, and the marine mammal behavioural threshold is exceeded up to 2 m horizontally from the source (Table 13). Additionally, the ranges to thresholds at the seafloor are accordingly small (Table 15); here it is of note that the 115 and 120 dB re 1 µPa²·s SEL levels are at their greatest ranges at Site 2 due to the greater distance the conical beam may propagate, and thus widen, before reaching the interface.

For the SBP, the PK-PK and PK results were treated in the same way as for the boomer; results are shown for a spherically spreading noise field with the on-axis sound pressure analysed to determine ranges to thresholds. For the identified thresholds of interest for the SBP, the vertical distance does not exceed 1.4 m. In summary, sound fields from the boomer and the SBP do not reach any of the assessed thresholds for benthic crustaceans or fish (Section 2) at the seafloor.

The single pulse results for the VSP operated at Site 5 are shown in Section 4.2.1.3. The source has a significantly higher source level than either the boomer or the sub-bottom profiler. The maximum range to the DEWHA (2008) criterion of 160 dB re 1 µPa²·s SEL is 1.06 km, while the $R_{95\%}$ range is predicted to be 1.03 km. The maximum ranges to the marine mammal and turtle behavioural thresholds of 160 and 166 dB re 1 µPa SPL are 2.56 and 1.55 km respectively. The per-pulse SEL levels at the seafloor were modelled using VSTACK to allow for levels to be determined at high propagation angles. The maximum per-pulse SEL on the seafloor below the array is 181 dB re 1 µPa²·s, therefore the levels from Day et al. (2016b) of 190, 188 and 186 dB re 1 µPa²·s, are not reached at the seafloor.

In the case of the VSP source, PK thresholds of interest are reached at the seafloor and so it was modelled fully with all environmental parameters considered, rather than the spherical spreading approach used for the other two sources. The results show that the lowest isopleth of interest derived from Day et al. (2016b), 209 dB re 1 µPa, is not reached at the seafloor, and the horizontal range along the seafloor to the 202 dB re 1 µPa PK-PK level from Payne et al. (2007) is 185 m. PK metrics relevant to the Popper et al. (2014) criteria for fish are also not reached at the seafloor.

In this modelling study, both the boomer and sub-bottom profiler sources were directed straight down. Consequently, the sound channels constructed as a result of the sound speed profile are unlikely to influence the propagation of sound greatly. It is of note, that if either high-frequency source is directed toward the sea surface then the sound channels are likely to enhance the propagation of these sources. As the VSP is typically a low-frequency source, the fine details in the sound speed profile near the surface are unlikely to influence the propagation.

5.3. Multiple pulse sound fields

The study included modelling to assess the cumulative effect of noise generated for four separate survey areas. The surveys themselves comprise multiple lines along which the boomer and sub-bottom profiler sources are fired alternately. In total, more than 27000 pulses were included for the Thylacine Combined survey over the estimated 51 h of survey, and more than 21000 pulses for each of the other three surveys over the estimated 40.2 h. Sound levels were assessed only at the seafloor with results shown in Table 14. The modelling results show that the SEL at the seafloor did not exceed 170 dB re 1 µPa²·s for any single survey. This is below any of the relevant isopleths for benthic invertebrates, including the 183 dB re 1 µPa²·s 'no effect' accumulated SEL (McCauley and Duncan 2016). Due to the identical sources, and sound speed profiles, and similar depths and geoacoustics, the ranges between the surveys are similar. The greatest ranges are realised for the Thylacine Combined survey; here, the survey is in deeper water than the others as well as featuring the caprock layer that is likely to produce stronger reflections off the sediment layer.

Glossary

3-D
Three-dimensional

1/3-octave-band
Non-overlapping passbands that are one-third of an octave wide (where an octave is a doubling of frequency). Three adjacent 1/3-octave-bands comprise a one octave-band. One-third-octave-bands become wider with increasing frequency. Also see octave.

90% time window
The time interval over which the cumulative energy rises from 5% to 95% of the total pulse energy. This interval contains 90% of the total pulse energy. Symbol: T_{90}.

90% sound pressure level (SPL(T_{90}))
The root-mean-square sound pressure levels calculated over the 90%-energy time window of a pulse. Used only for pulsed sounds.

attenuation
The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium.

audiogram
A graph of hearing threshold level (sound pressure levels) as a function of frequency, which describes the hearing sensitivity of an animal over its hearing range.

azimuth
A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also called bearing.

bandwidth
The range of frequencies over which a sound occurs. Broadband refers to a source that produces sound over a broad range of frequencies (e.g., seismic airguns, vessels) whereas narrowband sources produce sounds over a narrow frequency range (e.g., sonar) (ANSI/ASA S1.13-2005 R2010).

BIA
Biologically Important Area (http://www.environment.gov.au/marine/marine-species/bias)

broadside direction
Perpendicular to the travel direction of a source. Compare to endfire direction.

cetacean
Any animal in the order Cetacea. These are aquatic, mostly marine mammals and include whales, dolphins, and porpoises.

decibel (dB)
One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power (ANSI S1.1-1994 R2004).

endfire direction
Parallel to the travel direction of a source. Also see broadside direction.

ensonified area
The total area ensonified in conjunction with a specified isopleth.

frequency
The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

functional hearing group
Grouping of marine mammal species with similar estimated hearing ranges. Southall et al. (2007) proposed the following functional hearing groups: low-, mid-, and high-frequency cetaceans, pinnipeds in water, and pinnipeds in air.

geoacoustic
Relating to the acoustic properties of the seafloor.

hearing threshold
The sound pressure level that is barely audible for a given individual in the absence of significant background noise during a specific percentage of experimental trials.

hertz (Hz)
A unit of frequency defined as one cycle per second.

high-frequency cetacean
The functional hearing group that represents odontocetes specialised for using high frequencies.

impulsive sound
Sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA 2013, ANSI S12.7-1986 R2006). For example, seismic airguns and impact pile driving.

low-frequency cetacean
The functional hearing group that represents mysticetes (baleen whales).

maximum-over-depth (MOD)
The maximum value over all modelled depths above the sea floor.

mid-frequency cetacean
The functional hearing group that represents some odontocetes (dolphins, toothed whales, beaked whales, and bottlenose whales).

mysticete
Mysticeti, a suborder of cetaceans, use their baleen plates, rather than teeth, to filter food from water. They are not known to echolocate, but use sound for communication. Members of this group include rorquals (Balaenopteridae), right whales (Balaenidae), and the grey whale (*Eschrichtius robustus*).

non-impulsive sound
Sound that is broadband, narrowband or tonal, brief or prolonged, continuous or intermittent, and typically does not have a high peak pressure with rapid rise time (typically only small fluctuations in decibel level) that impulsive signals have (ANSI/ASA S3.20-1995 R2008). Marine vessels, aircraft, machinery, construction, and vibratory pile driving are examples.

octave
The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

odontocete
The presence of teeth, rather than baleen, characterises these whales. Members of the Odontoceti are a suborder of cetaceans, a group comprised of whales, dolphins, and porpoises. The toothed whales' skulls are mostly asymmetric, an adaptation for their echolocation. This group includes sperm whales, killer whales, belugas, narwhals, dolphins, and porpoises.

parabolic equation method
A computationally-efficient solution to the acoustic wave equation that is used to model transmission loss. The parabolic equation approximation omits effects of back-scattered sound, simplifying the computation of transmission loss. The effect of back-scattered sound is negligible for most ocean-acoustic propagation problems.

peak sound pressure level (PK)
The maximum instantaneous sound pressure level, in a stated frequency band, within a stated period. Also called zero-to-peak sound pressure level. Unit: dB re 1 µPa

permanent threshold shift (PTS)
A permanent loss of hearing sensitivity caused by excessive noise exposure. PTS is considered auditory injury.

pinniped
A common term used to describe all three groups that form the superfamily Pinnipedia: phocids (true seals or earless seals), otariids (eared seals or fur seals and sea lions), and walrus.

point source
A source that radiates sound as if from a single point (ANSI S1.1-1994 R2004).

power spectrum density
The acoustic signal power per unit frequency as measured at a single frequency. Unit: µPa^2/Hz, or µPa^2·s.

power spectrum density level
The decibel level ($10\log_{10}$) of the power spectrum density, usually presented in 1 Hz bins. Unit: dB re 1 µPa^2/Hz.

pressure, acoustic
The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: p.

pulsed sound
Discrete sounds with durations less than a few seconds. Sounds with longer durations are called continuous sounds.

received level
The sound level measured at a receiver.

signature
Pressure signal generated by a source.

sound
A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound exposure
Time integral of squared, instantaneous frequency-weighted sound pressure over a stated time interval or event. Unit: pascal-squared second (Pa^2·s) (ANSI S1.1-1994 R2004).

sound exposure level (SEL)
A measure related to the sound energy in one or more pulses. Unit: dB re 1 µPa^2·s.

sound field
Region containing sound waves (ANSI S1.1-1994 R2004).

sound pressure level (SPL)
The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 R2004).

For sound in water, the reference sound pressure is one micropascal (p_0 = 1 µPa) and the unit for SPL is dB re 1 µPa:

$$\mathrm{SPL} = 10\log_{10}\left(p^2/p_0^2\right) = 20\log_{10}\left(p/p_0\right)$$

Unless otherwise stated, SPL refers to the root-mean-square sound pressure level Unit: dB re 1 µPa.

sound speed profile
The speed of sound in the water column as a function of depth below the water surface.

source level (SL)
The sound pressure level or sound exposure level measured 1 metre from a theoretical point source that radiates the same total sound power as the actual source. Unit: dB re 1 µPa @ 1 m or dB re 1 µPa^2·s.

spectrum
An acoustic signal represented in terms of its power (or energy) distribution versus frequency.

SBP
Sub-bottom profiler.

temporary threshold shift (TTS)
Temporary loss of hearing sensitivity caused by excessive noise exposure.

transmission loss (TL)
Also called propagation loss, this refers to the decibel reduction in sound level between two stated points that results from sound spreading away from an acoustic source subject to the influence of the surrounding environment.

VSP
Vertical Seismic Profiler.

wavelength
Distance over which a wave completes one oscillation cycle. Unit: meter (m). Symbol: λ.

Literature Cited

[DEWHA] Department of the Environment, W., Heritage and the Arts. 2008. *EPBC Act Policy Statement 2.1 - Interaction Between Offshore Seismic Exploration and Whales*. *In*: Department of the Environment, W., Heritage and the Arts. 14 pp.

[ISO] International Organization for Standardization. 2016. *ISO/DIS 18405.2:2017. Underwater acoustics—Terminology*. Geneva. https://www.iso.org/standard/62406.html.

[ITC] International Transducer Corporation. 1993. *Application Equations for Underwater Sound Transducers* (pamphlet). International Transducer Corporation, Santa Barbara, CA.

[NMFS] National Marine Fisheries Service. 2013. *Marine Mammals: Interim Sound Threshold Guidance* (webpage). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html.

[NMFS] National Marine Fisheries Service. 2016. *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. 178 pp. http://www.nmfs.noaa.gov/pr/acoustics/Acoustic%20Guidance%20Files/opr-55_acoustic_guidance_tech_memo.pdf.

[NOAA] National Oceanic and Atmospheric Administration. 2013. *Draft guidance for assessing the effects of anthropogenic sound on marine mammals: Acoustic threshold levels for onset of permanent and temporary threshold shifts*, December 2013, 76 pp. Silver Spring, Maryland: NMFS Office of Protected Resources. http://www.nmfs.noaa.gov/pr/acoustics/draft_acoustic_guidance_2013.pdf.

[NSF] National Science Foundation (U.S.), U.S. Geological Survey, and [NOAA] National Oceanic and Atmospheric Administration (U.S.). 2011. *Final Programmatic Environmental Impact Statement/Overseas. Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey*. National Science Foundation, Arlington, VA.

Aerts, L., M. Blees, S. Blackwell, C. Greene, K. Kim, D. Hannay, and M. Austin. 2008. *Marine mammal monitoring and mitigation during BP Liberty OBC seismic survey in Foggy Island Bay, Beaufort Sea, July-August 2008: 90-day report*. Document Number LGL Report P1011-1. Report by LGL Alaska Research Associates Inc., LGL Ltd., Greeneridge Sciences Inc. and JASCO Applied Sciences for BP Exploration Alaska. 199 pp. http://www.nmfs.noaa.gov/pr/pdfs/permits/bp_liberty_monitoring.pdf.

ANSI S12.7-1986. R2006. *American National Standard Methods for Measurements of Impulsive Noise*. American National Standards Institute, New York.

ANSI S1.1-1994. R2004. *American National Standard Acoustical Terminology*. American National Standards Institute, New York.

ANSI S1.1-2013. R2013. *American National Standard Acoustical Terminology*. American National Standards Institute, New York.

ANSI/ASA S1.13-2005. R2010. *American National Standard Measurement of Sound Pressure Levels in Air*. American National Standards Institute and Acoustical Society of America, New York.

ANSI/ASA S3.20-1995. R2008. *American National Standard Bioacoustical Terminology*. American National Standards Institute and Acoustical Society of America, New York.

Applied Acoustics Engineering. 2013. *AA2xx Series Seismic Source Operation Manual*. https://www.seatronics-group.com/files/3714/1753/6053/Applied_Acoustic_A200_Boomer_Plate_-_Manual.pdf

Carnes, M.R. 2009. *Description and Evaluation of GDEM-V 3.0*. Document Number NRL Memorandum Report 7330-09-9165. US Naval Research Laboratory, Stennis Space Center, MS. 21 pp.

Collins, M.D. 1993. A split-step Padé solution for the parabolic equation method. *Journal of the Acoustical Society of America* 93(4): 1736-1742.

Collins, M.D., R.J. Cederberg, D.B. King, and S. Chin-Bing. 1996. Comparison of algorithms for solving parabolic wave equations. *Journal of the Acoustical Society of America* 100(1): 178-182.

Coppens, A.B. 1981. Simple equations for the speed of sound in Neptunian waters. *Journal of the Acoustical Society of America* 69(3): 862-863. http://link.aip.org/link/?JAS/69/862/1.

Day, R., D., R.D. McCauley, Q.P. Fitzgibbon, K. Hartmann, J.M. Semmens, and Institute for Marine and Antarctic Studies. 2016a. *Assessing the Impact of Marine Seismic Surveys on Southeast Australian Scallop and Lobster Fisheries. FRDC Project No 2012/008*. Impacts of Marine Seismic Surveys on Scallop and Lobster Fisheries. Fisheries Ressearch & Development Corporation, University of Tasmania, Hobart. 159 pp.

Day, R.D., R.D. McCauley, Q.P. Fitzgibbon, and J.M. Semmens. 2016b. Seismic air gun exposure during early-stage embryonic development does not negatively affect spiny lobster *Jasus edwardsii larvae* (Decapoda:Palinuridae). *Scientific Reports* 6: 1-9. http://dx.doi.org/10.1038/srep22723.

Dragoset, W.H. 1984. A comprehensive method for evaluating the design of airguns and airgun arrays. *16th Annual Proc. Offshore Tech. Conf.* Volume 3. 75–84 pp.

Duncan, A. 2017. *In-field validation of modelled underwater sound levels from the Crowes Foot 3D seismic survey*. Report Number 2016-35. Report by CMST for Origin Energy. 23 pp.

Fisher, F.H. and V.P. Simmons. 1977. Sound absorption in sea water. *Journal of the Acoustical Society of America* 62(3): 558-564. http://link.aip.org/link/?JAS/62/558/1.

Funk, D., D. Hannay, D. Ireland, R. Rodrigues, and W. Koski (eds.). 2008. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–November 2007: 90-day report*. LGL Report P969-1. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 218 pp.

Gedamke, J., N. Gales, and S. Frydman. 2011. Assessing risk of baleen whale hearing loss from seismic surveys: The effect of uncertainty and individual variation. *Journal of the Acoustical Society of America* 129(1): 496-506. http://www.ncbi.nlm.nih.gov/pubmed/21303030.

Hamilton, E.L. 1980. Geoacoustic modeling of the sea floor. *Journal of the Acoustical Society of America* 68(5): 1313-1340.

Hannay, D. and R. Racca. 2005. *Acoustic Model Validation*. Document Number 0000-S-90-04-T-7006-00-E, Revision 02. Technical report for Sakhalin Energy Investment Company Ltd. by JASCO Research Ltd. 34 pp.

Ireland, D.S., R. Rodrigues, D. Funk, W. Koski, and D. Hannay. 2009. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–October 2008: 90-Day Report*. Document Number LGL Report P1049-1. 277 pp.

Kinsler, L.E., A.R. Frey, A.B. Coppens, and J.V. Sanders. 1950. *Fundamentals of acoustics*. John Wiley & Sons Inc., New York.

Landro, M. 1992. Modeling of GI gun signatures. *Geophysical Prospecting* 40: 721–747.

Laws, M., L. Hatton, and M. Haartsen. 1990. Computer modeling of clustered airguns. *First Break* 8: 331–338.

Lurton, X. 2002. *An Introduction to Underwater Acoustics: Principles and Applications.* Springer, Chichester, U.K.

MacGillivray, A.O. and N.R. Chapman. 2012. Modeling underwater sound propagation from an airgun array using the parabolic equation method. *Canadian Acoustics* 40(1): 19-25. http://jcaa.caa-aca.ca/index.php/jcaa/article/view/2502.

Martin, B., J. MacDonnell, N.E. Chorney, and D. Zeddies. 2012. Appendix A: Sound Source Verification of Fugro Geotechnical Sources. *In ESS Group, Inc. Renewal Application for Incidental Harassment Authorization for the Non-Lethal Taking of Marine Mammals Resulting from Pre-Construction High Resolution Geophysical Survey*. For Cape Wind Associates, LLC. http://www.nmfs.noaa.gov/pr/pdfs/permits/capewind_iha_application_renewal.pdf.

Martin, B., K. Broker, M.-N.R. Matthews, J. MacDonnell, and L. Bailey. 2015. *Comparison of measured and modeled air-gun array sound levels in Baffin Bay, West Greenland. OceanNoise 2015*, 11-15 May, Barcelona, Spain.

Massa, D.P. 2003. Acoustic transducers. *In Wiley Encyclopedia of Telecommunications*. John Wiley & Sons, Inc.

Mattsson, A. and M. Jenkerson. 2008. *Single Airgun and Cluster Measurement Project*. *Joint Industry Programme (JIP) on Exploration and Production Sound and Marine Life Proramme Review*, October 28-30. International Association of Oil and Gas Producers, Houston, TX.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adihyta, J. Murdoch, et al. 2000. Marine seismic surveys: A study of environmental implications. *Australian Petroleum Production Exploration Association (APPEA) Journal* 40: 692-708.

McCauley, R.D. and A. Duncan. 2016. *Estimation of sound exposure levels at "Big Reef" from proposed Crowes Foot seismic survey, Victoria 2016*. Report 2016-26 by CMST for ERM / Origin Energy Ltd.

Moein, S.E., J.A. Musick, J.A. Keinath, D.E. Barnard, M.L. Lenhardt, and R. George. 1995. *Evaluation of Seismic Sources for Repelling Sea Turtles from Hopper Dredges, in Sea Turtle Research Program: Summary Report*. *In*: Hales, L.Z. (ed.). Report from U.S. Army Engineer Division, South Atlantic, Atlanta GA, and U.S. Naval Submarine Base, Kings Bay GA. Technical Report CERC-95. 90 pp.

O'Neill, C., D. Leary, and A. McCrodan. 2010. Sound Source Verification. (Chapter 3) *In* Blees, M.K., K.G. Hartin, D.S. Ireland, and D. Hannay (eds.). *Marine mammal monitoring and mitigation during open water seismic exploration by Statoil USA E&P Inc. in the Chukchi Sea, August-October 2010: 90-day report*. LGL Report P1119. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. for Statoil USA E&P Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 1-34.

Payne, J.F., C. Andrews, L. Fancey, A.L. Cook, and J.R. Christian. 2007. *Pilot study on the effects of seismic air gun noise on lobster (Homarus americanus)*. Report Number 2712.

Payne, J.F., C. Andrews, L. Fancey, D. White, and J. Christian. 2008. *Potential Effects of Seismic Energy on Fish and Shellfish: An Update since 2003*. Report Number 2008/060. Canadian Science Advisory Secretariat. 22 pp.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, et al. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. SpringerBriefs in Oceanography, Volume ASA S3/SC1.4 TR-2014. ASA Press.

Popper, A.N., T.J. Carlson, J.A. Gross, A.D. Hawkins, D. Zeddies, L. Powell, and J. Young. 2016. Effects of Seismic Air Guns on Pallid Sturgeon and Paddlefish. *Adv Exp Med Biol* 875: 871-8. NLM.

Porter, M.B. and Y.-C. Liu. 1994. Finite-element ray tracing. *In*: Lee, D. and M.H. Schultz (eds.). *Proceedings of the International Conference on Theoretical and Computational Acoustics*. Volume 2. World Scientific Publishing Co. 947-956 pp.

Racca, R., A. Rutenko, K. Bröker, and M. Austin. 2012a. A line in the water - design and enactment of a closed loop, model based sound level boundary estimation strategy for mitigation of behavioural impacts from a seismic survey. *11th European Conference on Underwater Acoustics 2012*. Volume 34(3), Edinburgh, United Kingdom.

Racca, R., A. Rutenko, K. Bröker, and G. Gailey. 2012b. *Model based sound level estimation and in-field adjustment for real-time mitigation of behavioural impacts from a seismic survey and post-event evaluation of sound exposure for individual whales*. *Acoustics 2012 Fremantle: Acoustics, Development and the Environment*, Fremantle, Australia. http://www.acoustics.asn.au/conference_proceedings/AAS2012/papers/p92.pdf.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, et al. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. *Aquatic Mammals* 33(4): 411-521.

Teague, W.J., M.J. Carron, and P.J. Hogan. 1990. A comparison between the Generalized Digital Environmental Model and Levitus climatologies. *Journal of Geophysical Research* 95(C5): 7167-7183.

Verbeek, N.H. and T.M. McGee. 1995. Characteristics of high-resolution marine reflection profiling sources. *Journal of Applied Geophysics* 33(4): 251-269.

Warner, G., C. Erbe, and D. Hannay. 2010. Underwater Sound Measurements. (Chapter 3) *In* Reiser, C.M., D.W. Funk, R. Rodrigues, and D. Hannay (eds.). *Marine Mammal Monitoring and Mitigation during Open Water Shallow Hazards and Site Clearance Surveys by Shell Offshore Inc. in the Alaskan Chukchi Sea, July-October 2009: 90-Day Report*. LGL Report P1112-1. Report by LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 1-54.

Zhang, Y. and C. Tindle. 1995. Improved equivalent fluid approximations for a low shear speed ocean bottom. *Journal of the Acoustical Society of America* 98(6): 3391-3396. http://scitation.aip.org/content/asa/journal/jasa/98/6/10.1121/1.413789.

Ziolkowski, A. 1970. A method for calculating the output pressure waveform from an air gun. *Geophysical Journal of the Royal Astronomical Society* 21(2): 137-161.

Zykov, M. 2013. *Underwater Sound Modeling of Low Energy Geophysical Equipment Operations*. Document Number 00600 Version 1.0. Technical report for CSA Ocean Sciences by JASCO Applied Sciences Ltd. http://www.slc.ca.gov/Programs/OGPP/AppG.pdf.

Appendix A. Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of $p_0 = 1$ µPa. Because the perceived loudness of sound, especially impulsive noise such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate noise and its effects on marine life. We provide specific definitions of relevant metrics used in the accompanying report. Where possible we follow the ANSI and ISO standard definitions and symbols for sound metrics, but these standards are not always consistent.

The zero-to-peak sound pressure level, or peak sound pressure level (PK; dB re 1 µPa), is the maximum instantaneous sound pressure level in a stated frequency band attained by an acoustic pressure signal, $p(t)$:

$$L_{p,pk} = 20 \log_{10} \left[\frac{\max(|p(t)|)}{p_0} \right] \tag{A-1}$$

$L_{p,pk}$ is often included as a criterion for assessing whether a sound is potentially injurious; however, because it does not account for the duration of a noise event, it is generally a poor indicator of perceived loudness.

The root-mean-square (rms) sound pressure level (SPL; dB re 1 µPa) is the rms pressure level in a stated frequency band over a specified time window (T, s) containing the acoustic event of interest. It is important to note that SPL always refers to an rms pressure level and, therefore, not instantaneous pressure:

$$L_p = 10 \log_{10} \left(\frac{1}{T} \int_T p^2(t) dt \Big/ p_0^2 \right) \tag{A-2}$$

The SPL represents a nominal effective continuous sound over the duration of an acoustic event, such as the emission of one acoustic pulse, a marine mammal vocalisation, the passage of a vessel, or over a fixed duration. Because the window length, T, is the divisor, events with similar sound exposure level (SEL) but more spread out in time have a lower SPL. Throughout this study, a fixed time window of 125 ms is used as the integration period.

The sound exposure level (SEL, dB re 1 µPa²·s) is a measure related to the acoustic energy contained in one or more acoustic events (N). The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T):

$$L_E = 10 \log_{10} \left(\int_T p^2(t) dt \Big/ T_0 p_0^2 \right) \tag{A-3}$$

where T_0 is a reference time interval of 1 s. The SEL continues to increase with time when non-zero pressure signals are present. It therefore can be construed as a dose-type measurement so the integration time used must be carefully considered in terms of relevance for impact to the exposed recipients.

SEL can be calculated over periods with multiple acoustic events or over a fixed duration. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10 \log_{10} \left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}} \right) \tag{A-4}$$

If applied, the frequency weighting of an acoustic event should be specified, as in the case of M-weighted SEL (e.g., $\mathrm{SEL}_{\mathrm{LFC,24h}}$). The use of fast, slow, or impulse exponential-time-averaging, or other time-related characteristics should else be specified.

Because the SPL and SEL are both computed from the integral of square pressure, these metrics are related by a simple expression, which depends only on the duration of the 90% energy time window T_{90}:

$$L_E = L_{p90} + 10\log_{10}(T_{90}) + 0.458 \tag{A-5}$$

where the 0.458 dB factor accounts for the SPL containing 90% of the total energy from the per-pulse SEL.

Appendix B. Acoustic Source Modelling

B.1. Transducer Beam Theory

Mid- and high-frequency underwater acoustic sources for geophysical measurements create an oscillatory overpressure through rapid vibration of a surface, using either electromagnetic forces or the piezoelectric effect of materials. A vibratory source based on the piezoelectric effect is commonly referred to as a transducer, and may be capable of receiving as well as emitting signals. Transducers are usually designed to produce an acoustic wave of a specific frequency, often in a highly directive beam. The directional capability increases with increasing operating frequency. The main parameter characterizing directivity is the beamwidth, defined as the angle subtended by diametrically opposite "half power" (-3 dB) points of the main lobe (Massa 2003). For different transducers, the beamwidth varies from 180° (almost omnidirectional) to a few degrees.

Transducers are usually built with either circular or rectangular active surfaces. For circular transducers, the beam pattern in the horizontal plane (assuming a downward pointing main beam) is equal in all directions. The beam pattern of a rectangular transducer is variable with the azimuth in the horizontal plane.

The acoustic radiation pattern, or beam pattern, of a transducer is the relative measure of acoustic transmitting or receiving power as a function of spatial angle. Directionality is generally measured in decibels relative to the maximum radiation level along the central axis perpendicular to the transducer surface. The pattern is defined largely by the operating frequency of the device and the size and shape of the transducer. Beam patterns generally consist of a main lobe, extending along the central axis of the transducer, and multiple secondary lobes separated by nulls. The width of the main lobe depends on the size of the active surface relative to the sound wavelength in the medium. Larger transducers produce narrower beams. Figure B-1 shows a 3-dimensional (3-D) visualisation of a typical beam pattern for a circular transducer.

The true beam pattern of a transducer can be obtained only by in situ measurement of the emitted energy around the device. Such data, however, are not always available, and for propagation modelling it is often sufficient to estimate the beam pattern of the source based on transducer beam theory. An example of a measured beam pattern is shown in Figure B-2.

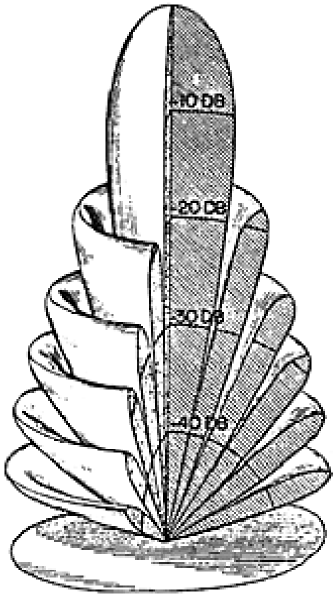


Figure B-1. Typical 3-D beam pattern for a circular transducer (Massa 2003).

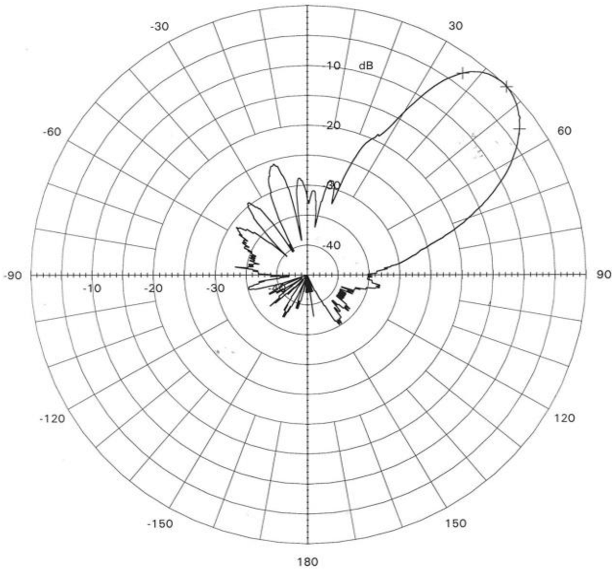


Figure B-2. Vertical cross section of a beam pattern measured in situ from a transducer used by Kongsberg (source: Zykov (2013)).

B.2. Circular Transducers

The beam of an ideal circular transducer is symmetrical about the main axis; the radiated level depends only on the depression angle. In this study, beam directivities were calculated from the standard formula for the beam pattern of a circular transducer (Kinsler et al. 1950, [ITC] International Transducer Corporation 1993). The directivity function of a conical beam relative to the on-axis pressure amplitude is:

$$R(\phi) = \frac{2 \cdot J_1\left(\pi D_\lambda \sin(\phi)\right)}{\pi D_\lambda \sin(\phi)} \text{ and } D_\lambda = \frac{60}{\theta_{bw}}, \qquad (1)$$

where J_1 is the first-order Bessel function, D_λ is the transducer dimension in wavelengths of sound in the medium, θ_{bw} is the beamwidth in degrees, and ϕ is the beam angle from the transducer axis. The beam pattern of a circular transducer can be calculated from the transducer's specified beamwidth or from the diameter of the active surface and the operating frequency. The calculated beam pattern for a circular transducer with a beamwidth of 20° is shown in Figure B-3. The grayscale represents the source level (dB re 1 µPa @ 1 m) and the declination angle is relative to a central vector (0°, 0°) pointing down.

Although some acoustic energy is emitted at the back of the transducer, the theory accounts for the beam power in only the front half-space ($\phi < 90°$) and assumes no energy directed into the back half-space. The relative power at these rearward angles is significantly lower, generally by more than 30 dB, and consequently the emission in the back half-space can be estimated by applying a simple decay rate, in decibels per angular degree, which gives a beam power at $\phi = 90°$ of 30 dB less than that at $\phi = 0°$. This is a conservative estimate of the beam power in the back half-space.

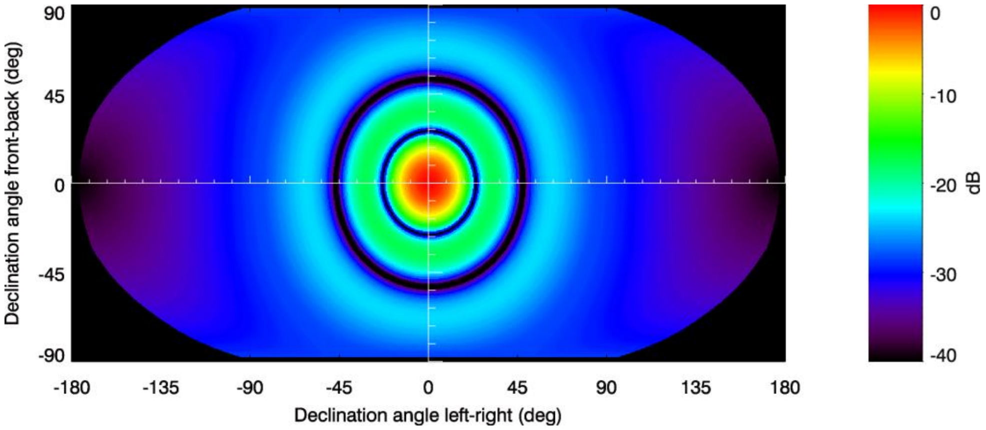


Figure B-3. Calculated beam pattern for a circular transducer with a beamwidth of 20°. The beam power function is shown relative to the on-axis level using the Robinson projection.

B.3. VSP Modelling

The source levels and directivity of the airgun array were predicted with JASCO's Airgun Array Source Model (AASM). AASM includes low- and high-frequency modules for predicting different components of the airgun array spectrum. The low-frequency module is based on the physics of oscillation and radiation of airgun bubbles, as originally described by Ziolkowski (1970), that solves the set of parallel differential equations that govern bubble oscillations. Physical effects accounted for in the simulation include pressure interactions between airguns, port throttling, bubble damping, and generator-injector (GI) gun behaviour discussed by Dragoset (1984), Laws et al. (1990), and Landro (1992). A global optimisation algorithm tunes free parameters in the model to a large library of airgun source signatures.

Whilst airgun signatures are highly repeatable at the low frequencies, which are used for seismic imaging, their sound emissions have a large random component at higher frequencies that cannot be predicted deterministically. Therefore, the high-frequency module of AASM uses a stochastic simulation to predict the sound emissions of individual airguns above 800 Hz, using a multivariate statistical model. The current version of AASM has been tuned to fit a large library of high quality seismic source signature data obtained from the Joint Industry Program (JIP) on Sound and Marine Life (Mattsson and Jenkerson 2008). The stochastic model uses a Monte-Carlo simulation of the random component of the high-frequency spectrum of each airgun in an array. The mean high-frequency spectra from the stochastic model augment the low-frequency signatures from the physical model, allowing AASM to predict airgun source levels at frequencies up to 25,000 Hz.

AASM produces a set of “notional” signatures for each array element based on:

- Array layout
- Volume, tow depth, and firing pressure of each airgun
- Interactions between different airguns in the array

These notional signatures are the pressure waveforms of the individual airguns at a standard reference distance of 1 m; they account for the interactions with the other airguns in the array. The signatures are summed with the appropriate phase delays to obtain the far-field source signature of the entire array in all directions. This far-field array signature is filtered into 1/3-octave-bands to compute the source levels of the array as a function of frequency band and azimuthal angle in the horizontal plane (at the source depth), after which it is considered to be a directional point source in the far field.

A seismic array consists of many sources and the point-source assumption is invalid in the near field where the array elements add incoherently. The maximum extent of the near field of an array (R_{nf}) is:

$$R_{\mathrm{nf}} < \frac{l^2}{4\lambda} \tag{B-2}$$

where λ is the sound wavelength and *l* is the longest dimension of the array (Lurton 2002, §5.2.4). For example, an airgun array length of $l = 21$ m yields a near-field range of 147 m at 2 kHz and 7 m at 100 Hz. Beyond this R_{nf} range, the array is assumed to radiate like a directional point source and is treated as such for propagation modelling.

The interactions between individual elements of the array create directionality in the overall acoustic emission. Generally, this directionality is prominent mainly at frequencies in the mid-range between tens of hertz to several hundred hertz. At lower frequencies, with acoustic wavelengths much larger than the inter-airgun separation distances, the directionality is small. At higher frequencies, the pattern of lobes is too finely spaced to be resolved and the effective directivity is less.

B.4. VSP Acoustic Source Levels and Directivity Results

Figure B-4 shows the broadside (perpendicular to the tow direction), endfire (parallel to the tow direction), and vertical overpressure signatures and corresponding power spectrum levels for the 3090 in^3 array. The signatures consist of a strong primary peak, related to the initial release of high-pressure air, followed by a series of pulses associated with bubble oscillations. Most energy is produced at frequencies below 200 Hz. Frequency-dependent peaks and nulls in the spectrum result from interference among airguns in the array, and correspond with the volumes and relative locations of the airguns to each other.

Horizontal 1/3-octave-band source levels are shown as a function of band centre frequency and azimuth (Figure B-5); directivity in the sound field is most noticeable at mid-frequencies as described in the model detail in Appendix B.3.

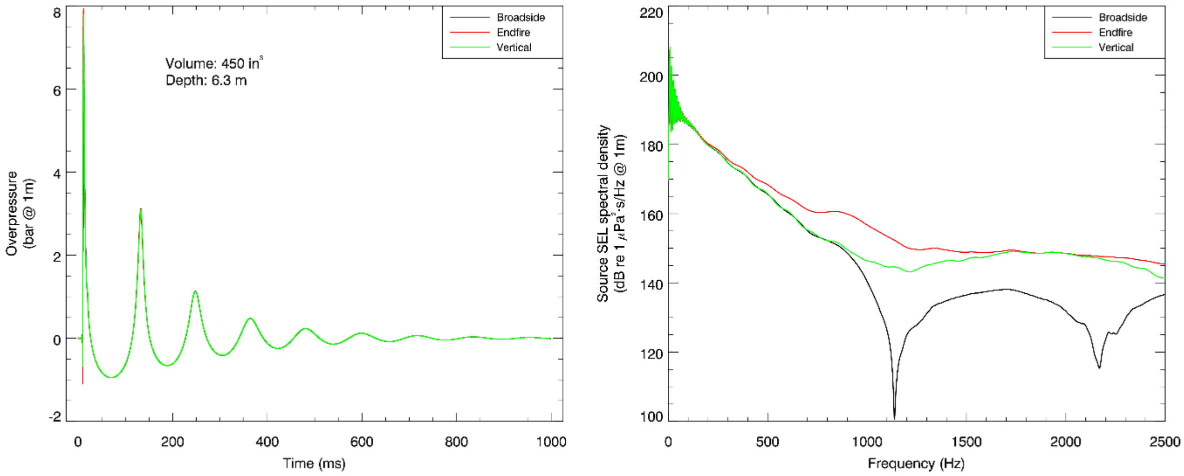
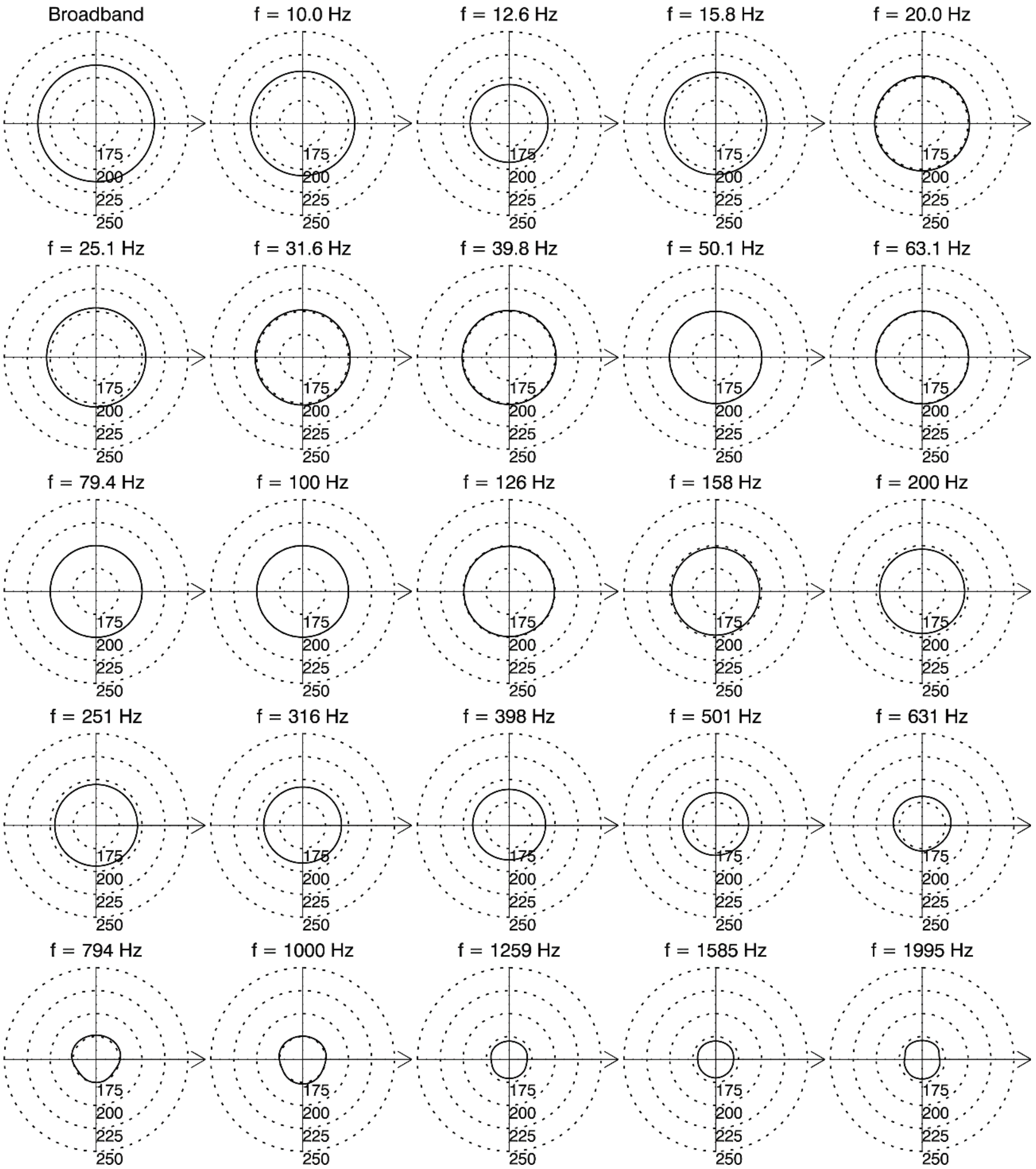


Figure B-4. Predicted source level details for the 450 in^3 VSP array operated at a centroid depth of 6 m. (Left) the overpressure signature and (right) the power spectrum for broadside (perpendicular to tow direction) and endfire (directly aft of the array) directions, and for vertically down.



Broadband f = 10.0 Hz f = 12.6 Hz f = 15.8 Hz f = 20.0 Hz f = 25.1 Hz f = 31.6 Hz f = 39.8 Hz f = 50.1 Hz f = 63.1 Hz f = 79.4 Hz f = 100 Hz f = 126 Hz f = 158 Hz f = 200 Hz f = 251 Hz f = 316 Hz f = 398 Hz f = 501 Hz f = 631 Hz f = 794 Hz f = 1000 Hz f = 1259 Hz f = 1585 Hz f = 1995 Hz

Figure B-5. Directionality of the predicted horizontal source levels for the 450 in^3 array, 5–2000 Hz. Source levels (in dB re 1 µPa^2·s) are shown as a function of azimuth for the centre frequencies of the 1/3-octave-bands modelled; frequencies are shown above the plots. Tow direction is to the right. Operating depth is 6 m (see Section 3.1.3).

Appendix C. Sound Propagation Models

C.1. MONM-BELLHOP

Underwater sound propagation (i.e., transmission loss) was predicted with JASCO's Marine Operations Noise Model (MONM). This model computes sound propagation at frequencies of 5 Hz to 1.25 kHz via a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). MONM computes sound propagation at frequencies > 1.25 kHz via the BELLHOP Gaussian beam acoustic ray-trace model (Porter and Liu 1994).

The parabolic equation method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins et al. 1996). MONM accounts for the additional reflection loss at the seabed, which results from partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces, and it includes wave attenuations in all layers. MONM incorporates the following site-specific environmental properties: a bathymetric grid of the modelled area, underwater sound speed as a function of depth, and a geoacoustic profile based on the overall stratified composition of the seafloor.

This version of MONM accounts for sound attenuation due to energy absorption through ion relaxation and viscosity of water in addition to acoustic attenuation due to reflection at the medium boundaries and internal layers (Fisher and Simmons 1977). The former type of sound attenuation is significant for frequencies higher than 5 kHz and cannot be neglected without noticeably affecting the model results.

MONM computes acoustic fields in three dimensions by modelling transmission loss within two-dimensional (2-D) vertical planes aligned along radials covering a 360° swath from the source, an approach commonly referred to as N×2-D. These vertical radial planes are separated by an angular step size of $\Delta\theta$, yielding $N = 360°/\Delta\theta$ number of planes (Figure C-1).

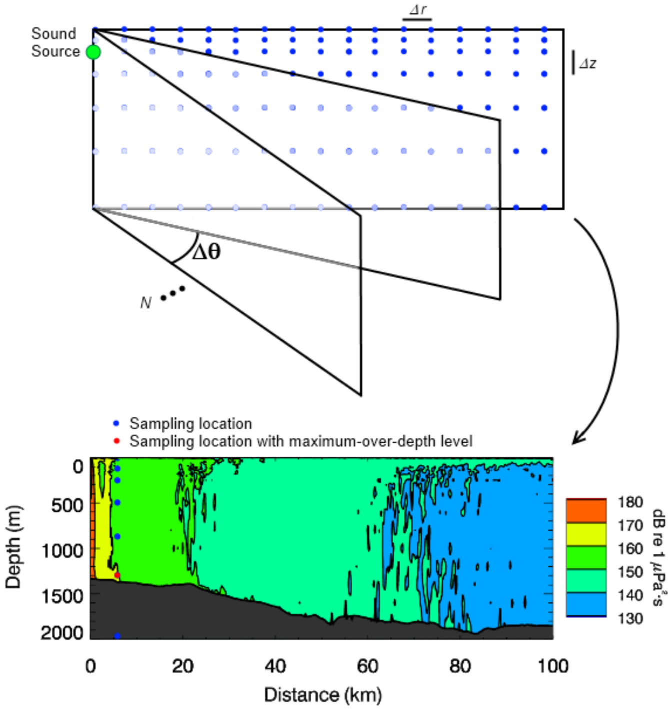


Figure C-1. The N×2-D and maximum-over-depth modelling approach used by MONM.

MONM treats frequency dependence by computing acoustic transmission loss at the centre frequencies of 1/3-octave-bands. Sufficiently many 1/3-octave-bands, starting at 10 Hz, are modelled to include most acoustic energy emitted by the source. At each centre frequency, the transmission loss is modelled within each of the N vertical planes as a function of depth and range from the source.

The 1/3-octave-band received per-pulse SELs are computed by subtracting the band transmission loss values from the directional source level in that frequency band. Composite broadband received SELs are then computed by summing the received 1/3-octave-band levels.

The received per-pulse SEL sound field within each vertical radial plane is sampled at various ranges from the source, generally with a fixed radial step size. At each sampling range along the surface, the sound field is sampled at various depths, with the step size between samples increasing with depth below the surface. The step sizes are chosen to provide increased coverage near the depth of the source and at depths of interest in terms of the sound speed profile. For areas with deep water, sampling is not performed at depths beyond those reachable by marine mammals. The received per-pulse SEL at a surface sampling receiver location is taken as the maximum value that occurs over all samples within the water column, i.e., the maximum-over-depth received per-pulse SEL. These maximum-over-depth per-pulse SELs are presented as colour contours around the source.

MONM's predictions have been validated against experimental data from several underwater acoustic measurement programs conducted by JASCO (Hannay and Racca 2005, Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Racca et al. 2012a, Racca et al. 2012b, Martin et al. 2015).

C.2. FWRAM

For impulsive sounds from the seismic array, time-domain representations of the pressure waves generated in the water are required to calculate SPL and peak pressure level. Furthermore, the airgun array must be represented as a distributed source to accurately characterise vertical directivity effects in the near-field zone. For this study, synthetic pressure waveforms were computed using FWRAM, which is a time-domain acoustic model based on the same wide-angle parabolic equation (PE) algorithm as MONM. FWRAM computes synthetic pressure waveforms versus range and depth for range-varying marine acoustic environments, and it takes the same environmental inputs as MONM (bathymetry, water sound speed profile, and seafloor geoacoustic profile). Unlike MONM, FWRAM computes pressure waveforms via Fourier synthesis of the modelled acoustic transfer function in closely spaced frequency bands. FWRAM employs the array starter method to accurately model sound propagation from a spatially distributed source (MacGillivray and Chapman 2012).

Besides providing direct calculations of the peak pressure level and SPL, the synthetic waveforms from FWRAM can also be used to convert the SEL values from MONM to SPL.

C.3. Wavenumber Integration Model

Sound pressure levels near the airgun array were modelled using JASCO's VSTACK wavenumber integration model. VSTACK computes synthetic pressure waveforms versus depth and range for arbitrarily layered, range-independent acoustic environments using the wavenumber integration approach to solving the exact (range-independent) acoustic wave equation. This model is valid over the full angular range of the wave equation and can fully account for the elasto-acoustic properties of the sub-bottom. Wavenumber integration methods are extensively used in the field of underwater acoustics and seismology where they are often referred to as reflectivity methods or discrete wavenumber methods. VSTACK computes sound propagation in arbitrarily stratified water and seabed layers by decomposing the outgoing field into a continuum of outward-propagating plane cylindrical waves. Seabed reflectivity in the model is dependent on the seabed layer properties: compressional and shear wave speeds, attenuation coefficients, and layer densities. The output of the model can be post-processed to yield estimates of the SEL, SPL, and PK.

VSTACK accurately predicts steep-angle propagation in the proximity of the source, but is computationally slow at predicting sound pressures at large distances due to the need for smaller wavenumber steps with increasing distance. Additionally, VSTACK assumes range-invariant bathymetry with a horizontally stratified medium (i.e., a range-independent environment) which is azimuthally symmetric about the source. VSTACK is thus best suited to modelling the sound field near the source.

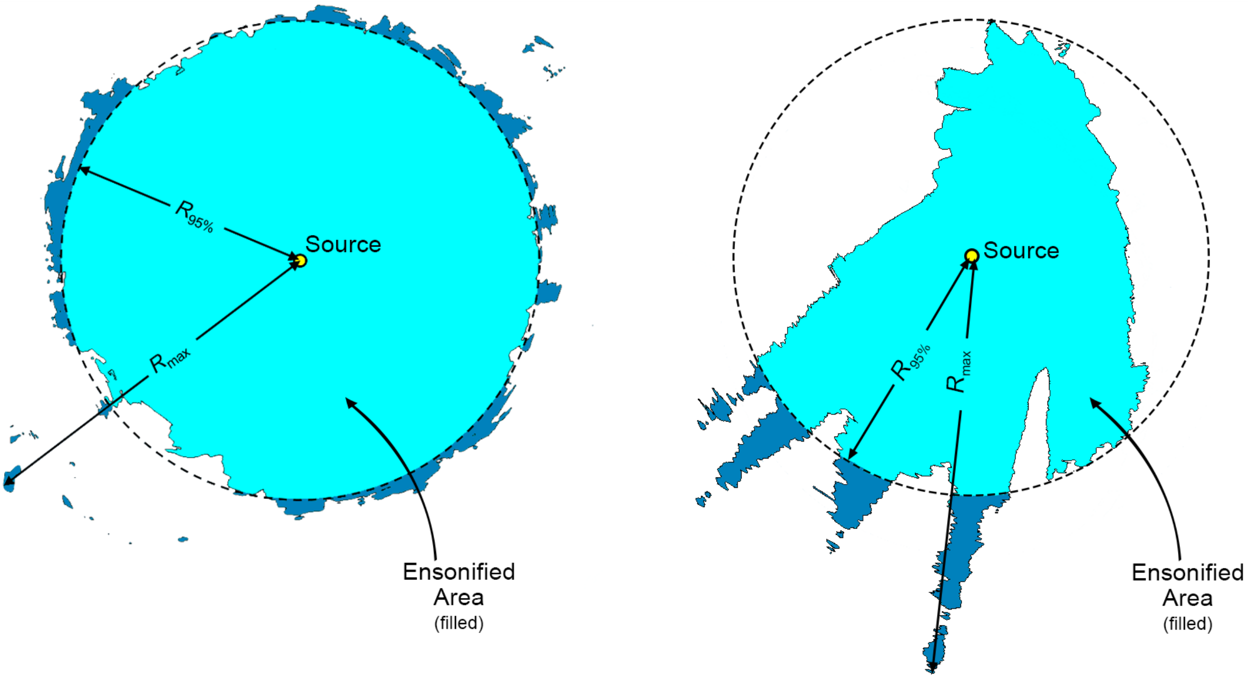
Appendix D. Methods and Parameters

This section describes the specifications of the airgun array source that was used at all sites and the environmental parameters used in the propagation models.

D.1. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) $R_{\max}$, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure D-1).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure D-1(a). In cases such as this, where relatively few points are excluded in any given direction, $R_{\max}$ can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure D-1(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases $R_{\max}$ might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between $R_{\max}$ and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.



(a) (b)

Figure D-1. Sample areas ensonified to an arbitrary sound level with $R_{\max}$ and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine $R_{\max}$.

D.2. Estimating SPL from Modelled SEL Results

The SEL of individual sound pulses is an energy-like metric related to the dose of sound received over the pulse's duration. The SPL on the other hand is related to the pulses intensity over a specified time interval (Appendix A). The time interval applied in this report is fixed at 125 ms.

Seismic pulses typically lengthen in duration as they propagate away from their source due to seafloor and surface reflections and other waveguide dispersion effects. The changes in pulse length affect the numeric relationship between SPL and SEL because the amount of pulse energy within the specified time interval changes. Full-waveform modelling is necessary to estimate SPL, but this type of modelling is computationally intensive and can be prohibitively time consuming when run at high spatial resolution over large areas.

The current study, modelled synthetic seismic pulses from 5–1024 Hz with FWRAM (Appendix C.2).

FWRAM uses Fourier synthesis to recreate the signal in the time domain so that both the SEL and SPL can be calculated from the propagated signal. SPL was calculated using a 125 ms fixed time window positioned to maximise the SPL over the pulse duration. The difference between the SEL and SPL was extracted for all ranges and depths corresponded to those generated in the high spatial-resolution MONM results. The resulting SEL-to-SPL offsets were then averaged in 0.5 km range bins. The final range-dependent conversion function for each site correspond to the 90th percentile curve derived from the SEL-to-SPL offsets along all radials at that site. These range-dependent conversion functions were applied to predicted per-pulse SEL results from MONM and BELLHOP to model SPLs. The range-dependent conversion function for the VSP at Site 5 is shown in Figure D-2.

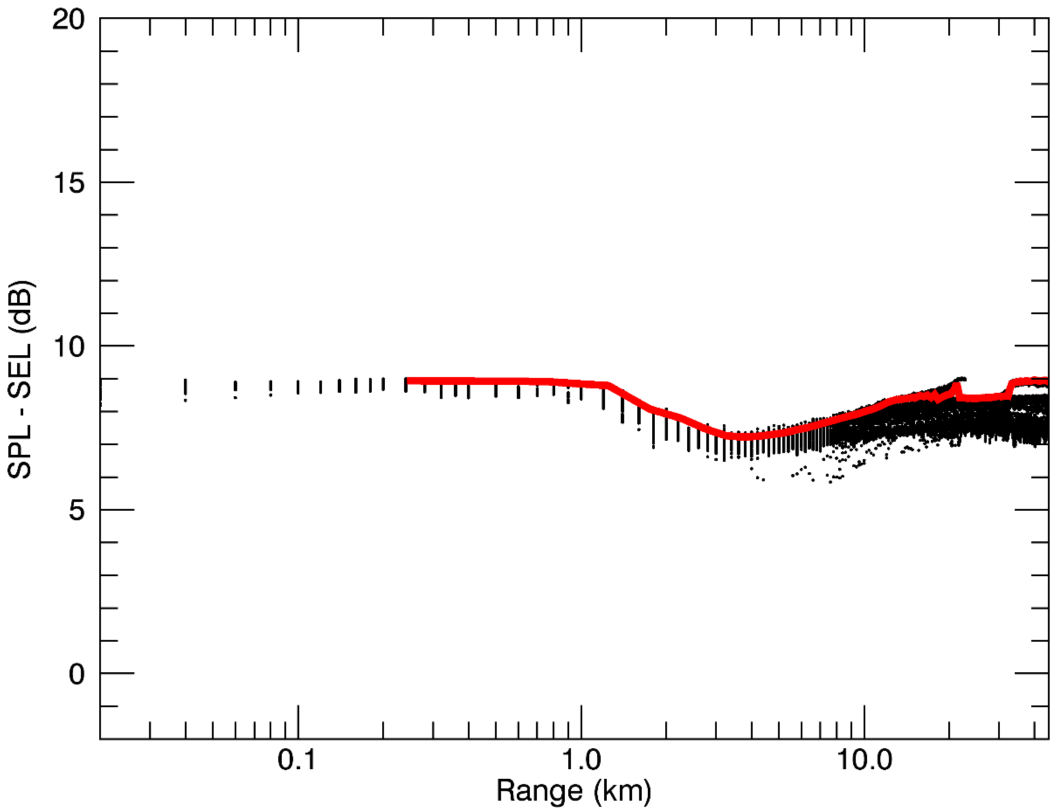


Figure D-2. Conversion Factor applied: Range-dependent conversion function for converting single-pulse SEL to SPL for the 450 in^3 VSP array.

D.3. Environmental Parameters

D.3.1. Bathymetry

Water depths throughout the modelled area were supplied by the client. The bathymetric data was re-gridded onto a Cartesian grid with a regular grid spacing of 50 × 50 m; this grid was used for all modelled sites in this study.

D.3.2. Sound speed profile

The sound speed profiles for the modelled sites were derived from temperature and salinity profiles from the U.S. Naval Oceanographic Office's *Generalized Digital Environmental Model V 3.0* (GDEM; Teague et al. 1990, Carnes 2009). GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the U.S. Navy's Master Oceanographic Observational Data Set (MOODS). The temperature and salinity profiles were converted to sound speed profiles according to the equations of Coppens (1981).

The sound speed profiles across the year were calculated across the area encompassing all sites, with the median sound speed at each depth retained for comparison. It was found that the sound speed profile for September provided the greatest propagation and is consequently used for the modelling. Since the profiles did not extend to the maximum water depth in the modelling area, they were supplemented with a deeper nearby offshore profile.

The final profile features a sound channel at 70 m, as well as a surface duct that may allow for enhanced high frequency propagation. Due to the bathymetry of the modelling region, most propagation is within the top two-hundred metres. At greater depths, the profile is downwardly refracting until 1300 m depth. The sound speed profile used throughout the modelling is shown in Figure D-3.

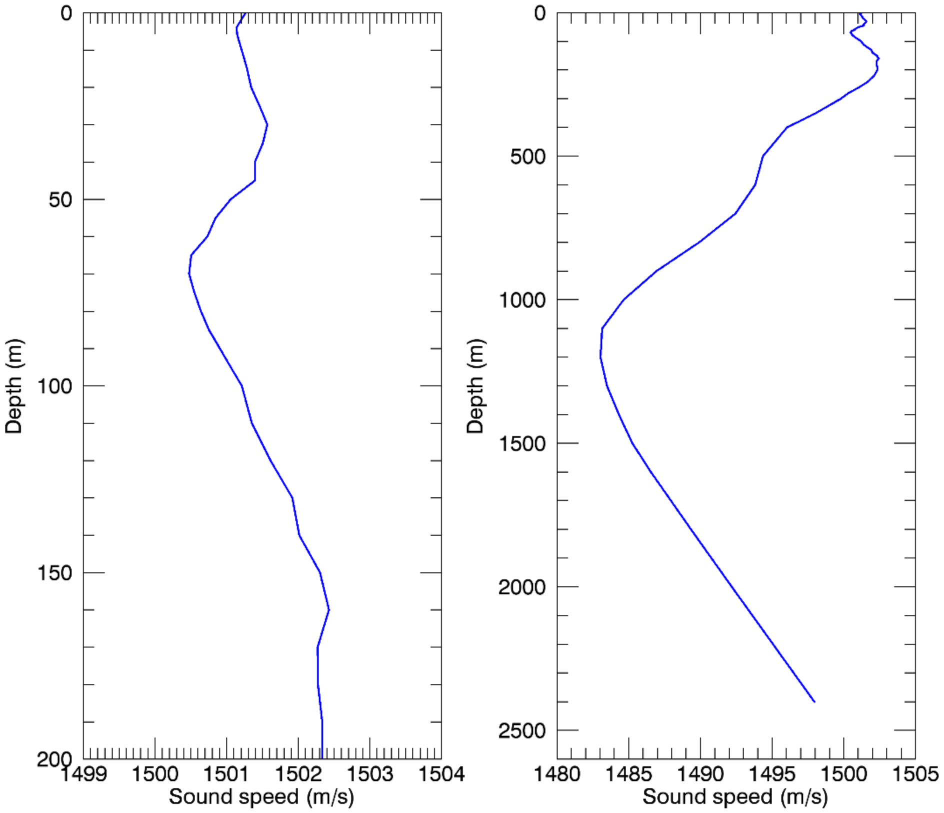


Figure D-3. The sound speed profile for September across the modelling region for the first 200 m (left), and over the entire range of depths (right). The profile was calculated from temperature and salinity profiles from GDEM V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

D.3.3. Geoacoustics

Each of the models used in this study utilise a single geoacoustic profile for each site. The geoacoustics determine how sound is reflected from the seabed, as well as how it is coupled into the sediment layers. The geoacoustic description for Site 5 are taken from a ground truthing report due to its proximity to the location (Duncan 2017). The geoacoustic profiles for the other sites were generated using lithographic descriptions from the geotechnical reports supplied by the client. Sites 1 and 2 located towards the south of the region were found typically to feature a well-cemented calcarenite caprock over a softer calcarenite layer. Sites 3, 4, and 6 typically exhibited a sand layer that sat above increasingly cemented calcarenite. In all cases, the calcarenite layer was found to extend to many hundreds of metres below the seafloor.

Geoacoustic values for Calcarenite have been taken from Duncan et al. 2013; where the calarenite is indicated to be increasingly consolidated with depth, the properties have been linearly interpolated. The geoacoustic parameters for sand are generated using models proposed by Hamilton (Hamilton 1980). The three final geoacoutics profiles used for the modelling are presented in Tables D-1 to D-3.

Table D-1. Geoacoustic profile used as the input to the models at Sites 1 & 2.

Depth below seafloor (m)	**Material**	**Density (g/cm³)**	**P-wave speed (m/s)**	**P-wave attenuation (dB/λ)**	**S-wave speed (m/s)**	**S-wave attenuation (dB/λ)**
0-1	Well-cemented carbonate caprock	2.7	2600	0.5	1200	0.5
1-20	Increasingly cemented calcarenite	2.2	2000	0.3	900	0.27
20-40		2.3	2120	0.34	960	0.316
40-60		2.4	2240	0.38	1020	0.362
60-80		2.5	2360	0.42	1080	0.408
80-10		2.6	2480	0.46	1140	0.454
>100	Well-cemented calcarenite	2.7	2600	0.5	1200	0.5

Table D-2. Geoacoustic profile used as the input to the models at Sites 3, 4, & 6.

Depth below seafloor (m)	**Material**	**Density (g/cm³)**	**P-wave speed (m/s)**	**P-wave attenuation (dB/λ)**	**S-wave speed (m/s)**	**S-wave attenuation (dB/λ)**
0-0.5	Coarse carbonate sand	2.03	1803.1	0.85	300	6.2
0.5-20	Increasingly cemented calcarenite	2.2	2000	0.3	900	0.27
20-40		2.3	2120	0.34	960	0.316
40-60		2.4	2240	0.38	1020	0.362
60-80		2.5	2360	0.42	1080	0.408
80-100		2.6	2480	0.46	1140	0.454
>100	Well-cemented calcarenite	2.7	2600	0.5	1200	0.5

Table D-3. Geoacoustic profile used as the input to the models at Site 5.

Depth below seafloor (m)	**Material**	**Density (g/cm³)**	**P-wave speed (m/s)**	**P-wave attenuation (dB/λ)**	**S-wave speed (m/s)**	**S-wave attenuation (dB/λ)**
0	Coarse carbonate sand	2.03	1802.2	0.85	300	6.2
20		2.07	1836.27	0.84	320	6.5
20-36	Increasingly cemented calcarenite	2.2	2000	0.3	900	0.27
36-52		2.3	2120	0.34	960	0.316
52-68		2.4	2240	0.38	1020	0.362
68-84		2.5	2360	0.42	1080	0.408
84-100		2.6	2480	0.46	1140	0.454
>100	Well-cemented calcarenite	2.7	2600	0.5	1200	0.5

Appendix J Sound Modelling Report – Wood and McPherson 2019

Technical Note

Supplemental modelling results for *Otway Basin Geophysical Operations Acoustic Modelling: Acoustic Modelling for Assessing Marine Fauna Sound Exposures*

From: Michael Wood and Craig McPherson
JASCO Applied Sciences (Australia) Pty Ltd

Date: 02 April 2019

Document: 01777

This technical note provides additional modelling results that supplement the original report: *Otway Basin Geophysical Operations Acoustic Modelling: Acoustic Modelling for Assessing Marine Fauna Sound Exposures* (McPherson and Wood 2017).

Tabulated ranges are provided to impact thresholds defined by NMFS (2018) for cetaceans and pinnipeds from operations involving the boomer and sub-bottom profiler (SBP) sound sources, and from the 450 in³ vertical seismic profiling (VSP) array.

The sound exposure level (SEL) results for the different auditory classes of marine mammal are frequency-weighted in accordance with NMFS (2018); the weighting functions are described in Appendix A; peak pressure levels (PK) are unweighted.

Results are presented for the Boomer and SBP in Section 1, and for the VSP in Section 2, while Section 3 discusses potential alternative sources for the study.

1. Boomer and SBP

1.1. Impact ranges from PK for high-frequency cetaceans

The ranges to identified impact thresholds for high-frequency cetaceans from the PK levels of the Boomer and SBP are shown in Table 1. The threshold levels for the equivalent effect in low- and mid-frequency cetaceans are appreciably higher, and thus were not reached.

Table 1. Maximum ranges to identified impact thresholds due to PK levels defined by NMFS for high-frequency cetaceans from SBP and Boomer operations.

PK Threshold Level dB re 1 µPa	Effect	SBP Range (m)	Boomer AP3000 Range (m)
202	PTS	0.6	2.8
196	TTS	1.2	5.5

1.2. Maximum ranges to impact thresholds from SEL_{24h} for marine mammals

The ranges to recommended impact thresholds from the Boomer and SBP are presented in Table 2. In all cases, the frequency-weighted levels are not high enough to reach the impact thresholds except for TTS in low-frequency cetaceans; the maximum range in this case is 10 m from the acoustic centre of the source.

Table 2. Maximum ranges to identified impact thresholds due to frequency-weighted SEL_{24h} levels defined by NMFS from SBP and Boomer operations.

Auditory group	Effect	Frequency-weighted Threshold Level dB re 1 µPa²·s	Artisan Range (m)	G3 Range (m)	Meeki Range (m)	Thy Comb Range (m)
Low-frequency Cetaceans	PTS	183	—	—	—	—
	TTS	168	10	<10	<10	<10
Mid-frequency Cetaceans	PTS	185	—	—	—	—
	TTS	170	—	—	—	—
High-frequency Cetaceans	PTS	155	—	—	—	—
	TTS	140	—	—	—	—
Phocid pinnipeds	PTS	185	—	—	—	—
	TTS	170	—	—	—	—
Otariid pinnipeds	PTS	203	—	—	—	—
	TTS	188	—	—	—	—

2. VSP

The ranges to recommended impact thresholds resulting from the VSP are presented in Table 3. Results assume both stationary source and receivers. Results are frequency-weighted in accordance with NMFS (2018). Maximum ranges are shown for 1, 5, 10, 15, 25, 144, and 360 impulses within a 24-hour period. Ranges up to 2.5 km calculated using 1 m resolution modelling on 5 m resolution gridded sound fields; ranges greater 2.5 km calculated using 10 m resolution modelling on 25 m resolution gridded sound fields.

Table 3. Maximum ranges to identified impact thresholds due to frequency-weighted SEL_{24h} defined by NMFS from VSP operations assuming different numbers of impulses during a 24-hour period.

Auditory group	Effect	Frequency-weighted Threshold Level dB re 1 µPa²·s	Number of impulses						
			1 R_{max} (m)	5 R_{max} (m)	10 R_{max} (m)	15 R_{max} (m)	25 R_{max} (m)	144 R_{max} (m)	360 R_{max} (m)
Low-frequency Cetaceans	PTS	183	11	30	45	56	72	323	738
	TTS	168	81	335	625	924	1227	3051	4743
Mid-frequency Cetaceans	PTS	185	—	—	—	—	—	—	—
	TTS	170	—	—	—	—	—	<10	<10
High-frequency Cetaceans	PTS	155	—	—	—	<10	<10	18	32
	TTS	140	<10	21	29	36	51	149	256
Phocid pinnipeds	PTS	185	—	—	—	<10	<10	21	34
	TTS	170	<10	22	32	40	55	222	409
Otariid pinnipeds	PTS	203	—	—	—	—	—	—	—
	TTS	188	—	—	—	—	—	<10	14

3. Comparison of sources

Beach Energy solicited tenders for the geophysical survey, and received three responses which proposed alternative equipment to that considered in McPherson and Wood (2017). These three responses have been evaluated, with the findings summarised below.

The primary sources of concern are the boomer and sub-bottom profiler, with other the potential sources for this project such as multi-beam echo sounders and side-scan-sonars being high frequency devices only, with centre frequencies over 100 Hz. As no mid-frequency multi-beam sonars are being considered, the potential for overlap between marine fauna hearing ranges and multi-beam sonar signals of concern is extremely limited.

The proposed sub-bottom profiler is the Edgetech X-star system, which is the same source as considered in the modelling study. Alternative boomers suggested as potential sources instead of the AP3000 include the AA251, AA300 and AA301. The modelled AP3000 signature was based upon scaling the signature of an AA202 single boomer plate. The frequency spectrum components of these potential sources are very similar to the modelled AP3000, and they will also exhibit a similar beam pattern. The peak source pressure level of the alternative boomers is slightly higher than the AP3000, which has a peak source pressure level of 210.8 dB re 1 μPa^{2}m^2, with that for the AA251 being of 212 dB re 1 μPa^{2}m^2 and AA301's 215 dB re 1 μPa^{2}m^2. This results in slightly greater ranges to PK thresholds for high-frequency cetaceans (Table 4), however criteria for other mammal auditory groups are not reached. There is also an increase in distance to PK-PK sound levels of interest, however the resulting ranges are still small, with no PK-PK sound level applied in the impact assessment exceeded more than 18 m from the source (Table 5). However, as both the Boomer and SBP are both towed at 3 m, the maximum depth at which the sound level of 202 dB re 1 μPa will be reached will be 21 m. As the shallowest modelling site of interest (Artisan, Table 1 in McPherson and Wood (2017)) has a depth of 71 m, no PK-PK sound levels of interest for benthic invertebrates will be reached at the seafloor.

Despite the differences in peak source pressure level between the modelled and potential alternative boomers, there is estimated to be only a very minor change in the per-pulse source sound exposure level (SEL), partly due to the length of the impulse from these alternative sources. Due to minor changes expected in term of per-pulse SEL, the modelling results presented in McPherson and Wood (2017) for SEL_{24h} are considered to be appropriate approximations of the potential sound fields and ranges to SEL_{24h} impact criteria.

Table 4. Maximum ranges to identified impact thresholds due to PK levels defined by NMFS for high-frequency cetaceans for the modelled boomer (AP3000) and two potential alternative boomers.

PK Threshold level dB re 1 µPa	Effect	Boomer AP3000 Range (m)	Boomer AA251 Range (m)	Boomer AA301 Range (m)
202	PTS	2.8	3.2	4.5
196	TTS	5.5	6.3	8.9

Table 5. Maximum ranges to identified PK-PK sound levels for the modelled boomer (AP3000) and two potential alternative boomers.

PK-PK dB re 1 µPa	Boomer AP3000 Range (m)	Boomer AA251 Range (m)	Boomer AA301 Range (m)
215	2.4	2.8	3.9
212	3.4	3.9	5.5
210	4.3	4.9	7.0
209	4.8	5.5	7.8
205	7.6	8.7	12.4
202	10.8	12.4	17.5

References

[NMFS] National Marine Fisheries Service. 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 pp. https://www.fisheries.noaa.gov/webdam/download/75962998.

Finneran, J.J. 2015. *Auditory weighting functions and TTS/PTS exposure functions for cetaceans and marine carnivores*. Technical report by SSC Pacific, San Diego, CA.

Finneran, J.J. 2016. *Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise*. Technical Report for Space and Naval Warfare Systems Center Pacific, San Diego, CA. 49 pp. http://www.dtic.mil/dtic/tr/fulltext/u2/1026445.pdf.

McPherson, C.R. and M.A. Wood. 2017. *Otway Basin Geophysical Operations Acoustic Modelling*. Document Number 01473. Technical report by JASCO Applied Sciences for Lattice Energy.

Appendix A.

NMFS (2018) Frequency weighting functions

In 2015, a U.S. Navy technical report by Finneran (2015) recommended new auditory weighting functions. The auditory weighting functions for marine mammals are applied in a similar way as A-weighting for noise level assessments for humans. The new frequency-weighting functions are expressed as:

$$G(f) = K + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\} \tag{A-1}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively), phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA’s technical guidance that assesses noise impacts on marine mammals (NMFS 2018). Table A-1 lists the frequency-weighting parameters for each hearing group. Figure A-1 shows the resulting frequency-weighting curves.

Table A-1. Parameters for the auditory weighting functions recommended by NMFS (2018).

Functional hearing group	***a***	***b***	***f*₁ (Hz)**	***f*₂ (Hz)**	**K (dB)**
Low-frequency cetaceans	1.0	2	200	19,000	0.13
Mid-frequency cetaceans	1.6	2	8,800	110,000	1.20
High-frequency cetaceans	1.8	2	12,000	140,000	1.36
Phocid pinnipeds in water	1.0	2	1,900	30,000	0.75
Otariid pinnipeds in water	2.0	2	940	25,000	0.64

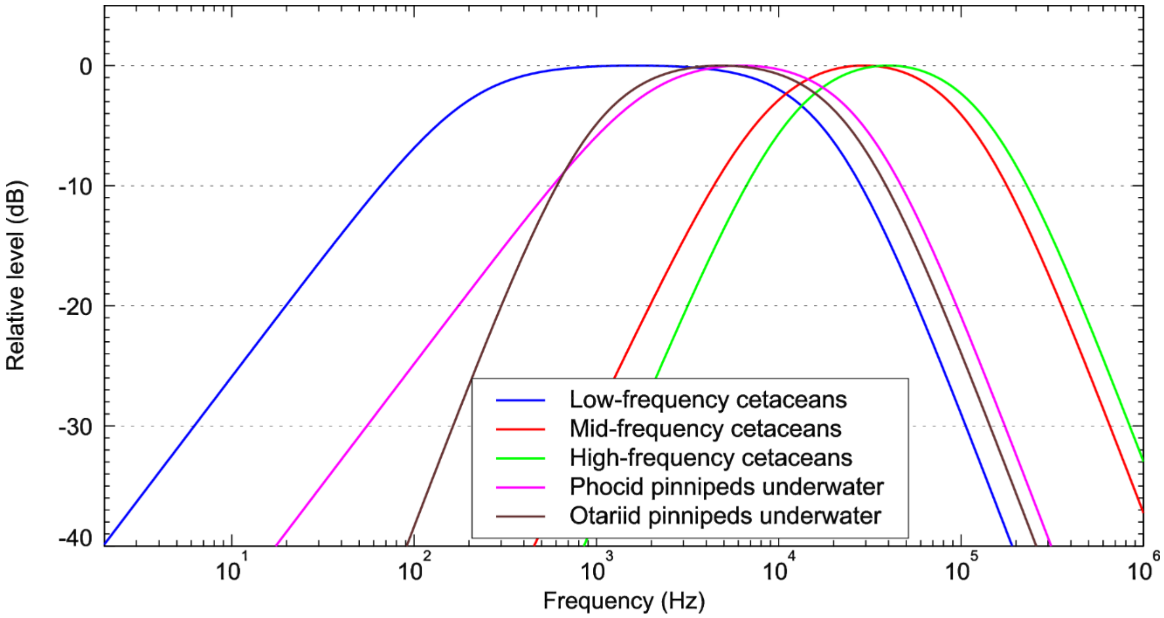


Figure A-1. Auditory weighting functions for the functional marine mammal hearing groups as recommended by NMFS (2018).

Appendix K Project GHG Emissions Report

Beach Energy Limited

Otway Offshore Gas Victoria Project

GHG Emissions Report

ASSIGNMENT P100383-S04
DOCUMENT P-100383-S04-A-REPT-001

XODUS

Perth

Level 1
1 William Street . Perth
WA 6000 . Australia

T +61 (0)86555 5600
E kenneth.see@xodusgroup.com

www.xodusgroup.com

REVISIONS & APPROVALS

This report has been prepared by Xodus Group exclusively for the benefit and use of Beach Energy Limited. Xodus Group expressly disclaims any and all liability to third parties (parties or persons other than Beach Energy Limited) which may be based on this report.

The information contained in this report is strictly confidential and intended only for the use of Beach Energy Limited. This report shall not be reproduced, distributed, quoted or made available – in whole or in part – to any third party other than for the purpose for which it was originally produced without the prior written consent of Xodus Group.

The authenticity, completeness and accuracy of any information provided to Xodus Group in relation to this report has not been independently verified. No representation or warranty express or implied, is or will be made in relation to, and no responsibility or liability will be accepted by Xodus Group as to or in relation to, the accuracy or completeness of this report. Xodus Group expressly disclaims any and all liability which may be based on such information, errors therein or omissions therefrom.

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A04	04/03/25	Issue for use	KS	MH	MH	
A03	25/10/24	Issue for use	KS	AC	AC	

CONTENTS

Abbreviations

ACRYONM	DESCRIPTION
AHTS	Anchor Handling Tug Supply Vessel
API	American Petroleum Institute
CRA	Corrosion Resistant Alloy
CSV	Construction Support Vessel
DSV	Diving Support Vessel
EF	Emission Factor
FLEM	Flowline Ending Manifold
GHG	Greenhouse Gas
GWP	Global Warming Potential
IMR	Inspection, Maintenance and Repair
ISV	Installation Support Vessel
LPG	Liquefied Petroleum Gas
MDO	Marine Diesel Oil
MODU	Mobile Offshore Drilling Unit
NGER	National Greenhouse Gas and Energy Reporting
OPP	Offshore Project Proposal
PLV	Pipe Lay Vessel
PSV	Platform Support Vessel
PTS	Pipeline Termination Structure
SBM	Synthetic Based Drilling Fluid
SDU	Subsea Distribution Unit
SVS	Subsea Valve System
TMD	Total Measured Depth (of well)
WBM	Water Based Drilling Fluid

1 INTRODUCTION

1.1 Foreword

Revision 5 of the report and recalculation of the GHG inventory was carried out under Xodus Assignment P100383-S04. Revision 5 is an update with new production information and the inclusion of downstream distribution emissions.

1.2 Background

Beach Energy Limited ('Beach') has engaged Xodus to develop a Greenhouse Gas (GHG) emissions study ('this report') for the Otway Offshore Gas Victoria Project ('the Project') to inform the Offshore Project Proposal (OPP). The key activities and sources of emissions for the Project are as follows:

- Drilling of up to 8 wells between 2025 and 2026 (Note Artisan has been drilled, making a total of 9 wells in scope of the Project).
- Completions of up to 9 wells in 2027.
- Installation of associated infrastructure and flowlines for up to 9 wells in 2028.
- Production from existing wells and new wells from the Project to year 2045. The wells from the Project is forecasted to produce hydrocarbons from 2028 to 2045.
- Operations, and decommissioning of up to 9 wells and associated infrastructure from the Project by 2049.

The characteristics of the hydrocarbons, including CO_2 content, from the La Bella and Artisan fields were based on samples from these fields. Compositions from nearby fields targeting similar geological formations (Artisan and Thylacine) were used as representative samples for the future prospects for this inventory assessment. Note that the assumptions and boundary conditions for the GHG emissions inventory assumed that all wells will be developed.

1.3 Boundary and source emissions

The Project boundary and its relationship to the Otway Development is outlined in Figure 1. The Project involves the drilling and completions of new hydrocarbon wells from different fields that will be tied back to the Otway Gas Plant (OGP) for processing. Details of the identified activities and source emissions resulting in GHG emissions and relevant assumptions are tabulated in Appendix A.

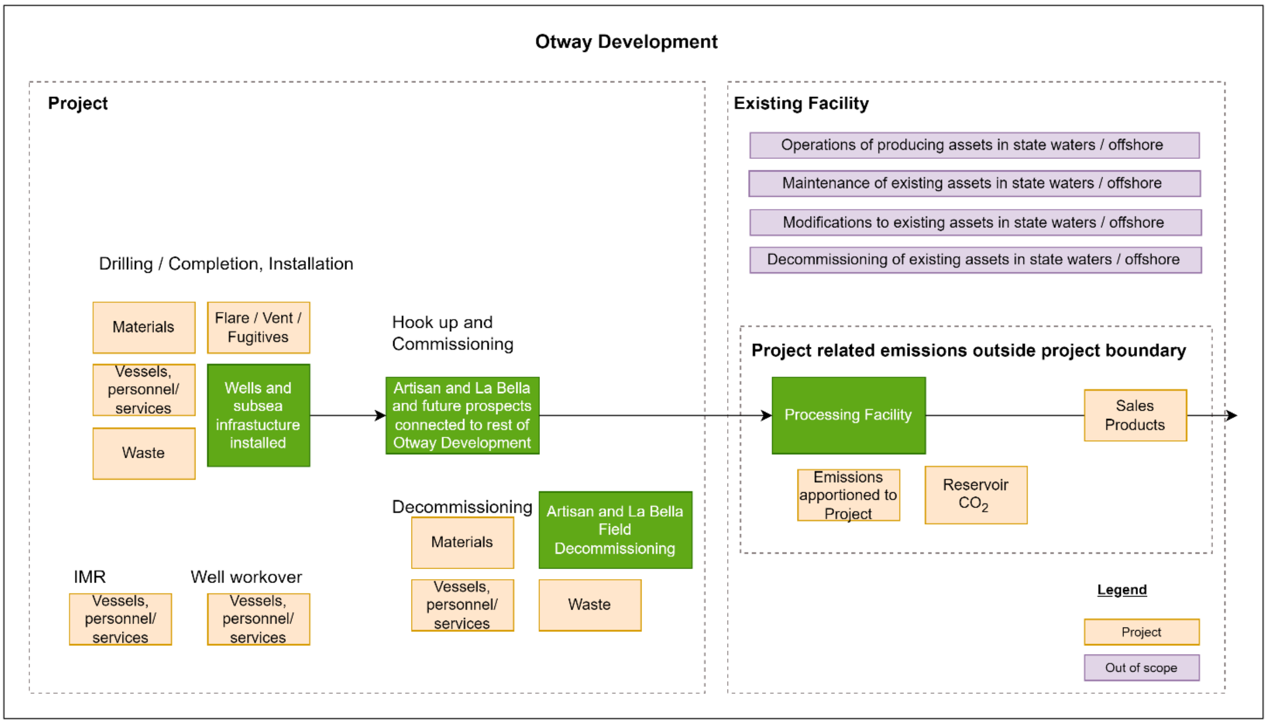


Figure 1: Boundary showing the Otway Development, and relationship between the Project and Existing Otway Facilities.

The Project GHG emissions inventory ('this report') describes the GHG contributions from the Project to the overall Otway Development. The GHG emissions are categorised as follows:

- Scope 1: Direct emissions from the combustion of fuel from owned or controlled sources. This is further categorised as follows:
  - Scope 1: Emitted within the Project Boundary, i.e., scope of OPP
  - Scope 1*: Emitted outside Project Boundary.
- Scope 2: Indirect emissions from the generation of purchased electricity, steam, heating, and cooling consumed by the company.
- Scope 3: All other indirect emissions not covered in scope 2, which occur in the value chain.

Table 1 summarises the activities and sources that emit GHG emissions over the lifecycle of the Project.

Table 1: GHG emissions categorisation. Refer to Appendix B for a full list of source emissions included.

GHG Scope	Phase	Sub-Category	Source / Activities
1 (Emitted within Project Boundary. Scope of OPP)	Drilling and Completions; Production	Flaring & Venting	Well clean-up and completion, well testing. Well intervention.
	Production	Fugitive Emissions	Fugitive emissions from wells and flowlines.
1* (Emitted outside Project Boundary)	Production	Reservoir CO_2	Reservoir CO_2 from Artisan, La Bella and future prospects emitted at Otway Gas Plant (OGP).
	Production	Onshore gas processing	Estimated fuel use apportioned to the processing of well fluids from Artisan, La Bella and prospects.
	Production	Onshore gas processing (fugitive emissions)	Fugitive emissions from OGP apportioned to throughput from Artisan, La Bella and prospects.
3	Support Activities (all stages)	Vessels / Helicopters	Variations of fleet including Mobile Offshore Drilling Unit (MODU) and support vessels and helicopters required for • Drilling • Installation • Inspection, Maintenance and Repair (IMR) • Well workover • Decommissioning
	Production	Sales Product	Use of sales gas, condensate from Artisan, La Bella and future prospects.
	Drilling and Completions, Installation, Decommissioning	Embodied carbon	Materials and equipment required to construct and decommission facilities, e.g., wells, flowlines, subsea equipment, cement, drilling mud.

2 METHODOLOGY

2.1 Source and activity identification

The assumptions list (Appendix A) co-developed by Beach and Xodus defines the activities and sources GHG emissions included in the GHG emissions inventory for Project. Justifications were provided where sources were identified and excluded from the inventory.

2.2 Calculations

2.2.1 Fuel use and related emissions

The National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Compilation 18) emission factors for Method 1 were applied for combustion related calculations across the Otway Development. No site-specific emissions factors were available for the existing facility. In general, the calculation for combustion related emissions is as follows:

$$\text{Emissions } [CH_4, CO_2, N_2O] \text{ (tonnes } CO_2e) = \text{Activity / Source [e.g., condensate product]} \times \text{EF } [CH_4, CO_2, N_2O]$$

2.2.2 Embodied carbon

No supplier / reference dataset for materials and equipment, or design basis was available. Thus, the embodied carbon emissions were estimated a range of Xodus propriety tools and methodologies, and publicly available databases. Note that the embodied carbon is based on the assumptions stated in Appendix A.

The general calculation approach for embodied carbon is as follows:

$$\text{Emissions (tonnes } CO_2e) = \text{Material / Equipment} \times \text{EF [material, equipment]}$$

2.2.3 Project well fluid onshore processing

The OGP fuel use for processing reservoir fluids was apportioned to the OPP by ratio of existing field and new field reservoir fluids for the forward estimates provided.

The general calculation approach for apportionment of fuel use is as follows:

$$\text{Emissions (tonnes } CO_2e \text{ apportioned to OPP)} = \text{Fuel use} \times \%$$
$$\text{[OPP reservoir fluids at OGP inlet / total reservoir fluid at inlet]} \times \text{EF [material, equipment]}$$

2.2.4 Transmission and distribution losses

Product from Beach at 60 PJ/year is sold into the Victorian Market (300 PJ/year). It is assumed that all the OGP product is sold into the Victorian Market, transmitted, and distributed by the following entities. The publicly available information from the Safeguard Mechanism (SGM) for 2022/23 is stated.

- Ausnet Gas Services (AGS): 185,486 tonnes CO_2-e
- Ausnet Gas Networks (AGN): 172, 611 tonnes CO_2-e
- Multinet Principal Distribution Network and South Gippsland Pipeline (MPDN) - 182,383 tonnes CO_2-e

It is further assumed:

- the Market is static.
- the reported SGM values from these entities is representative of the Market transmission and distribution losses.

Thus, transmission and distribution losses attributable from the Project saleable product entering the Victorian Market post sales gate can be directly apportioned based on the energy content of Project gas entering the market.

2.2.5 Sold product

Losses in the transmission and distribution system is subtracted, and the product usage by the customer is assumed to be fully combusted.

3 RESULTS

The results presented are credible high estimates, which account for extended contingencies beyond a typical schedule. The inventory covers the period from 2025 to 2056.

3.1 Project lifecycle GHG emissions summary

Table 2 is a summary of the GHG emissions over the Project lifecycle.

Table 2: GHG emissions forward estimates for the Project over its lifecycle in tonnes CO_2-e.

GHG Scope	Phase	Sub-Category	CO_2-e (tonnes)
1 (Emitted within Project Boundary. Scope of OPP)	Drilling and Completions; Production (well work over)	Flaring	103,505
	Drilling and Completions; Production (well work over)	Venting	1,507
	Production	Fugitive Emissions	14,560
		Scope 1 OPP boundary, Sub-total	**119,572**
1* (Emitted outside Project Boundary)	Production	Reservoir CO_2	318,645
	Production	Onshore gas processing	751,162
	Production	Onshore gas processing (fugitive emissions)	20,235
		Scope 1* outside OPP boundary,, Sub-total	**1,090,043**
3	Support Activities (all stages)	Vessels	393,296
	Support Activities (all stages)	Helicopters	1,287
	Drilling and Completions, Installation, Decommissioning	Embodied carbon	124,322
		Scope 3 upstream	**517,532**
	Production	Transmission and distribution losses	**366,203**
		Scope 3 sales product	**10,954,872**

3.2 Embodied carbon emissions

Table 3 details the estimated embodied carbon emissions for identified materials and equipment for the Project.

Table 3: Embodied carbon emissions of material / equipment including waste, per phase, over Project lifecycle.

Phase	Material / Equipment	CO_2-e (tonnes)	Notes
Drilling	Cement	3,200	
	Well casing	18,360	Steel / CRA
	WBDF	737	20% Bentonite/ Polymer
Installation	8" flowlines	57,448	API 17J flexible flowlines
	Umbilicals	28,943	Estimated as 8” nominal diameter type
	Subsea equipment	11,205	Estimated per piece equipment as weights not available
	Oily water discharge	<<1	15ppmv; negligible
Decommissioning	Cement	3,600	
	WBDF	829	20% Bentonite/ Polymer

3.3 Annualised emissions related to the Project

Table 4 details the annualised GHG emissions forward estimates for the Project. Note that emissions from existing fields processed at OGP is not accounted for here, which together, extends overall life (production at OGP) to 2055.

Table 4: GHG emissions related to the Project calculated for the Project lifecycle from fuel use and emissions from production in tonnes CO_2-e.

Year	Scope 1 (Inside Project Boundary)			Scope 3				Scope 1* (Outside Project Boundary)		
	Flaring	Fugitive	Venting	Helicopter	Product (incl. downstream losses)	Vessel	Embodied carbon	Fugitive	Processing	Reservoir CO_2
2025	-	-	-	55	-	6,522	2,787	-	-	-
2026	-	-	-	386	-	45,653	19,510	-	-	-
2027	84,686	-	1,233	403	-	80,959	0	-	-	-
2028	-	936	-	46	356,187	55,608	97,596	392	14,541	24,196
2029	-	936	-	-	1,267,689	-	-	1,286	47,742	86,219
2030	-	936	-	-	1,419,097	-	-	1,445	53,649	76,358
2031	-	936	-	-	-	-	-	1,590	59,006	49,509
2032	-	936	-	31	1,101,570	36,936	-	1,459	54,148	29,163

Year	Scope 1 (Inside Project Boundary)			Scope 3				Scope 1* (Outside Project Boundary)		
2033	-	832	-	-	-	-	-	1,161	43,114	7,352
2034	9,410	832	137	5	617,424	4,793	-	1,060	39,346	6,110
2035	-	832	-	28	543,554	3,195	492	1,039	38,555	5,417
2036	-	832	-	5	460,731	6,156	-	996	36,984	4,632
2037	-	728	-	31	430,018	36,936	-	1,042	38,672	4,364
2038	-	728	-	0	426,897	-	-	1,123	41,694	4,364
2039	-	728	-	28	423,616	3,195	492	1,209	44,866	4,364
2040	-	728	-	5	421,989	6,156	-	1,285	47,685	4,376
2041	9,410	728	137	5	417,813	4,793	-	1,360	50,489	4,364
2042	-	728	-	31	412,504	36,936	-	1,195	44,376	3,044
2043	-	728	-	-	337,622	-	-	1,050	38,989	2,190
2044	-	728	-	-	247,805	-	-	768	28,493	1,381
2045	-	728	-	-	223,024	-	-	776	28,816	1,242
2046	-	-	-	-	-	-	-	-	-	-
2047	-	-	-	-	-	-	-	-	-	-
2048	-	-	-	193	-	22,365	3,445	-	-	-
2049	-	-	-	36	-	43,092	-	-	-	-
Total	103,505	14,560	1,507	1,287	11,321,075	393,296	124,332	20,235	751,162	318,645

4 CONCLUSIONS

Table 5 summarises the estimates of GHG forward GHG emissions related to the Project.

Table 5: Summary of GHG emissions related to the Project.

GHG Scope		CO_2-e (tonnes)
1 (Emitted within Project Boundary. Scope of OPP)	Upstream	119,572
1* (Emitted outside Project Boundary)	Upstream	1,090,043
3	Upstream	518,905
	Downstream (transmission and distribution losses)	366,203
	Downstream (product use)	10,954,872

APPENDIX A BOUNDARY AND ASSUMPTION LIST

Phase	Assumptions / Givens	Information Source
All	Chartered support vessel emissions project-wide considered as scope 3 emissions.	Beach inputs aligned to GHG Protocol.
	Existing facilities: Onshore gas processing & Thylacine platform. These values are used to apportion fuel gas use only. OPP (this scope): Artisan, La Bella, and prospects with up to 9 wells in total. GHG emissions inventory assumed all 9 wells and associated infrastructure developed.	Beach inputs based on project concept design.
	Electricity is not purchased or sold; all generated electricity is consumed.	Confirmed by Beach.
	No bunkering of vessels is required for all phases.	Beach inputs based on operational experience in the region.
	Physical Properties (for conversions and calculations): • Marine Diesel Oil: 38.6 MJ/l • Aviation Kerosene: 36.8 MJ/l • Condensate: 46.5GJ/tonne • LPG: 25.7 GJ/kl; 46 GJ/tonne • Natural gas (fuel gas, sales gas): 39.3MJ/m^3	Aligned with NGER and agreed with Beach.
	• CO_2: 1.847 g/l • Condensate: 0.8 g/l • Reservoir gas: 0.68 g/l	Xodus assumptions agreed with Beach.
Activity schedule	The input values provided are considered “credible high” values – credible high values account for extended contingencies beyond a typical schedule of an activity.	Beach inputs.
	Expected duration of activities with emissions. • Drilling: 33 days per well + 7 days contingency – Total of up to 8 wells (excluding the drilled Artisan well) • Completions: 25+5 contingency days per well, 9 wells total • Installation: 25 days +5 days contingency for each associated well flowline / umbilical / subsea infrastructure.	Beach inputs based on project concept design.

Phase	Assumptions / Givens	Information Source
	– All fields connected via a single hot tap. • Production – Products, fuel use etc., per production profile for OPP scope. – IMR: 180 days. – Well workover: 30 days • Decommissioning: – P&A: 15 days +5 days contingency per well. – Infrastructure: 30 days for each associated well flowline/umbilical/subsea infrastructure.	
	Expected schedule of activities with emissions. • Drilling: – La Bella: 2025 – Prospects: 2026 • Completions: – Artisan La Bella, & prospects: 2027. • Installation: – Artisan, La Bella and prospects: 2028. • Production: – IMR: every 5 years from 2027. – Well workover: 1 well requiring workover every 7 years. – Flaring and venting for well workover: same as well completion. • Decommissioning: – Artisan: 2038/39 (well/ infrastructure). – La Bella: 2035/36. – Prospects: 2048/49.	Drilling, completions, and installation timing based on the 2025/2026 Equinox drilling programme inclusive of assumptions around timing of future drilling, completions and installation activities. IMR & workover frequency based on Beach operational experience in offset fields, workover to be carried out as required, assuming 1 every 7 years as a credible high value, accounting for extended contingencies beyond a typical schedule of an activity. Progressive well & infrastructure decommissioning to comply with decommissioning guidelines and policies.
Fuel consumption rate	Fuel consumption on daily rate basis. • MODU: 15m^3 MDO. • AHTS: 15m^3 MDO. • ISV/DSV: 15m^3 MDO. • PSV: 15m^3 MDO. • Multicat: 5m^3 MDO. • PLV: 56m^3 MDO. • Helicopters (Transport): 13m^3 Aviation kerosene.	Beach inputs based on operational experience in the region.

Phase		Assumptions / Givens	Information Source
Drilling and completions		Artisan drilling has finished and is not included.	Beach inputs – Artisan already drilled and suspended pending completion and future connection.
	Vessels (including supply and services, and transport)	- 1× MODU - 3× AHTS - Helicopter flights: 8 flights a week.	Beach inputs based on operational experience in the region.
	Materials per well basis	- Cement: 400 tonnes dry basis - Well casing/conductor: API 280m 36”, 1700m 13 3/8”, 3850m 9 5/8”, rest to 4,430m MD 5””. - Water based drilling fluid: 1500m^3.	Beach inputs as per OGV Drilling and P&A Environment Plan under assessment with NOPSEMA.
	Waste	Water based drilling fluid and waste cement all disposed at sea with no further treatment. Negligible GHG emissions.	Beach inputs as per OGV Drilling and P&A Environment Plan under assessment with NOPSEMA.
Well clean up and completion	Flaring	Flare rate of 65MMscfd for up to 2 days. In the unlikely event that SBM is required, SBM will be recovered and not flared.	Beach inputs reviewed by Xodus for consistency with light modelling.
Per well basis	Venting	To estimate using NGER 3.46AB Method 1. Item 4.	Xodus assumptions agreed with Beach.
	Vessels (including supply and services, and transport)	- 1× MODU - 3× AHTS - Helicopter flights: 8 flights a week.	Beach inputs based on operational experience in the region.
	Materials	N/A	Beach inputs.
	Waste	N/A	Beach inputs.
Installation	Flaring and venting	No changes to production requirements.	Beach inputs, and Xodus assumptions agreed with Beach.
Including hook up and commissioning	Stabilisation material	Not included.	Beach inputs based on operational experience in the region.
	Flowline (material)	Flowlines are all API 17J.	Beach inputs based on operational experience in

Phase		**Assumptions / Givens**	**Information Source**
			the region and project concept design.
	Flowline (main)	8" flowline from La Bella to hot tap tee - 21km; 8" flowline Artisan to hot tap tee, 10km.	Beach inputs based on project concept design.
	Flowlines (to each prospective well, 7 in addition to the 2 above)	8" flowline connecting each well to hot tap tee - 10 km. Note that the hot tap tee referred to are the same hot tap tee.	Beach inputs based on project concept design.
	Umbilical (main)	Umbilical from Thylacine to La Bella and Artisan - 45 km.	Beach inputs based on project concept design.
	Umbilical (7, to each prospective well, in addition to main)	Umbilical - 10km	Beach inputs based on project concept design
	Vessels (including supply and services, and transport)	• 1× ISV/CSV • 1× PLV • 1× Multicat • 1x DSV (hot tap assembly - 5 days) • Helicopter flights: 1 flight a week.	Beach inputs based on operational experience in the region.
	Materials (other infrastructure)	For each well, • 2× FLEM • 1× diverless interface skid • 1× SVS • 2x SDU	Beach inputs based on operational experience in the region and project concept design,
	Waste	Oily water discharged. Assume volume of discharge at 1.5× flowline volume with hydrocarbon concentration of 15ppmv. Considered immaterial <<1 tonne CO_2-e.	Beach inputs based on operational experience in the region and project concept design.
Production	Product	All products are assumed to be combusted as end-use. Fugitive emissions post sales gate not included.	Xodus assumptions agreed with Beach.
	Processing	Fuel gas and diesel usage accounts for onshore and offshore (Thylacine platform) consumption.	Beach inputs.
	Processing	The emissions from gas processing at OGP is estimated based on the ratio of throughput for the Project and existing facility.	Xodus estimate based on Beach production profile for total OGP throughput, agreed with Beach.

Phase		Assumptions / Givens	Information Source
	Fugitive emissions (offshore)	For wells proposed in OPP, 104 tonnes per annum CO_2-e each.	Beach inputs based on existing facility reporting.
	Fugitives (OGP, Thylacine, and existing wells)	GHG emissions of 3,522 tonnes CO_2-e per annum for all fugitive emissions reported for NGER. Given estimated emissions from each existing well of 104 tonnes CO_2-e, (10 existing wells) fugitive emissions related to processing is 2,482 tonnes CO_2-e per annum.	Beach inputs based on existing facility reporting.
	Materials	N/A.	Beach inputs.
	Waste	N/A.	Beach inputs.
IMR	Vessels (including supply and services, and transport)	• 1× ISV/CSV • 1× PSV • 1× Multicat • Helicopter flights: 1 flight a week.	Beach inputs based on operational experience in the region.
Well intervention	Vessels	• 1× MODU • 3× AHTS • Helicopter flights: 6 – 8 flights a week. • Flaring and venting	Beach inputs based on operational experience in the region.
Decommissioning		Assume decommissioning requires the same equipment for drilling and installation / commissioning. Durations are based on previous decommissioning campaigns.	Beach inputs based on operational experience in the region.
	Flaring and venting	No flaring and venting during decommissioning.	Beach inputs based on operational experience in the region.
	Materials	• Cement: 400 tonnes dry basis. • Water based drilling fluid: 1500m^3.	Beach inputs as per OGV Drilling and P&A Environment Plan under assessment with NOPSEMA.
	Waste	Water based drilling fluid and waste cement all disposed at sea with no further treatment. Negligible GHG emissions.	Beach inputs as per OGV Drilling and P&A Environment Plan under assessment with NOPSEMA.

APPENDIX B INPUTS TO INVENTORY

This table abstracts from Appendix A, sources of emissions related to the Project considered in the GHG inventory. Unless stated, all input sources were included in the inventory.

Activity	Source	Details	Notes
Drilling	Vessels	Combustion emissions from vessels. • 1× MODU • 3× AHTS • Drilling duration of 40 days per well, including 7 days contingency per well.	Artisan has been drilled and suspended pending completion, a further 8 wells to be drilled.
	Helicopters	Combustion emissions from helicopters for personnel transport. • 8 flights a week.	
	Drilling fluid	Embodied GHG emissions. • 1500 m^3 per well. This is the total drilling fluid and completion fluid per well. • The inventory accounted for water based fluids.	Similar embodied carbon values for the categories i.e., water based, or oil based.
	Cement	Embodied GHG emissions. • 400 tonnes, dry basis, per well.	
	Well string	Embodied GHG emissions. • API 280m 36", 1700m 13 3/8", 3850m 9 5/8", rest to 4,430m MD 5"". • It is assumed that all wells are the same design.	
	Waste	Water based drilling fluids and cement waste disposed at sea is not considered to breakdown or react resulting in further GHG emissions.	
Completions	Vessels	Combustion emissions from vessels. • 1× MODU • 3× AHTS Completions duration of 30 days per well, including 5 days contingency per well.	Total of 9 wells to be completed.
	Helicopters	Combustion emissions from helicopters for personnel transport. • 8 flights a week.	
	Completion fluid	Embodied GHG emissions. Total volume accounted as drilling and completions, and assuming similar category of fluid, i.e., water based.	
	Venting	Reservoir gas released to atmosphere arising from well completions activities. Venting losses from well completions per event, total 9 wells.	Completions with flare package on MODU.
	Flaring	Flaring emissions arising from well completions activities. Estimated flaring from well completions including cleaning and testing. • 130 MMscf, total flow per well.	

Activity	Source	Details	Notes
Installation	Vessels	Combustion emissions from vessels. - 1× ISV/CSV - 1× PLV - 1× Multicat Installation duration of 25 days, including 5 days contingency.	Duration per set of associated flowline / umbilical / subsea infrastructure.
	Vessels	Combustion emissions from vessels. Single connection for connecting all new flowlines to existing infrastructure. - 1x DSV Hot tap assembly duration of 5 days.	
	Helicopters	Combustion emissions from helicopters for personnel transport. - 1 flight a week.	
	Flaring and venting	Considered production and activity impacts. No material flaring and venting emissions identified from hot tap activity.	
	Stabilisation material	Stabilisation materials not included in inventory.	
	Flowlines	Embodied GHG emissions. - Total length of flowlines at 101 km.	
	Umbilicals	Embodied GHG emissions. - Total length of umbilicals at 105 km.	
	Other infrastructure	Embodied GHG emissions. For each well, the following set of associated infrastructure: - 2x FLEM - 1x diverless interface skid - 2x SDU - 1x SVS	
	Waste	Oily water discharges from hook up and commissioning considered immaterial.	Estimated << 1 tonne CO_2-e at 15ppmv.
Production	Gas plant	- Emissions during production were estimated on a deterministic mid case of the expected reservoirs' performance and sequencing, the actual emissions may vary based on the actual reservoir performance and production sequencing. [1]	
	Gas plant equipment	Combustion emissions from fuel gas driven equipment, relevant to the processing of gas from Project. The major equipment / system are: - Power generation - Boilers	The fuel gas forecast for the gas plant on an annual basis was provided for the existing wells, and gas from the proposed wells.
	Gas plant equipment	Combustion emissions from diesel gas driven equipment, relevant to the processing of gas from Project. The diesel usage for production is zero and excludes auxiliary aspects of	The total diesel use forecast for the gas

---

[1] *The EOFL of Project fields is revised in R05 to align the EOFL in the GHG Assessment with the EOFL in the OPP Project Description (i.e. 2045).*

Activity	Source	Details	Notes
		the gas plant requiring diesel, e.g., backup systems that may be tested from time to time.	plant on an annual basis was provided.
	Gas plant equipment and offshore facilities for existing facility	Fugitive emissions for the existing facility. Total fugitive emissions was given at 3,522 tonnes CO_2-e. This included all fugitives for the existing 10 wells to the gas plant to the sales gas boundary. • Fugitive emissions from each well (and associated infrastructure): 104 tonnes CO_2-e. • Attributable fugitive emissions to the onshore facilities: 2,482 tonnes CO_2-e.	
	Gas plant equipment and offshore facilities for attributable to Project	Fugitive emissions was estimated for the Project from gas plant and offshore facilities. • Fugitive emissions from the onshore facilities was apportioned to the Project on a raw gas volume basis. • Fugitive emissions from each well (and associated infrastructure): 104 tonnes CO_2-e.	Ratio of raw gas derived from the production forecast provided on an annual basis.
Production - IMR	Vessels	Combustion emissions from vessels for IMR activities. • 1× ISV/CSV • 1× PLV • 1× Multicat Planned IMR campaign duration of 180 days every 5 years.	
	Helicopter	Combustion emissions from helicopters for personnel transport. • 1 flight a week. Planned IMR campaign duration of 180 days every 5 years.	
	Replacement equipment	Replacement of major equipment is not considered a likely scenario and has not been included. Replacement of minor items e.g., seals, may take place during IMR, but the embodied GHG emissions from the replacement equipment are considered immaterial.	
Production – Well intervention	Vessels	Combustion emissions from vessels. • 1× MODU • 3× AHTS Planned well workover activities of 1 well every 7 years, lasting 30 days per event.	It is assumed that the workover events will have the same fugitive emissions and flaring requirements as a well completion event. This is likely conservative.
	Helicopter	Combustion emissions from helicopters for personnel transport. • 8 flights a week. Planned well workover activities of 1 well every 7 years, lasting 30 days per event.	
	Replacement equipment	Replacement of major equipment is not considered a likely scenario and has not been included. Replacement of well control equipment e.g., loggers, may take place during well	

Activity	Source	Details	Notes
		intervention, but the embodied GHG emissions from the replacement equipment are considered immaterial.	
Production – Transport	Transmission and distribution pipeline fugitive emissions	GHG emissions from downstream transmission and distribution losses. Estimates of the fugitive emissions from NG downstream of the sales gate, i.e., from Beach owned assets to non-Beach owned assets to customers in the Victoria market are based on the following assumptions: • All gas sold from Otway is to the Victorian Market. • The Market is static at 300 PJ / year. • The Market GHG Scope 1 emissions are reported under the SGM, and these reported values from the entities AGS, AGN and MPDN are representative of the Market transmission and distribution losses. • The publicly available information for year 2022/23 as follows: – AGS: 185,486 tonnes CO_2-e – AGN: 172, 611 tonnes CO_2-e – MPDN - 182,383 tonnes CO_2-e • The GHG emissions apportioned to the Project is by energy supplied by the OPP into the Market.	
Production – Sales gas	Sales gas usage at customer location	Assumed to be 100% combusted, less downstream transmission and distribution losses.	
De-commissioning	Vessels	Combustion emissions from vessels. Assumed the same vessels and schedule required for decommissioning of wells, flowlines and associated subsea infrastructure.	
	Flaring and venting	No requirement for flaring or venting identified.	
	Materials	Embodied GHG emissions related to well plug and abandonment, same as drilling.	

Appendix L Hydrotest Discharge Modelling Report

OFFSHORE GAS VICTORIA

Hydrotest Dispersion Modelling

MAQ1296J
Rev1
17 August 2023

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
A	Draft for internal review	Dr. Larissa Perez	Dr. Ryan Dunn	Nathan Benfer	10 August 2023
0	Draft issued for Client review			Nathan Benfer	11 August 2023
1	Draft issued for Client review	Dr. Larissa Perez		Nathan Benfer	17 August 2023

Approval for issue

Nathan Benfer	17 August 2023

Prepared by:

RPS

Nathan Benfer
Principal Consultant

Lakehouse Corporate Space, Suite 425
Level 2, 34-38 Glenferrie Drive
Robina, QLD, 4226

T +61 7 5553 6900
E Nathan.Benfer@rpsgroup.com

Prepared for:

Beach Energy Ltd

Phil Wemyss
Principal Environmental Advisor

80 Flinders Street,
Adelaide, SA, 5001

T +61 8 8433 2394
E Phil.Wemyss@beachenergy.com.au

Contents

Tables

Figures

EXECUTIVE SUMMARY

Background

Beach Energy Limited (Beach) has plans for development within the Otway Basin.

In order to support the environmental approvals, Beach commissioned RPS to undertake a detailed discharge modelling study of chemically treated seawater used to undertake system hydrotesting of the infield subsea facilities before being used to deliver the product.

The principal aim of the study was to determine the potential area of exposure from the preservation chemical within the treated seawater discharge. A detailed dewater discharge modelling study was commissioned, which examined a 6,000 m^3 discharge of treated seawater over a period of 42.9 hours (140 m^3/hr), 2 m above the seafloor. The initial concentration of the preservation chemical was assumed to be 550 mg/L (or parts per million (ppm)). The treated seawater will have the same water temperature and salinity as the surrounding seawater.

The predicted extent of the preservation chemical is reported as an annual assessment (i.e. any time of year).

Methodology

The modelling study was carried out in stages. Firstly, a 10-year current dataset (2010–2019) that includes the combined influence of large-scale ocean and tidal currents was prepared. Secondly, the near-field plume dynamics based on the discharge configuration and treated seawater characteristics was assessed under weak, moderate, and strong static current speeds. This step assessed the initial dilution of the treated water plume, which was then followed by an investigation of the far-field mixing. Different modelling approaches are required for calculating the near-field and far-field dilutions due to the differing hydrodynamic scales.

A total of 100 far-field simulations were run, with each simulation having a different start time to ensure a range of current conditions were sampled to assess the mixing and dispersion (i.e. dilution) of the preservation chemical. Once the simulations were complete, the individual outputs were combined to determine the maximum distances to achieved dilutions of the preservation chemical as an annual assessment, based on the 95th, 99th and 100th percentiles.

Summary of Modelling Results

- The near-field modelling revealed the results showed that treated seawater would initially project upward at a 45-degree angle due to the diffuser orientation and the high exit velocity. Once the plume lost its momentum, the plume descended slightly till it was neutrally buoyant with the ambient water and then mixed laterally due to ambient currents.
- The far-field modelling results indicate that for the 99th and 100th percentile analysis (i.e. 99% and 100% of the time), the maximum distances from the Release Location to the predicted dilutions of 1:550 (i.e. 1 mg/L which represents the impact threshold concentration/trigger value) contour were 20 m and 156 m, respectively. Based on the 95th percentile analysis (or 95% of the time), the 1:550 dilution was achieved very close to the release location (20 m).

1 INTRODUCTION

1.1 Background

Beach Energy Limited (Beach) has plans for development within the Otway Basin.

In order to support the environmental approvals, Beach commissioned RPS to undertake a detailed discharge modelling study of chemically treated seawater used to undertake system hydrotesting of the infield subsea facilities before being used to deliver the product.

The principal aim of the study was to determine the potential area of exposure from the preservation chemical within the treated seawater discharge. A detailed dewater discharge modelling study was commissioned, which examined a 6,000 m^3 discharge of treated seawater over a period of 42.9 hours (140 m^3/hr), 2 m above the seafloor. The initial concentration of the preservation chemical was assumed to be 550 mg/L (or parts per million (ppm)). The treated seawater will have the same water temperature and salinity as the surrounding seawater.

The coordinates of the Release Location is presented in Table 1-1 and illustrated in Figure 1-1.

The predicted extent of the preservation chemical is reported as an annual assessment (i.e. any time of year).

Table 1-1 Coordinates Release Location used for the treated seawater discharge modelling assessment.

Release Location	Latitude*	Longitude*	Water depth (m)
Release Location South	39.7485° S	143.1637° E	~155

*Datum: WGS 1984

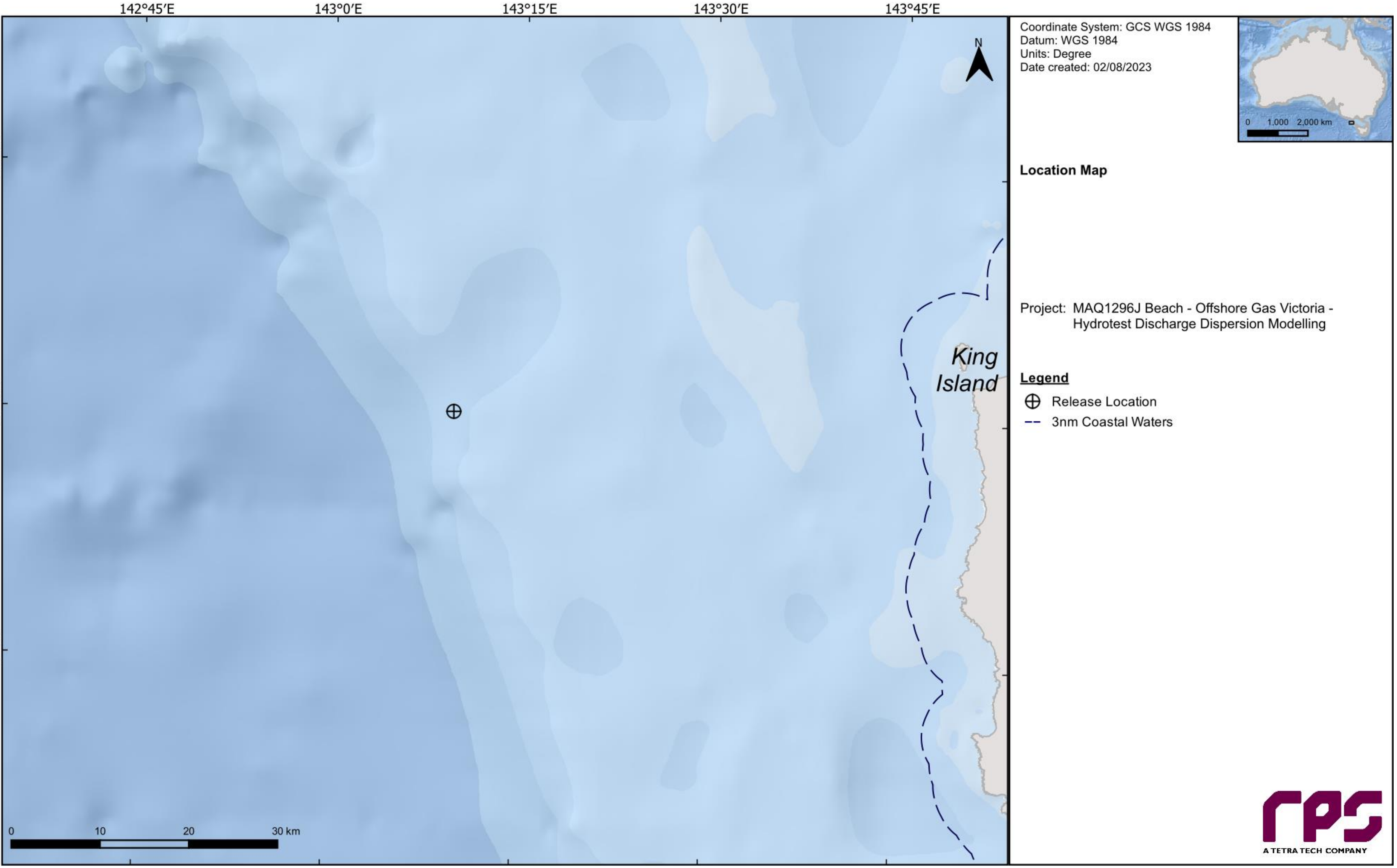


Figure 1-1 Location of the release site used for the treated seawater discharge modelling assessment.

2 SCOPE OF WORK

The physical mixing of the discharge can be separated into two distinct zones: near-field and far-field. The near-field zone focusses on the mixing of the treated seawater; while the mixing of the preservation chemical is assessed in the far-field. The near-field zone is defined by the region that is controlled by the plume's initial jet momentum and the static current. Normally, the buoyancy difference is considered in the near-field, however, it is negligible in this instance given that the treated seawater has the same density as the surrounding seawater. Once the near-field assessment is complete, the far-field phase examined the transport and mixing of the corrosion inhibitor by the ambient currents. Therefore, the scope of work included the following components:

1. Generate 10-years (2010-2019) of three-dimensional current data, that includes the combined influence of drift and tidal currents and is suitably long to be indicative of interannual variability in ocean currents;
2. Analyse the 10-year current dataset and identify the weak (5th percentile), moderate (50th percentile) and strong (95th percentile) current speeds, which were used as inputs in the near-field model;
3. Calculate the near-field plume dynamics (or initial dilution) based on the diffuser configuration and treated seawater characteristics under weak, moderate and strong static current speeds;
4. Run 100 far-field simulations, with each simulation having randomly selected start dates and times between 2010-2019 to ensure a range of current conditions were sampled to assess the mixing and dispersion of the preservation chemical; and
5. Combine the results for all 100 simulations and determine the maximum distances from the Release Location and total areas of exposure for the achieved far-field dilutions of the preservation chemical, including a dilutions equivalent to the impact threshold of 1 ppm (equivalent to 1 mg/L), based on 95th, 99th and 100th percentile outcomes.

3 REGIONAL CURRENTS

Bass Strait is a body of water separating Tasmania from the southern Australian mainland, specifically the state of Victoria. The strait is a relatively shallow area of the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. Currents within the straight are primarily driven by tides, winds, incident continental shelf waves and density driven flows; high winds and strong tidal currents are frequent within the area (Jones, 1980).

The varied geography and bathymetry of the region, in addition to the forcing of the south-eastern Indian Ocean and local meteorology lead to complex shelf and slope circulation patterns (Middleton & Bye, 2007). Figure 3-1 displays seasonal current trends within the Bass Strait. During winter there is a strong eastward water flow due to the strengthening of the South Australian Current (fed by the Leeuwin Current in the Northwest Shelf), which bifurcates with one extension moving though the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery & Kämpf, 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward, as the coastal current develops due to south-easterly winds.

To accurately describe the variability in currents between the inshore and offshore region, a hybrid regional dataset was developed by combining deep ocean predictions obtained from HYCOM (Hybrid Coordinate Ocean Model) with surface tidal currents developed by RPS. The following sections provide a summary of the hybrid regional dataset.

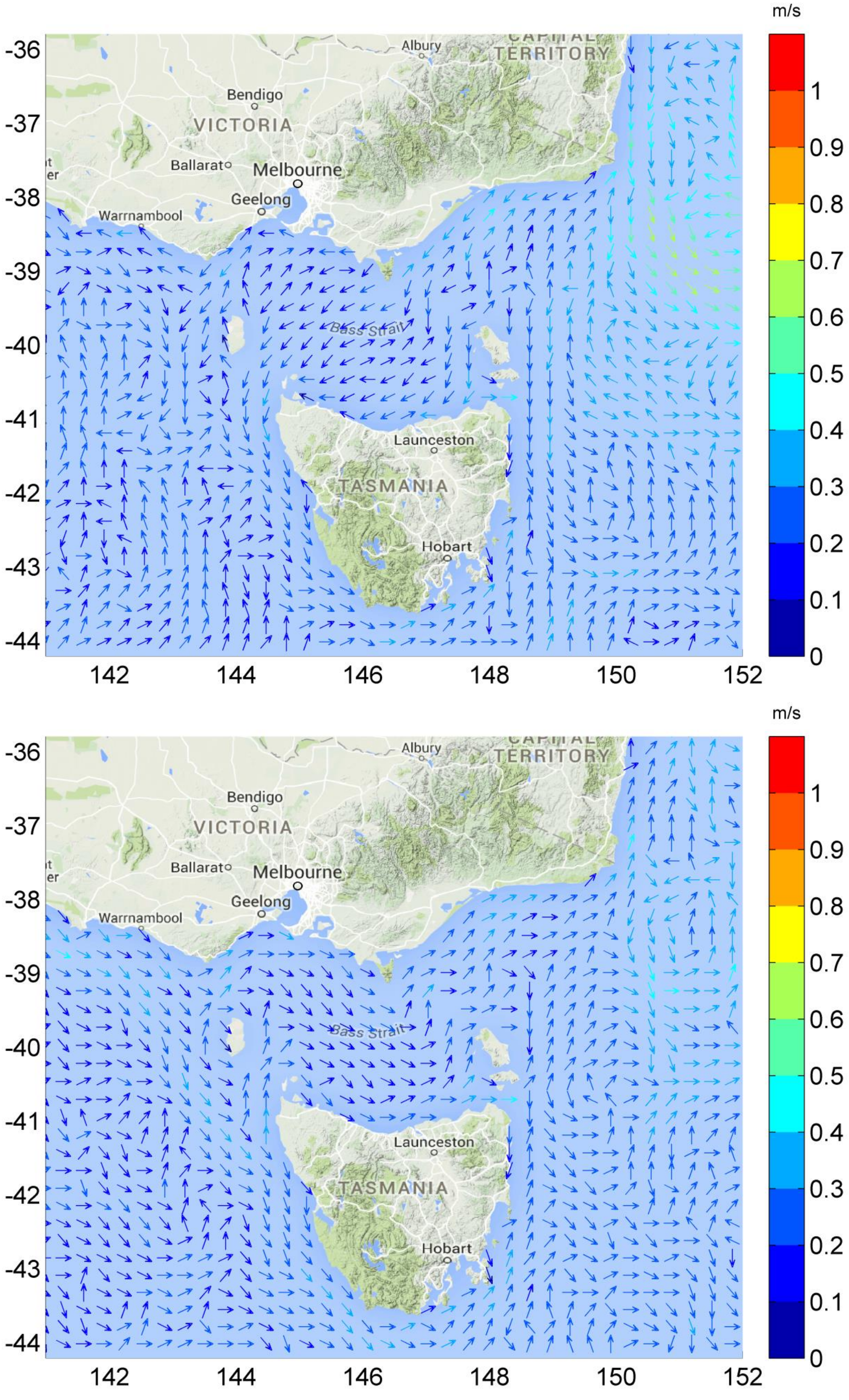


Figure 3-1 HYCOM averaged seasonal surface drift currents during summer (upper image) and winter (lower image).

3.1 Tidal Currents

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world over the past 38 years (Isaji & Spaulding, 1984; Isaji et al., 2001; Zigic et al., 2003). HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

HYDROMAP employs a sophisticated sub-gridding strategy, which supports up to six levels of spatial resolution, halving the grid cell size as each level of resolution is employed. The sub-gridding allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, and/or of particular interest to a study.

The numerical solution methodology follows that of Davies (1977a and 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji & Spaulding (1984) and Isaji et al. (2001).

3.1.1 Grid Setup

The tidal model domain was sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids are progressively allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 3-2 shows the tidal model grid covering the study domain.

A combination of datasets was used and merged to describe the shape of the seabed within the grid domain (Figure 3-3). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

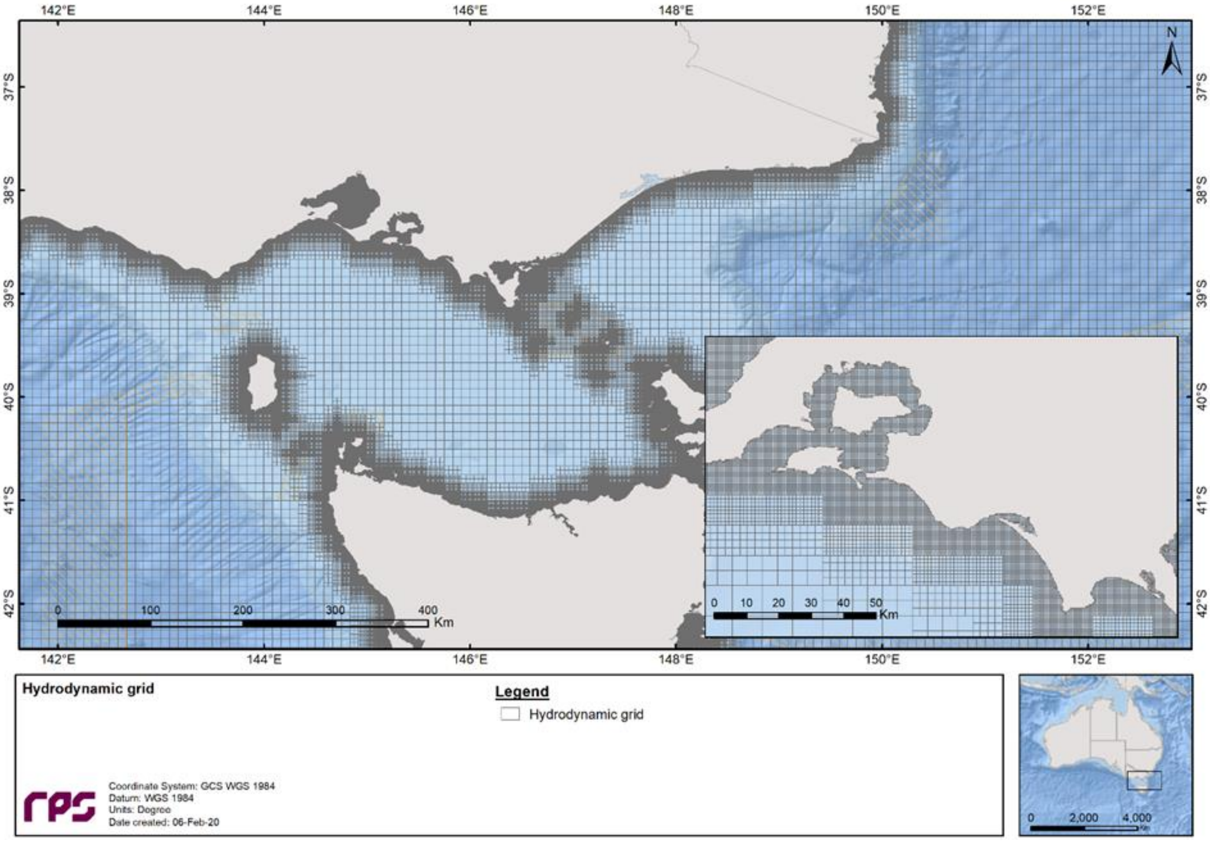


Figure 3-2 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

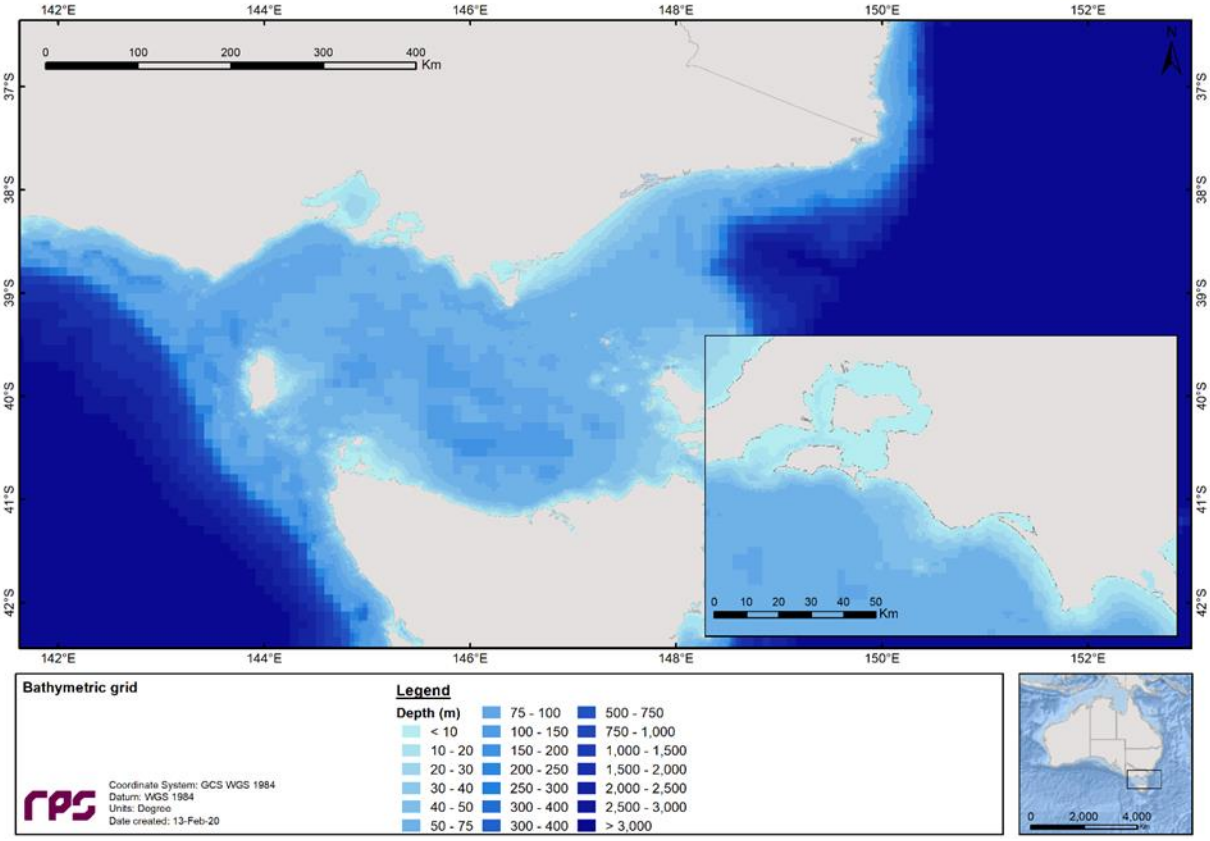


Figure 3-3 Bathymetry defined throughout the tidal model domain.

3.1.2 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 7.2) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were K_2, S_2, M_2, N_2, K_1, P_1, O_1 and Q_1. Using the tidal data, surface heights were firstly calculated along the open boundaries, at each time step in the model.

The TOPEX/Poseidon satellite data has a global resolution of 0.25 degrees and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The satellites equipped with two highly accurate altimeters and capable of taking sea level measurements with an accuracy of ± 5 cm measured oceanic surface elevations (and the resultant tides) for over 13 years (1992–2005). In total, these satellites carried out 62,000 orbits of the planet.

The TOPEX/Poseidon tidal data has been widely used amongst the oceanographic community, being included in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk & Tangdong, 2004; Qiu & Chen 2010). As such the TOPEX/Poseidon tidal data is considered suitably accurate for this study.

3.2 Ocean Currents

Data describing the flow of ocean currents was obtained from HYCOM (Hybrid Coordinate Ocean Model, (Chassignet et al., 2007), which is operated by the HYCOM Consortium, sponsored by the National Ocean Partnership Program (NOPP), as part of the U.S. Global Ocean Data Assimilation Experiment (GODAE). HYCOM is a data-assimilative, three-dimensional ocean model that is run as a hindcast (for a past period), assimilating time-varying observations of sea surface height, sea surface temperature and in-situ temperature and salinity measurements (Chassignet et al., 2009). The HYCOM predictions for drift currents are produced at a horizontal spatial resolution of approximately 8.25 km (1/12th of a degree) over the region, at a frequency of every 3 hours. HYCOM uses isopycnal layers in the open, stratified ocean, but uses the layered continuity equation to make a dynamically smooth transition to a terrain following coordinate in shallow coastal regions, and to z-level coordinates in the mixed layer and/or unstratified seas.

For this study, the HYCOM hindcast currents were obtained for the years 2010 to 2019 (inclusive).

3.3 Near-seabed Currents

Figure 3-4 and Figure 3-5 present the monthly and annual current rose plots, respectively, in the vicinity of the Release Location based on combined tidal and ocean currents.

Note the convention for defining current direction throughout this report is the direction the current flows towards. Each branch of the current rose distribution represents the currents flowing to that direction, with north to the top of the diagram. The branches are divided into segments of different colour, which represent the current speed ranges for each direction. Speed intervals of 0.2 m/s are typically used in these current roses. The length of each coloured segment within a branch is proportional to the frequency of currents flowing within the corresponding speed and direction.

The data showed that the currents predominantly flowed along the southwest–northeast axis. Average monthly current speeds ranged between 0.08 m/s and 0.11 m/s. Additionally, the maximum monthly near-seabed current speeds ranged between 0.20 m/s (December) and 0.39 m/s (July, Table 3-1).

Table 3-1 Predicted monthly average, maximum and percentile near-seabed currents at the Release Location South. Data were based on conditions between 2010 and 2019.

Month	Maximum current speed (m/s)	Average current speed (m/s)	5th Percentile current speed (m/s)	50th Percentile current speed (m/s)	95th Percentile current speed (m/s)
January	0.27	0.08	0.02	0.07	0.14
February	0.23	0.08	0.02	0.07	0.14
March	0.25	0.08	0.02	0.08	0.15
April	0.26	0.08	0.02	0.07	0.15
May	0.34	0.09	0.02	0.08	0.18
June	0.28	0.09	0.02	0.09	0.18
July	0.39	0.11	0.03	0.10	0.21
August	0.33	0.10	0.03	0.09	0.20
September	0.28	0.09	0.03	0.09	0.16
October	0.35	0.08	0.02	0.08	0.15
November	0.21	0.08	0.02	0.08	0.14
December	0.20	0.08	0.02	0.08	0.14
Minimum	**0.20**	**0.08**	**0.02**	**0.07**	**0.14**
Maximum	**0.39**	**0.11**	**0.03**	**0.10**	**0.21**

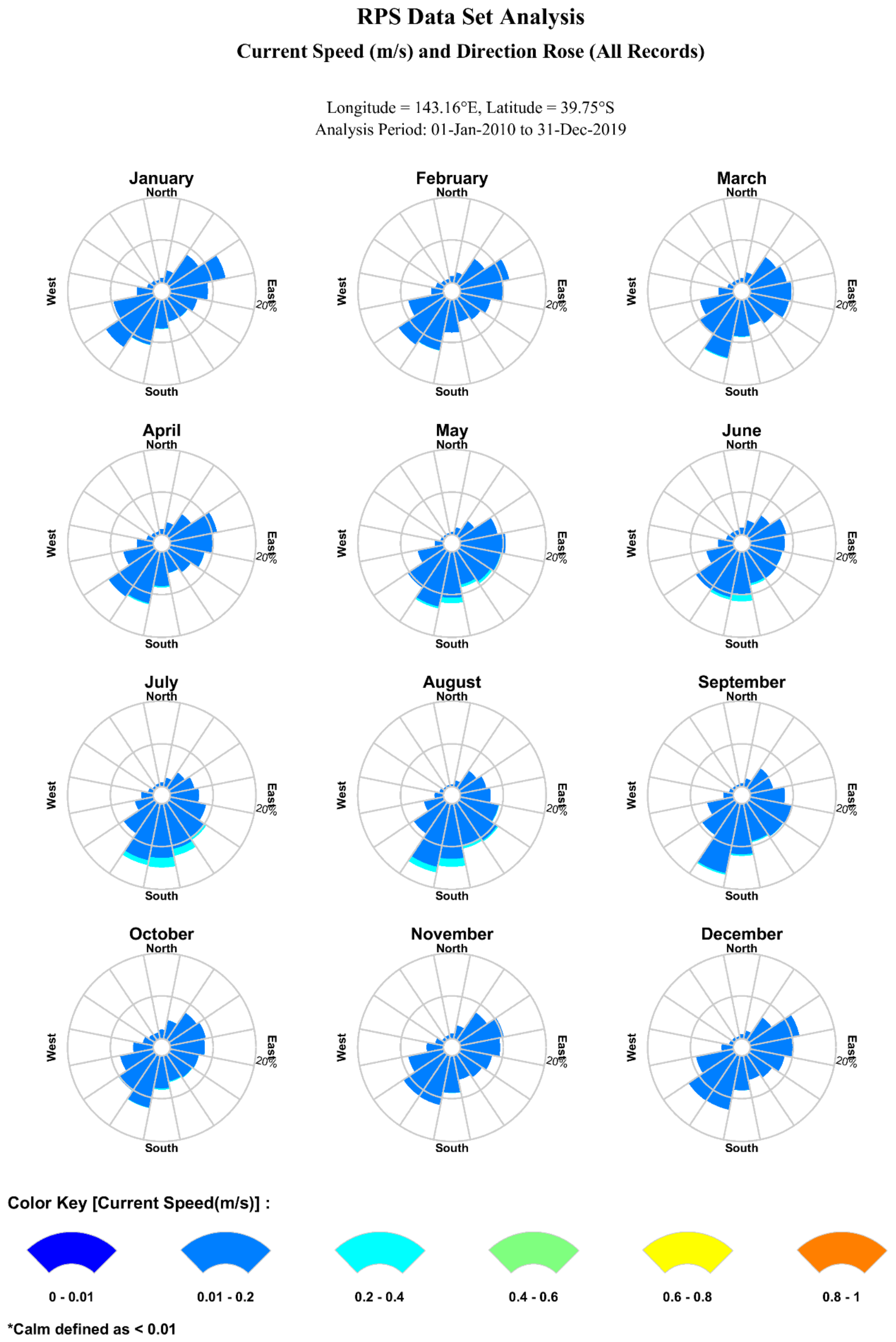


Figure 3-4 Monthly near-seabed current rose plots adjacent to the Release Location, derived from the 2010 to 2019 modelled dataset.

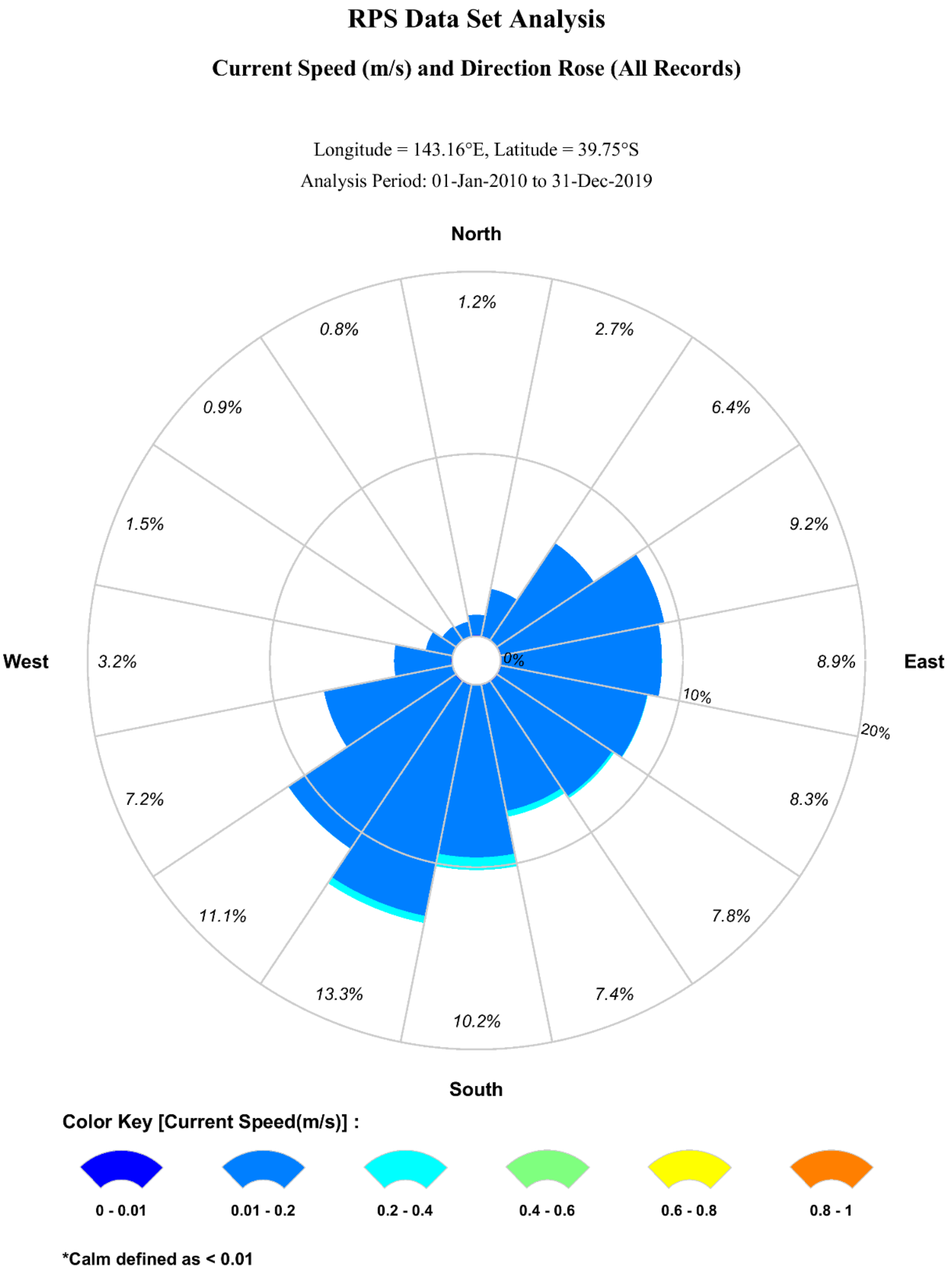


Figure 3-5 Annual near-seabed current rose plots adjacent to the Release Location, derived from the 2010 to 2019 modelled dataset.

4 WATER TEMPERATURE AND SALINITY

Table 4-1Table 4-1 shows the temperature and salinity data used as part of the near and far field modelling, which was obtained from the World Ocean Atlas 2018 database produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration) and its co-located World Data Center for Oceanography (Levitus et al., 2013). March and October conditions were used to represent summer and winter condition, as these were the months which revealed the highest and lowest temperatures, respectively.

Near-seabed (150 m) temperatures ranged between 11.5 ˚C (winter) and 12.7 ˚C (summer). Additionally, the summer and winter temperature profile exhibits reducing temperature with increasing depth (e.g. ~7 ˚C difference between the surface and bottom water layers). Salinity levels are generally consistent with season, and depth indicating a vertically well-mixed water body ranging between 35.3-35.4 psu through the water column.

Table 4-1 Summer and winter water temperature and salinity through the water column adjacent to the release location. March and October conditions were used to represent summer and winter condition, as these were the months which revealed the highest and lowest temperatures, respectively.

Water Depth (m)	Temperature (°C) Summer	Salinity (psu) Summer	Temperature (°C) Winter	Salinity (psu) Winter
0	18.4	35.4	13.3	35.4
2	18.4	35.4	13.3	35.4
4	18.4	35.4	13.3	35.4
6	18.4	35.4	13.3	35.4
8	18.4	35.4	13.3	35.4
10	18.4	35.4	13.3	35.4
12	18.4	35.4	13.3	35.4
15	18.4	35.4	13.3	35.4
20	18.4	35.4	13.2	35.4
25	18.4	35.4	13.2	35.4
30	18.3	35.4	13.2	35.4
35	18.2	35.4	13.2	35.4
40	18.1	35.4	13.2	35.4
45	18.0	35.4	13.2	35.4
50	17.7	35.4	13.1	35.4
60	16.2	35.3	13.1	35.4
70	14.8	35.2	13.1	35.4
80	13.9	35.2	13.0	35.4
90	13.1	35.2	13.0	35.4
100	12.6	35.2	13.0	35.4
125	12.0	35.1	12.8	35.4
150	11.5	35.1	12.7	35.3

5 ENVIRONMENTAL REPORTING CRITERIA

Beach plan to use a preservation chemical such as Hydrosure 0-3670R to treat the seawater that will be potentially discharged from the flowline. As per the ConocoPhillips Barossa OPP (ConocoPhillips, 2017) and Shell Crux OPP (Shell Australia Pty Ltd, 2020) an impact threshold concentration/trigger value of 1 ppm (equivalent to 1 mg/L) of the preservation chemical was used as part of this study. According to both OPPs, an impact threshold of 1 mg/L for the preservation chemical was defined as it was considered that concentrations below this threshold would not result in significant environmental impacts. It is a threshold, which is consistent with published acute toxicity test data for aquatic species for typical biocides including the Wheatstone Project Offshore Facilities and Produced Formation Water Discharge Management Plan: Stage 1 (Chevron Australia, 2015) which had identified an acute toxicity threshold of 1 ppm for Hydrosure, a representative preservation product. The Safety Data Sheet for Hydrosure O-3670R states the 96-hour LC_{50} as 3.09 mg/L for fish in marine waters, with a 48-hour EC_{50} of 5.66 mg/L for aquatic invertebrates (Champion Technologies, 2013). Note that ecotoxicological studies are typically undertaken using constant doses for periods ranging from 24 to 96 hours under controlled conditions when establishing ecotoxicological threshold of interest.

This approach is in contrast to the natural environment, where the concentration and exposure durations can vary widely. For the purpose of this assessment, selection of an impact threshold of 1 ppm provides a conservative basis to evaluate the potential effects of biocide in the receiving environment.

6 MODELLING METHODOLOGY

6.1 Near-Field Modelling

6.1.1 Description of the Near-Field Model: CORMIX

The near-field mixing and dispersion of the treated water discharge was simulated using the three-dimensional flow model, CORMIX. CORMIX is a mixing zone model and decision support system for environmental impact assessment of regulatory mixing zones. CORMIX contains a series of elements for the analysis and design of single or multi-port discharges. Discharges may be submerged or above surface, buoyant or denser than receiving water and the receiving water may be stratified or unstratified. The emphasis of the model is the influence of the geometry and dilution characteristics on the initial mixing zone (Doneker & Jirka, 1990; Jirka et al., 1991). CORMIX is widely applied worldwide and has been validated in many independent studies (http://www.cormix.info/validations.php).

CORMIX is a collection of analytic solutions to simplified forms of the mathematical equations describing transport and dispersion of water borne constituents. The simplifications are established through a range of assumptions about the source configuration, source characteristics (discharge and buoyancy) and the ambient environment. These assumptions effectively limit the domain within which the analytic solutions apply.

Although CORMIX does calculate far-field dispersion, the assumptions of the algorithms limit application to homogeneous environments with no eddies in the ambient flow and little recirculation. For this reason, the CORMIX component of the calculations for this study were limited to the near-field zone.

CORMIX specifies the average dilution or bulk dilution (flux averaged) as 1.7 times the centreline dilution. The centreline is defined by the points of maximum concentration (maximum temperature, minimum dilution etc) at each vertical section along the longitudinal axis. Accordingly, centreline depth is defined as the depth of the maximum concentration point (maximum temperature, minimum dilution) along the longitudinal axis.

6.1.2 Near-Field Model Setup

Summary of the treated seawater discharge characteristics are presented in Table 6-1. The discharge was anticipated to occur 2 m above the seabed through a single outlet from a diffuser orientated vertically upwards at 45 degrees with a 2 inch diameter. The discharge was anticipated to have a salinity and temperature as per ambient waters (see Section 4 Water Temperature and Salinity).

Table 6-1 Summary of the treated seawater discharge characteristics.

Parameter	Inputs
Total Discharge Volume	6,000 m^3
Discharge flow rate	140 m^3/hr
Diameter of discharge pipe	2"
Depth of discharge (below MSL)	153 m
Discharge Configuration (i.e. up, down, horizontal, number of ports)	Vertical upwards at 45 degrees
Surrounding water depth	155 m
Discharge temperature	Ambient
Discharge salinity	Ambient

Inputs to the CORMIX model also included constant current speeds. The 10-year data was statistically analysed to determine the 5th, 50th and 95th percentile current speeds at varying depths (Table 6-2) for input to the near-field model to reflect contrasting mixing and advection cases:

- 5th percentile current speed: weak currents, low mixing and slow advection;
- 50th percentile (median) current speed: average currents, moderate mixing and advection; and
- 95th percentile current speed: strong currents, high mixing and rapid advection to nearby areas.

The 5th, 50th and 95th percentile values are referenced as weak, medium and strong current speeds, respectively.

Table 6-2 Adopted ambient current conditions adjacent to the Release Location.

Depth (m)	5th percentile (weak) current speed (m/s)	50th percentile (medium) current speed (m/s)	95th percentile (strong) current speed (m/s)
Near-seabed	0.02	0.08	0.16

6.2 Far-Field Modelling

6.2.1 Overview

The far-field modelling expands on the near-field work by allowing the time-varying nature of currents to be included and for the potential for localised build-up when current speeds are low (e.g. at the turning of the tide) and recirculation of the plume back to the discharge location might occur. In this case, concentrations near the discharge point can be increased due to the discharge plume mixing with the remnant plume from an earlier time. This may be a potential source of episodic increases in pollutant concentrations in the receiving waters.

6.2.2 Description of Far-Field Model: MUDMAP

The mixing and dispersion of the preservation chemical was predicted using the three-dimensional discharge and plume behaviour model, MUDMAP. The far-field calculation (passive dispersion stage) employs a particle-based, random walk procedure. Any chemicals (constituents) within the discharge stream are represented by a sample of Lagrangian particles. These particles are moved in three dimensions over each subsequent time step according to the prevailing local current data as well as horizontal and vertical mixing coefficients.

MUDMAP treats the Lagrangian particles as conservative tracers (i.e. they are not removed over time to account for chemical interactions, decay or precipitation). Predicted concentrations will therefore be conservative overestimates where these processes actually do occur. Each particle represents a proportion of the discharge, by mass, and particles are released at a given rate to represent the rate of the discharge (mass per unit time). Concentrations of constituents are predicted over time by counting the number of particles that occur within a given depth level and grid square and converting this value to mass per unit volume.

The system has been extensively validated and applied for discharge operations in Australian waters (e.g. Burns et al., 1999; King & McAllister, 1997, 1998).

6.2.3 Far-Field Model Setup

Table 6-3 presents a summary of the far-field model inputs used to calculate the transport and mixing of the preservation chemical by the ambient currents. 100 simulations were run and each simulation had randomly selected (different) start dates and times (between 2010–2019), which ensured a range of current conditions were sampled.

Table 6-3 Summary of the chemical preservation far-field discharge characteristics.

Parameter	Inputs
Hindcast modelling period	2010–2019
Seasons	Annual
Total volume of treated water released (m^3)	6,000
Duration of release (hours)	42.9
Preservation chemical (mg/L or ppm)	550
Simulated period (days)	3

6.2.3.1 Mixing Parameters

The horizontal and vertical dispersion coefficients represent the mixing and diffusion caused by turbulence, both of which are sub-grid-scale processes. Both coefficients are expressed in units of rate of area change per second (m^2/s). Increasing the horizontal dispersion coefficient will increase the horizontal spread of the discharge plume and decrease the centreline concentrations faster. Increasing the vertical dispersion coefficient spreads the discharge across the vertical layers (or depths) faster.

Spatially constant, conservative dispersion coefficients of 0.15 m^2/s and 0.001 m^2/s were used to control the spreading of the plume in the horizontal and vertical directions, respectively. Each of the mixing parameters was selected following extensive sensitivity testing to recreate the plume characteristics predicted by the near-field modelling. It would be expected that the in-situ mixing dynamics would be greater under average and high energy conditions by a factor of 10 (King & McAllister, 1997; 1998) and thus the far-field model results are designed to produce a conservative result for concentration extents.

6.2.3.2 Grid Configuration

MUDMAP uses a three-dimensional grid to represent the geographic region under study (water depth and bathymetric profiles). A resolution of 10 m x 10 m was to track the movement and fate of the preservation chemical horizontally. The vertical resolution (z-axis) was set to 10 m. It is important to note, that the grid cell sizes were selected following extensive sensitivity testing in order to achieve similar dilution rates reflecting those predicted for the end of near-field mixing.

6.2.4 Interpretation of Percentile Dilution Contours

Once the simulations were complete, the individual outputs were combined and a statistical analysis performed to produce percentile dilutions. In the following sections, outcomes are presented for 95th 99th percentile and 100th (maximum) percentile dilution.

Note that the percentile figures represent concentrations that had occurred at each grid cell derived from 100 simulations and all time steps.

Moreover, the dilutions presented assume the background concentration of the preservation chemical in the receiving waters is zero and there is no biodegradation.

7 MODELLING RESULTS

7.1 Near-Field Modelling

Table 7-1 summarises the near-field modelling results. The near-field results showed that the treated seawater would initially propel upward at a 45 degree angle due to the diffuser orientation and the high exit velocity. The high exit velocity is also responsible for the initial mixing of the discharge plume and receiving waters that takes place. Once the plume lost its momentum, the plume descended slightly till it was neutrally buoyant with the ambient water and then mixed laterally due to ambient currents.

Within 30 m of the discharge, the predicted dilutions resulted in reductions of the initial concentration (550 mg/L) of the preservation chemical from to 3.6 mg/L (1:154.7 dilution), 2.6 mg/L (1:212.5 dilution) and 2.5 mg/L (or ppm; 1:222.5 dilution) under weak, medium and strong current conditions, respectively. Note that the required dilution corresponding to the impact threshold concentration/trigger value of 1 mg/L is 1:550 (see Section 5 Environmental Reporting Criteria). Importantly, the reported near-field predictions (Table 7-1) rely on the persistence of constant current speed(s) and direction over time and do not account for the build-up of the plume under time-varying hydrodynamic conditions (e.g. recirculation of the plume back to the Release Location).

Vertical cross-section and plan views of the predicted dilutions for the discharge under the modelled low, moderate and high currents are presented in Figure 7-1 to Figure 7-3, respectively.

Table 7-1 Predicted treated seawater near-field plume characteristics at 10 m and 30 m from the Release Location under weak, medium and strong current speeds during annualised conditions.

Surface current speed (m/s)	Distance from the Release Location (m)	Minimum centreline dilution (1:x)	Plume centre concentration (mg/L) following initial concentration of 550 mg/L	Plume diameter (m)
Weak (0.02)	10	55.1	10.0	3.2
	30	154.7	3.6	9.0
Medium (0.08)	10	66.6	8.3	3.4
	30	212.5	2.6	7.8
Strong (0.16)	10	75.1	7.3	3.0
	30	222.5	2.5	6.2

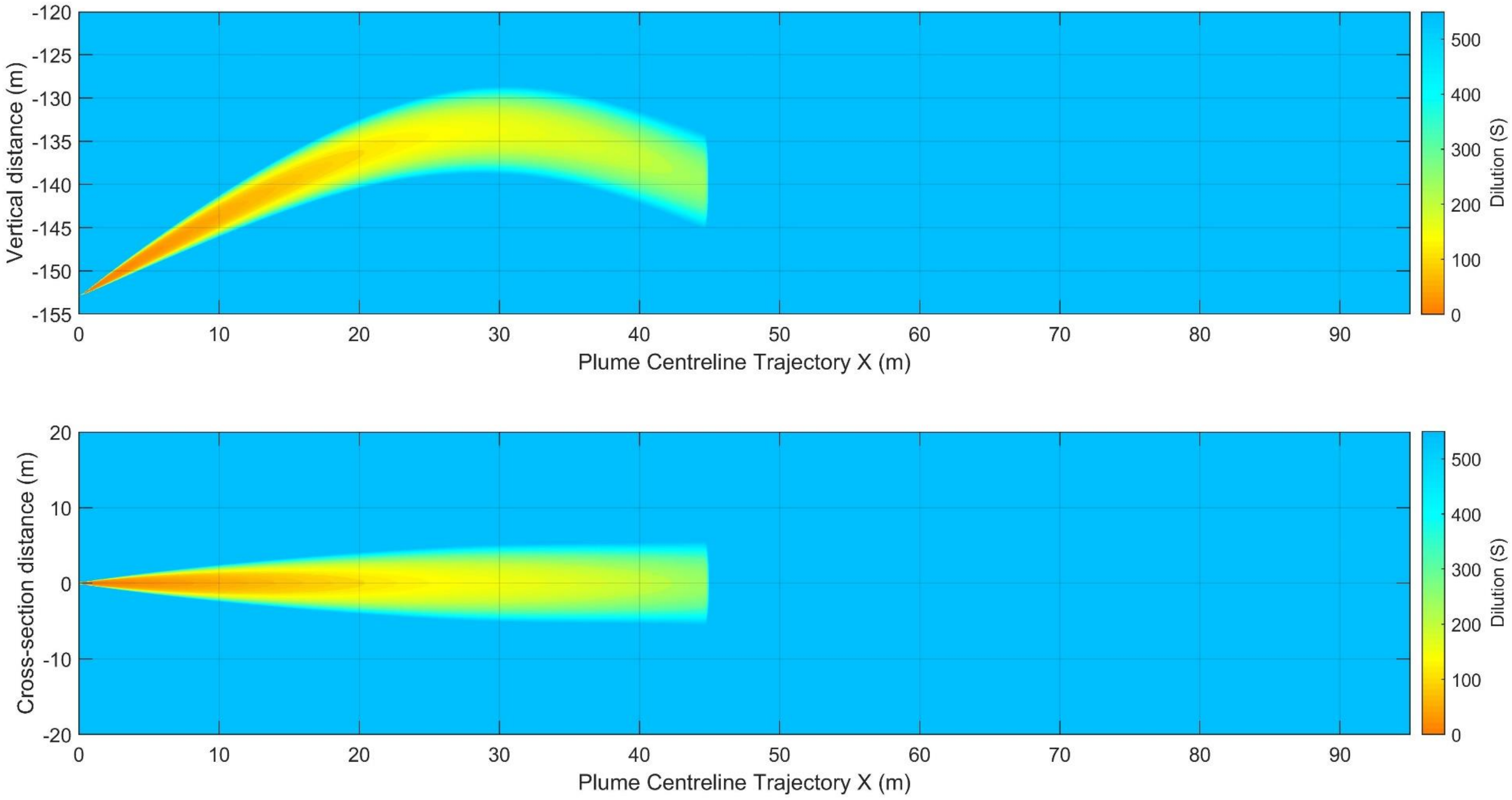


Figure 7-1 Vertical cross-section (top panel) and plan view (bottom panel) dilutions (1:S) for the discharge under low currents.

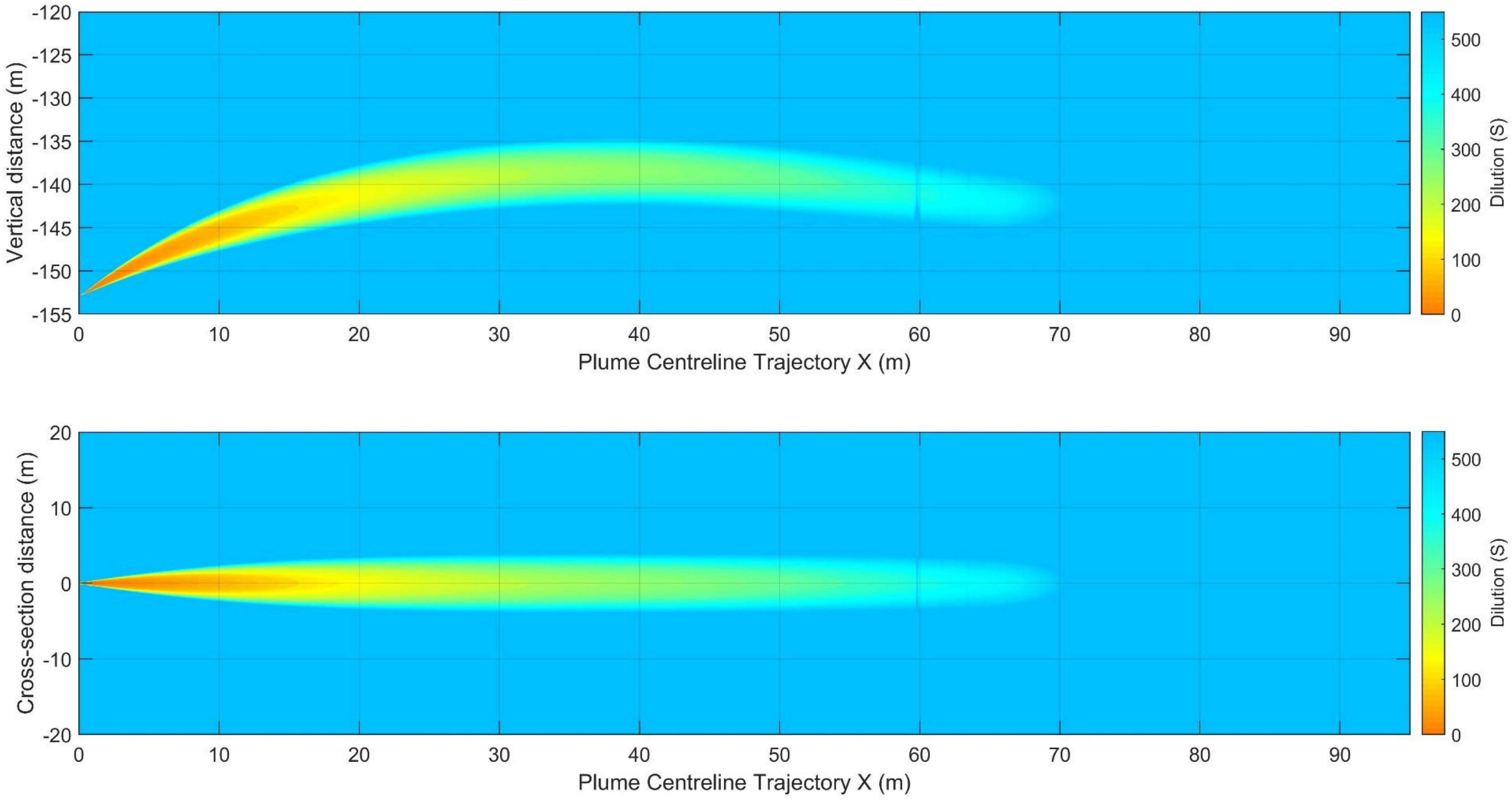


Figure 7-2 Vertical cross-section (top panel) and plan view (bottom panel) dilutions (1:S) for the discharge under moderate currents.

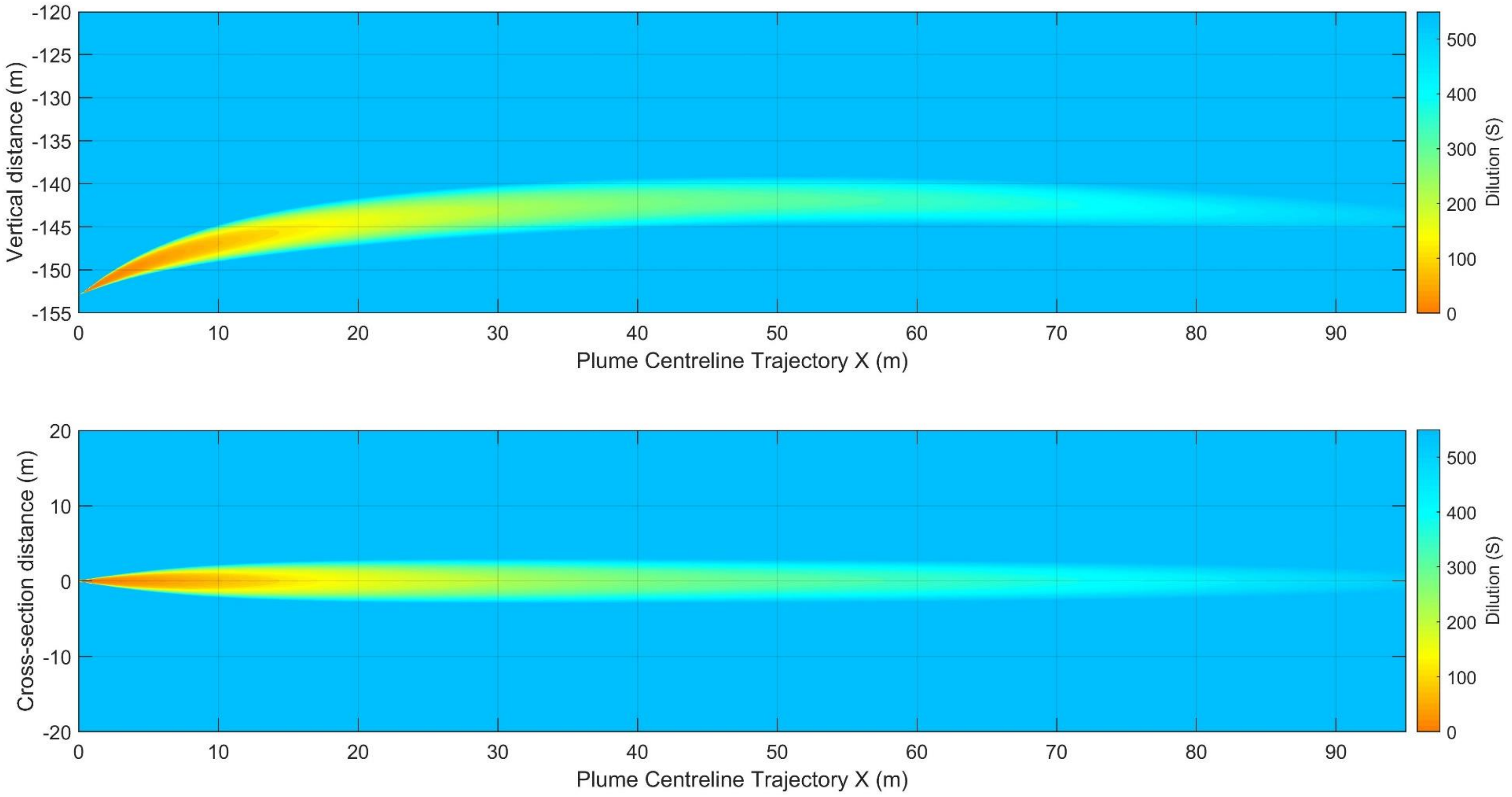


Figure 7-3 Vertical cross-section (top panel) and plan view (bottom panel) dilutions (1:S) for the discharge under high currents.

7.2 Far-Field Modelling

7.2.1 General Observations

Figure 7-4and Figure 7-5 present snapshots of predicted concentrations for a single simulation at +3, +6, +12 and +24 hours. The intention of the snapshots is to illustrate the spatially-varying orientation of the plume and the rapidly-varying nature of the achieved dilutions that could be observed under general conditions.

The far-field results demonstrated the dewatering discharge plume drifted horizontally through the water column in all directions from the Release Locations, whilst maintaining a low profile above the seafloor.

The snapshots illustrate that the dilutions became more variable over time because of changes in current speed and direction. Higher dilutions (i.e. lower concentrations) were predicted during periods of increased current speed, whereas patches of lower dilutions (i.e. higher concentrations) tended to accumulate during the turning of the tide or during periods of weak currents. During prolonged periods of lowered current speeds, the plume had a more continuous appearance, with higher-concentrated patches moving as a unified group.

Findings are agreeable with the research of King & McAllister (1997; 1998) who noted that concentrations within discharge plumes generated from offshore releases were patchy and likely to peak around the reversal of the tides.

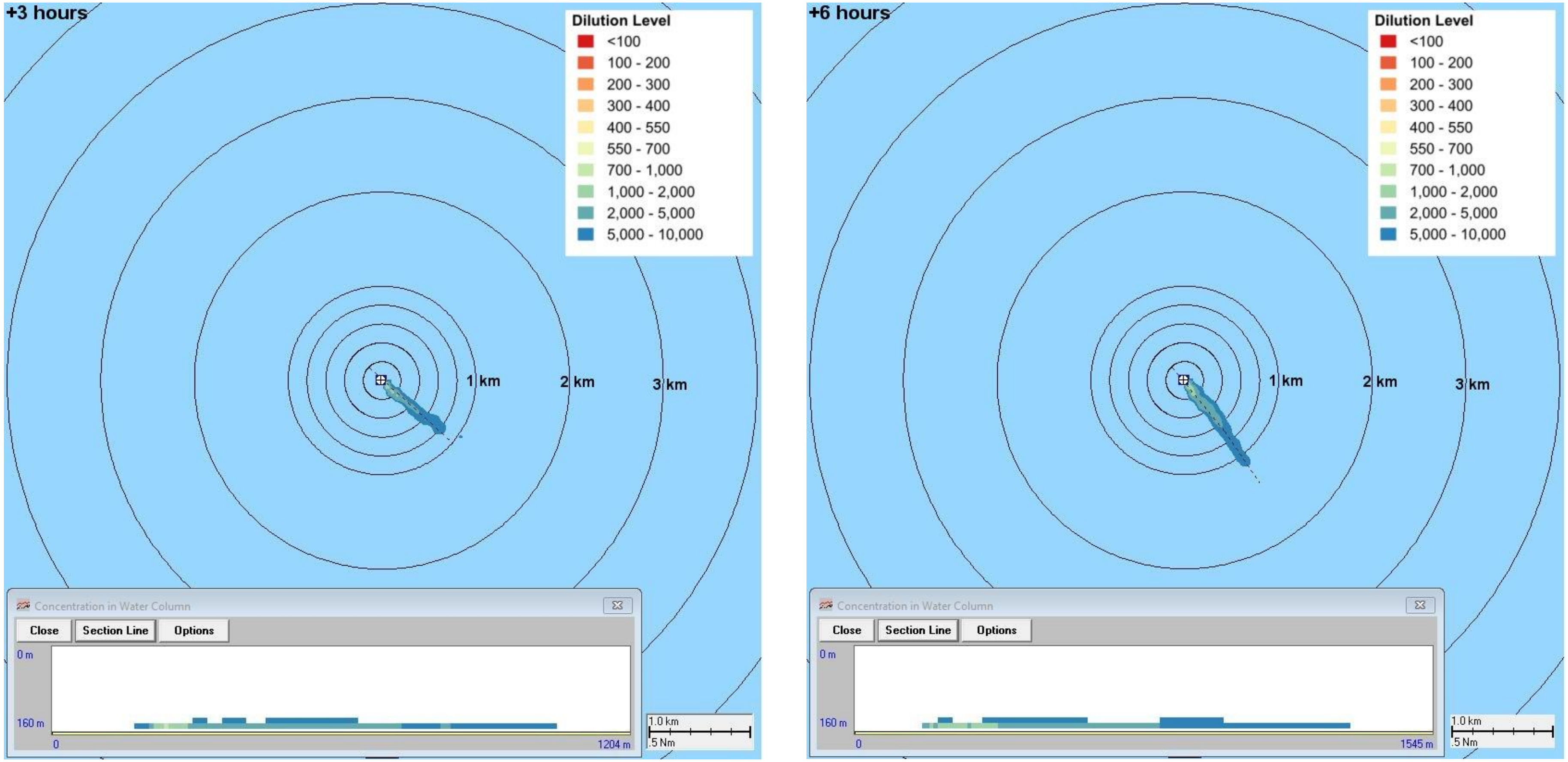


Figure 7-4 Example snapshots of predicted maximum concentrations, at +3 and +6 hours for a single simulation.

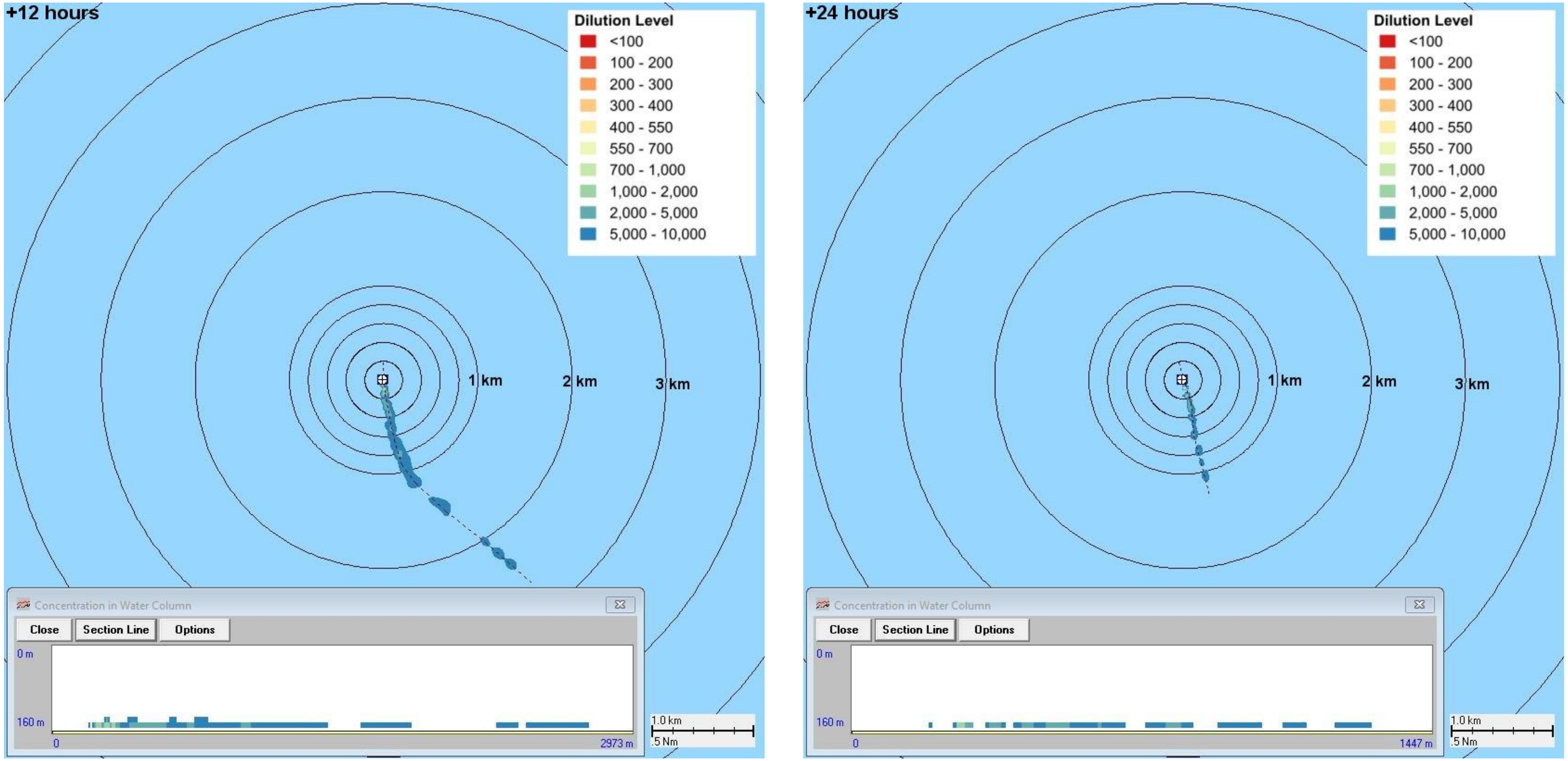


Figure 7-5 Continuing example snapshots of predicted maximum concentrations, at +12 and +24 hours for the single simulation presented in Figure 7-4.

7.2.2 Annualised Results

The results from all 100 simulations were combined and presented on an annualised basis.

Table 7-2 summarises the maximum distances from the discharge location to achieving dilutions up to 1:10,000. The results indicate that for the 99th and 100th percentiles, the maximum distances from the Release Location to instances of achieved dilutions of 1:550 (i.e. 1 mg/L which represents the impact threshold concentration/trigger value) were predicted to occur 20 m and 156 m from the Release Location, respectively. For the 95th percentile 1:550 dilutions are reached very close to the Release Location (20 m).

Figure 7-6 to Figure 7-10 present the results for the 95th, 99th and 100th percentile concentrations.

Table 7-2 Maximum distances from the Release Location to achieve selected dilutions. The results were calculated from 100 simulations and presented as an annual assessment.

Dilutions	Maximum distance (m) from discharge location to achieve selected dilutions		
	95th percentile	99th percentile	100th percentile
0-100	<10	<10	<10
100-200	<10	<10	<10
200-300	<10	<10	24
300-400	<10	<10	45
400-550	<10	20	156
550-700	<10	43	227
700-1,000	<10	112	231
1,000-2,000	125	201	819
2,000-5,000	344	592	5,779
5,000-10,000	782	1,389	6,253

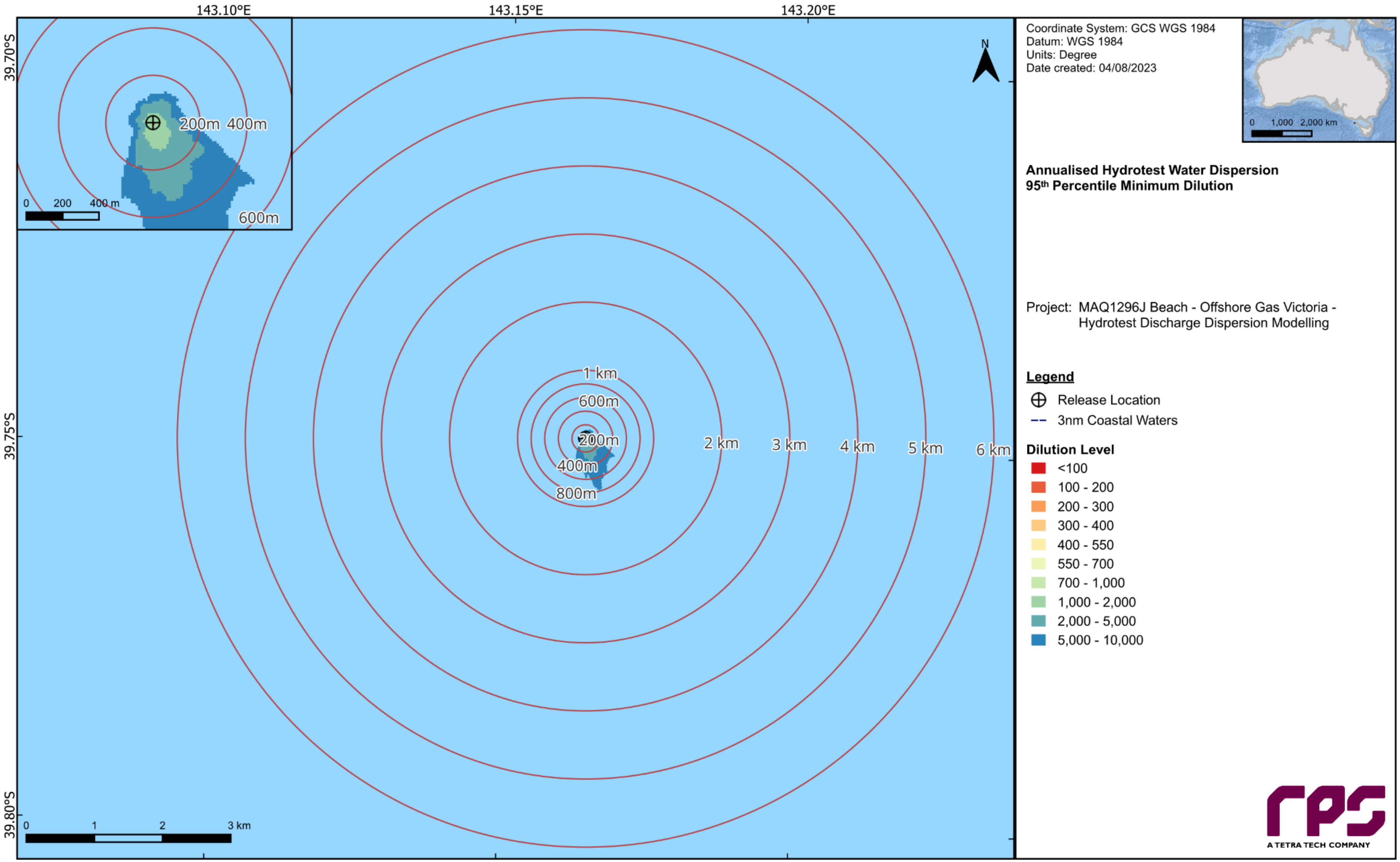


Figure 7-6 Predicted 95th percentile concentrations of the preservation chemical. The results were calculated from 100 simulations and presented as an annual assessment.

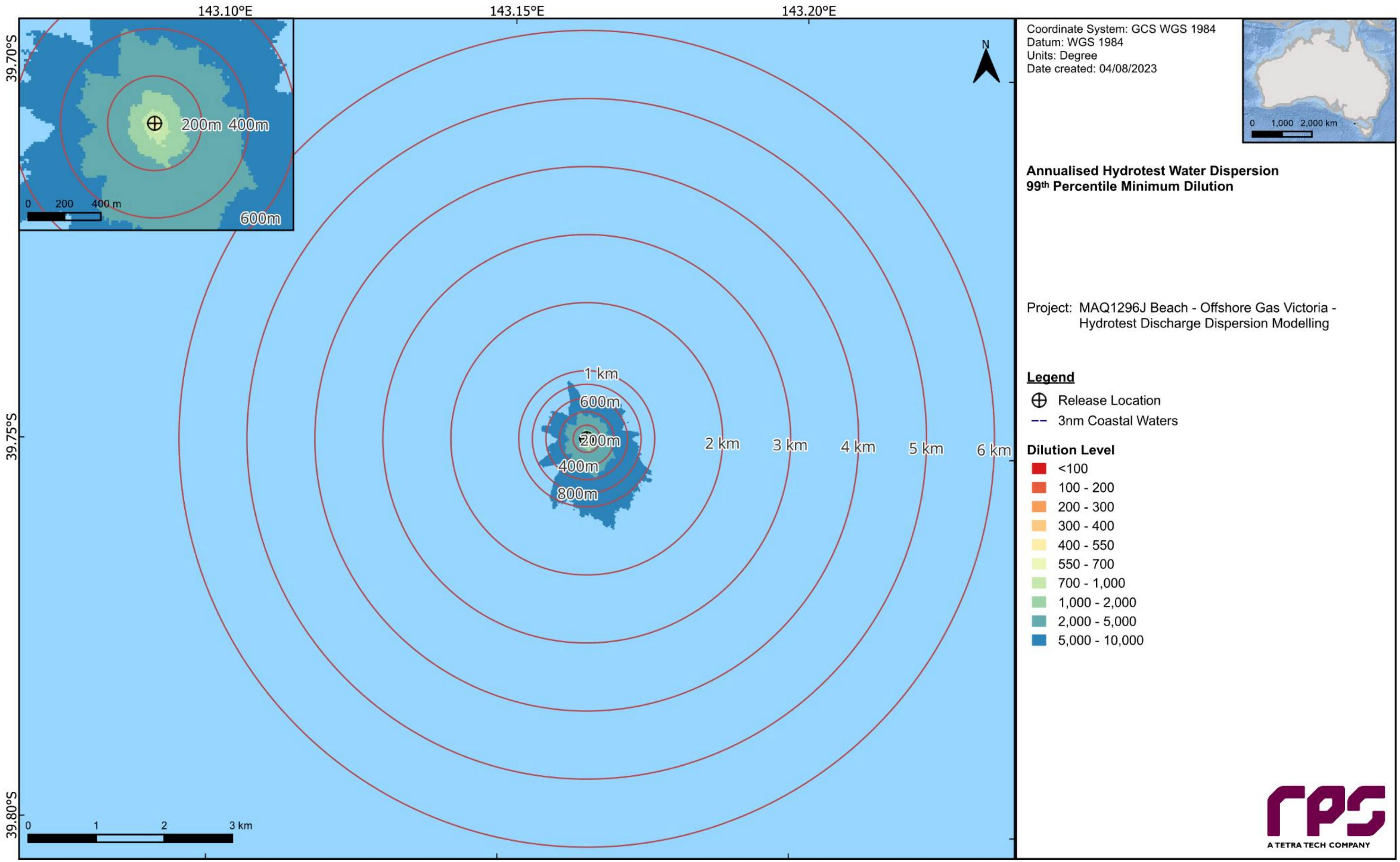


Figure 7-7 Predicted 99th percentile concentrations of the preservation chemical. The results were calculated from 100 simulations and presented as an annual assessment.

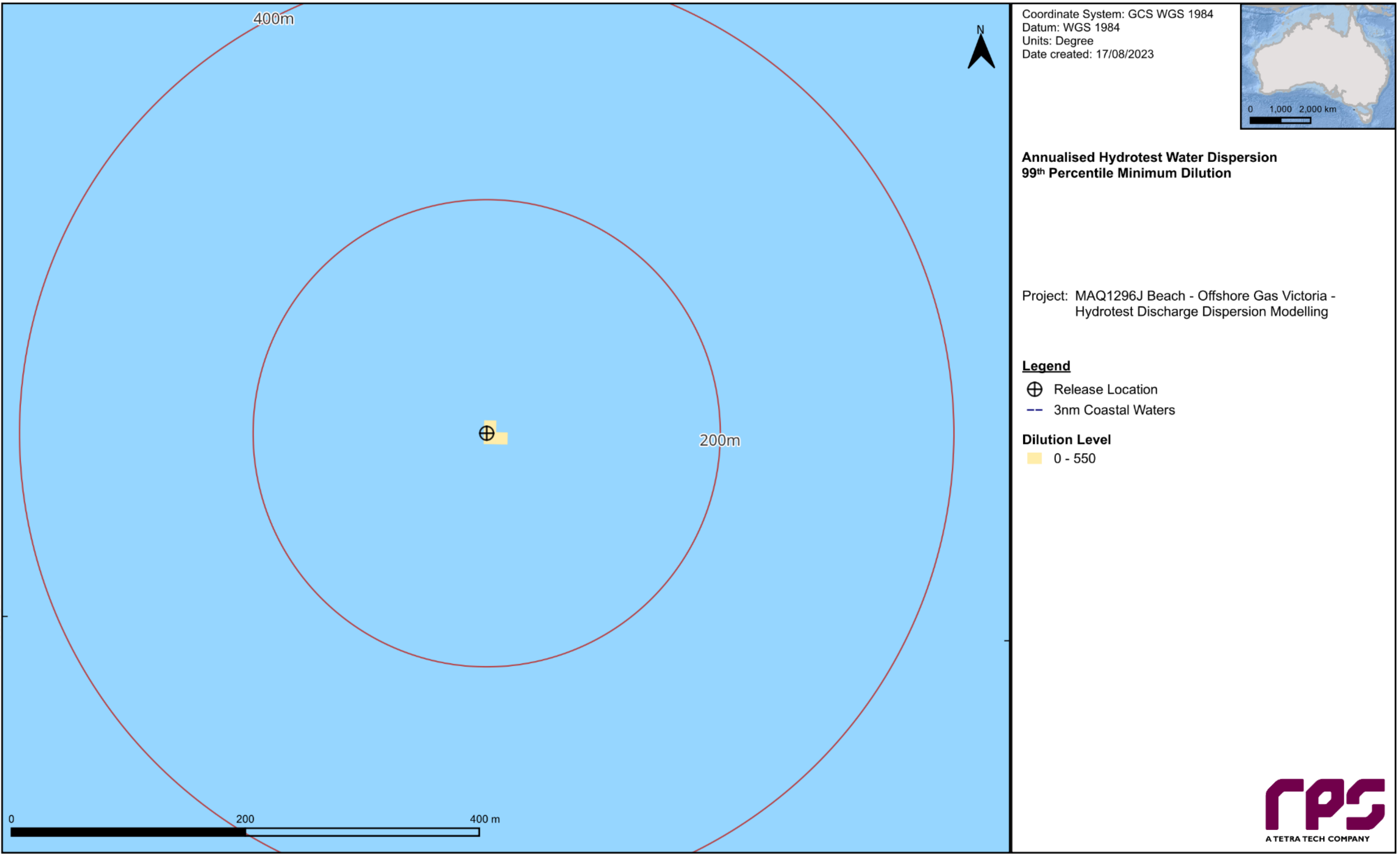


Figure 7-8 Predicted 99th percentile concentrations of the preservation chemical up until 550 dilutions (1 ppm). The results were calculated from 100 simulations and presented as an annual assessment.

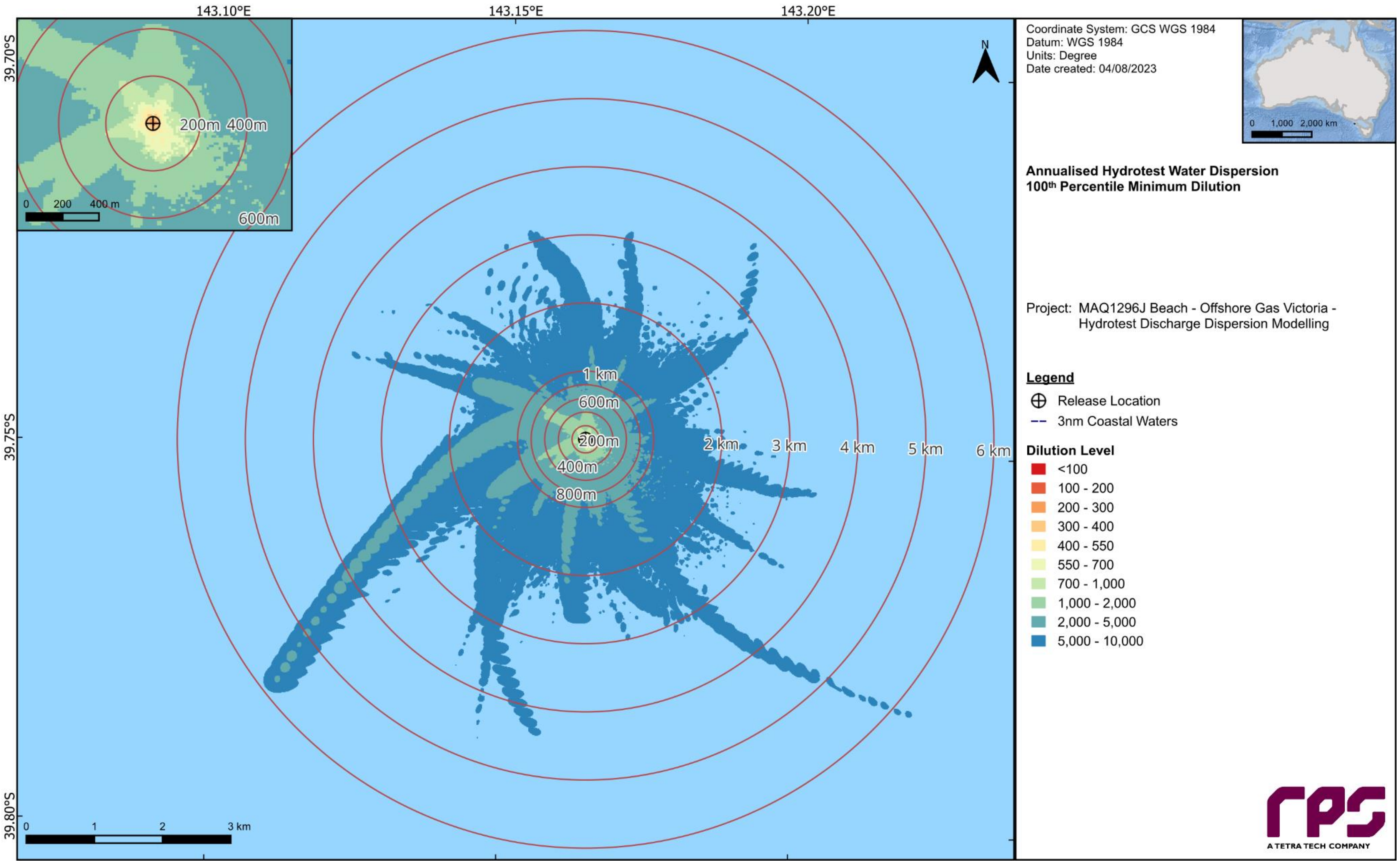


Figure 7-9 Predicted 100th percentile concentrations of the preservation chemical. The results were calculated from 100 simulations and presented as an annual assessment.

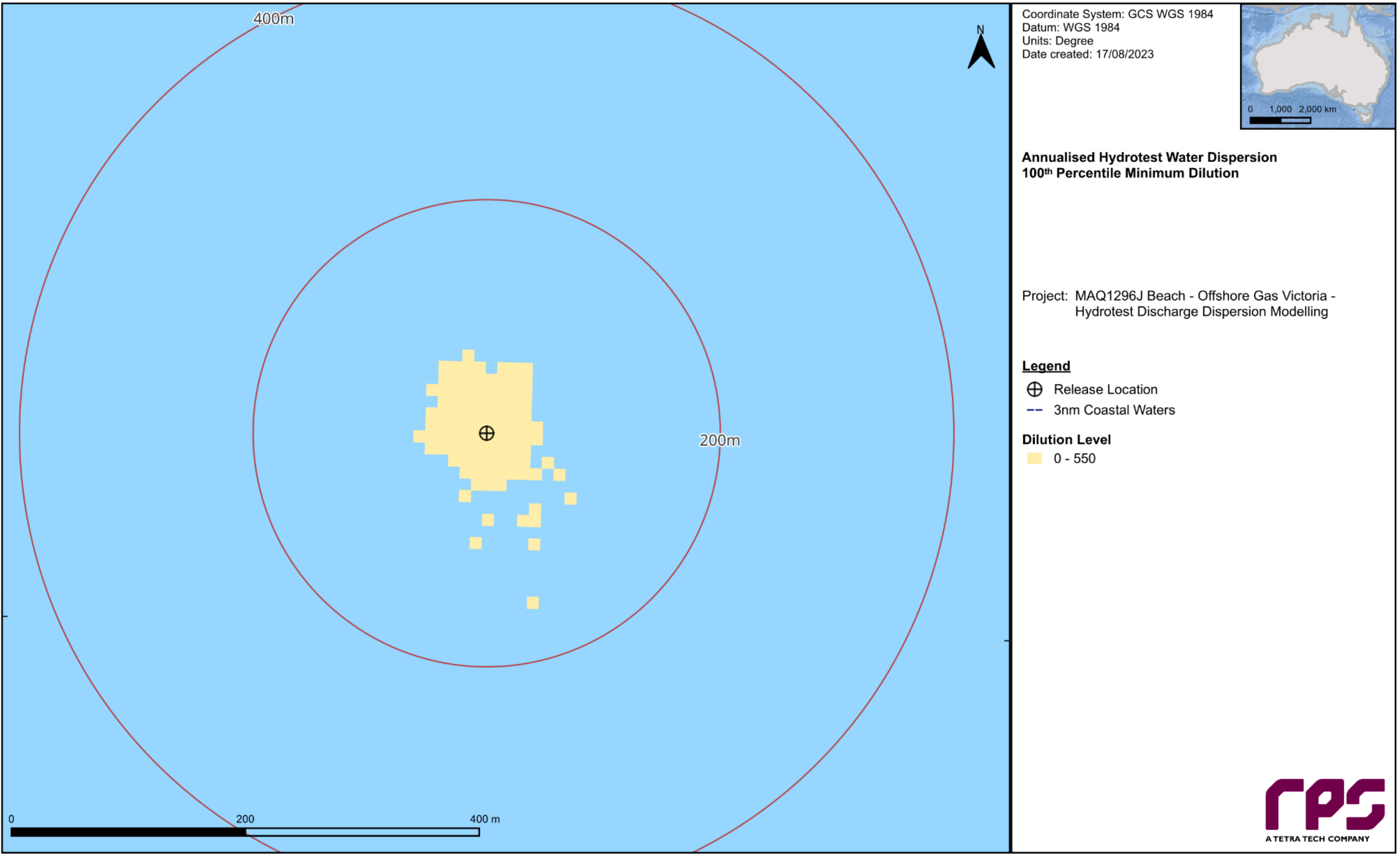


Figure 7-10 Predicted 100th percentile concentrations of the preservation chemical up until 550 dilutions (1 ppm). The results were calculated from 100 simulations and presented as an annual assessment

8 REFERENCES

Andersen, OB 1995, ‘Global ocean tides from ERS 1 and TOPEX/POSEIDON altimetry’. *Journal of Geophysical Research: Oceans*, vol. 100, no. C12, pp. 25249–25259.

Australian Maritime Safety Authority (AMSA) 2002, *National marine oil spill contingency plan*, Australian Maritime Safety Authority, Canberra, ACT, Australia.

Becker, JJ, Sandwell, DT, Smith, WHF, Braud, J, Binder, B, Depner, J, Fabre, D, Factor, J, Ingalls, S, Kim, S-H, Ladner, R, Marks, K, Nelson, S, Pharaoh, A, Trimmer, R, Von Rosenberg, J, Wallace, G, Weatherall, P 2009, ‘Global bathymetry and evaluation data at 30 arc seconds resolution: SRTM30_PLUS’, *Marine Geodesy*, vol. 32, no. 4, pp. 355–371.

Burns, K, Codi, S, Furnas, M, Heggie, D, Holdway, D, King, B & McAllister, F 1999, ‘Dispersion and fate of produced formation water constituents in an Australian Northwest Shelf shallow water ecosystem’, *Marine Pollution Bulletin*, vol. 38, pp. 593-603.

Champion Technologies 2013, ‘Hydrosure 0-3670R Safety Data Sheet’ https://safety365.sevron.co.uk/substances/accessSDS/SDS-5742-58d0d0dc9c5e59.78331216 (accessed 30 March 2023).

Chassignet, EP, Hurlburt, HE, Smedstad, OM, Halliwell, GR, Hogan, PJ, Wallcraft, AJ, Baraille, R, Bleck, R 2007, ‘The HYCOM (HYbrid Coordinate Ocean Model) data assimilative system’, *Journal of Marine Systems,* pp. 65, 60–83.

Chassignet, EP, Hurlburt, HE, Metzger, E, Smedstad, OM, Cummings, J & Halliwell, GR 2009, ‘U.S. GODAE: Global ocean prediction with the HYbrid Coordinate Ocean Model (HYCOM)’, *Oceanography*, vol. 22, no. 2, pp. 64-75.

Chevron Australia, 2015. Wheatstone Project Offshore Facilities and Produced Formation Water Discharge Management Plan: Stage 1 (Document No. WS0-0000-HES-PLN-CVX-000-00101–000). Chevron Australia Pty Ltd, Perth, Western Australia.

Davies, AM 1977a, ‘The numerical solutions of the three-dimensional hydrodynamic equations using a B-spline representation of the vertical current profile’. In: Nihoul, J.C. (ed). Bottom Turbulence: Proceedings of the 8th Liège Colloquium on Ocean Hydrodynamics, Elsevier Scientific, Amsterdam, pp. 1–25.

Davies, AM 1977b, ‘Three-dimensional model with depth-varying eddy viscosity’. In: Nihoul, J.C. (ed), Bottom Turbulence: Proceedings of the 8th Liège Colloquium on Ocean Hydrodynamics, Elsevier Scientific, Amsterdam, pp. 27–48.

Doneker, R & Jirka, G 1990, ‘Expert System for Hydrodynamic Mixing Zone Analysis of Conventional and Toxic Submerged Single Port Discharges (CORMIX1)’, EPA/600/3-90/012, U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, Georgia.

Gordon, R 1982, ‘Wind driven circulation in Narragansett Bay’, PhD thesis, University of Rhode Island, Kingston, RI, USA.

Isaji, T & Spaulding, M 1984, ‘A model of the tidally induced residual circulation in the Gulf of Maine and Georges Bank’. *Journal of Physical Oceanography*, vol. 14, no. 6, pp. 1119–1126.

Isaji, T, Howlett, E, Dalton C, Anderson, E 2001, ‘Stepwise-continuous-variable-rectangular grid hydrodynamics model’, Proceedings of the 24th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar (including 18th TSOCS and 3rd PHYTO). Environment Canada, Edmonton, pp. 597–610.

Jirka, GH, Doneker, RL, & Barnwell, TO, 1991, ‘CORMIX: an expert system for mixing zone analysis’, *Water Science and Technology*, vol. 24, no. 6, pp. 267–274.

Jones, ISF 1980, ‘Tidal and wind driven currents in Bass Strait’, *Australian Journal of Marine and Freshwater Research*, vol. 31, pp 109–117.

King, B & McAllister, FA 1997, ‘The application of MUDMAP to investigate the dilution and mixing of the above water discharge at the Harriet A petroleum platform on the Northwest Shelf’, in *Modelling the Dispersion of Produced Water Discharge in Australia*, Australian Institute of Marine Science, Canberra, ACT, Australia.

King, B & McAllister, FA 1998, ‘Modelling the dispersion of produced water discharges’, *APPEA Journal*, pp. 681–691.

Kostianoy, AG, Ginzburg, AI, Lebedev, SA, Frankignoulle, M, Delille, B 2003, ‘Fronts and mesoscale variability in the southern Indian Ocean as inferred from the TOPEX/POSEIDON and ERS-2 Altimetry data’, *Oceanology*, vol. 43, no. 5, pp. 632–642.

Levitus, S, Antonov, JI, Baranova, OK, Boyer, TP, Coleman, CL, Garcia, HE, Grodsky, AI, Johnson, DR, Locarnini, RA, Mishonov, AV, Reagan, JR, Sazama, CL, Seidov, D, Smolyar, I, Yarosh, ES & Zweng, MM 2013, ‘The world ocean database’, *Data Science Journal*, vol. 12, pp. WDS229-WDS234.

Ludicone, D, Santoleri, R, Marullo, S, Gerosa, P 1998, ‘Sea level variability and surface eddy statistics in the Mediterranean Sea from TOPEX/POSEIDON data’, *Journal of Geophysical Research*, vol. 103, no. C2, pp. 2995–3011.

Matsumoto, K, Takanezawa, T, Ooe, M 2000, ‘Ocean tide models developed by assimilating TOPEX/POSEIDON altimeter data into hydrodynamical model: A global model and a regional model around Japan’. *Journal of Oceanography*, vol. 56, no.5, pp. 567–581.

Middleton, JF & Bye AT 2007, ‘A review of shelf-slope circulation along Australia’s southern shelves: Cape Leeuwin to Portland, *Progress in Oceanography*, vol. 75: 1–41

Owen, A 1980, ‘A three-dimensional model of the Bristol Channel’, *Journal of Physical Oceanography*, vol. 10, no. 8, pp. 1290–1302.

Qiu, B & Chen, S 2010, ‘Eddy-mean flow interaction in the decadally modulating Kuroshio Extension system’, *Deep-Sea Research II*, vol. 57, no. 13, 1098–1110.

Sandery, P & Kämpf, J 2007, ‘Transport timescales for identifying seasonal variation in Bass Strait, south-eastern Australia’, *Estuarine, Coastal and Shelf Science*, vol. 74, pp 684–696.

Shell Australia Pty Ltd 2020, ‘Crux Project, Offshore Project Proposal, June 2020’, https://www.nopsema.gov.au/sites/default/files/documents/2021-03/A742335.pdf (accessed 29 March 2023).

Yaremchuk, M & Tangdong, Q 2004, ‘Seasonal variability of the large-scale currents near the coast of the Philippines’, *Journal of Physical Oceanography*, vol. 34, no., 4, pp. 844–855.

Zigic, S, Zapata, M, Isaji,T, King, B, Lemckert, C 2003, ‘Modelling of Moreton Bay using an ocean/coastal circulation model’, Proceedings of the 16th Australasian Coastal and Ocean Engineering Conference, the 9th Australasian Port and Harbour Conference and the Annual New Zealand Coastal Society Conference, Institution of Engineers Australia, Auckland, paper 170.

Appendix M Oil Spill Modelling Report

OFFSHORE GAS VICTORIA

Oil Spill Modelling

GOC365512
17 October 2024

rpsgroup.com

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
Rev A	Internal draft	N. Benfer L. Perez	R. Dunn	N. Benfer	28 August 2024
Rev 0	Draft issued to client		R. Dunn	N. Benfer	29 August 2024
Rev 1	Issued to client			N. Benfer	17 October 2024

Approval for issue

Nathan Benfer	Natth	17 October 2024

Prepared by:

RPS

Nathan Benfer
Principal Consultant

Lakehouse Corporate Space, Suite 425
Level 2, 34-38 Glenferrie Drive
Robina, QLD, 4226

T +61 7 5553 6900
E Nathan.Benfer@rpsgroup.com

Prepared for:

Beach Energy Ltd.

Tim Flowers
Head of Environment

80 Flinders Street,
Adelaide, SA, 5001

T +61 8 8433 2416
E Tim.Flowers@beachenergy.com.au

Contents

Tables

Figures

TERMS AND ABBREVIATIONS

AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
API	American Petroleum Institute gravity. A measure of how heavy or light a petroleum liquid is compared to water.
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BIA	Biologically Important Areas
Bonn Agreement	An agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances, 1983, includes: Governments of the Kingdom of Belgium, the Kingdom of Denmark, the French Republic, the Federal Republic of Germany, the Republic of Ireland, the Kingdom of the Netherlands, the Kingdom of Norway, the Kingdom of Sweden, the United Kingdom of Great Britain and Northern Ireland and the European Union.
BP	Boiling point. The temperature at which the vapor pressure of the liquid is equal to the pressure exerted on it by the surrounding atmosphere
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
Decay	The process where oil components are changed either chemically or biologically (biodegradation) to another compound. It includes breakdown to simpler organic carbon compounds by bacteria and other organisms, photo-oxidation by solar energy, and other chemical reactions.
Deterministic (single) oil spill modelling	Oil spill modelling involving a computer simulation of a single hypothetical oil spill event subject to a single sequence of wind, current and other sea conditions over time. Single oil spill modelling, also referred to as “deterministic modelling” provides a simulation of one possible outcome of a given spill scenario, subject to the metocean conditions that are imposed. Single oil spill modelling is commonly used to consider the fate and effects of ‘worst-case’ oil spill scenarios that are carefully selected in consideration of the nature and scale of the offshore petroleum activity and the local environment (NOPSEMA, 2017). Because the outcomes of a single oil spill simulation can only represent the outcome of that scenario under one sequence of metocean conditions, worst-case conditions are often identified from stochastic modelling. It is impossible to calculate the likelihood of any outcome from a single oil spill simulation. Single oil spill modelling is generally used for response planning, preparedness planning and for supporting oil spill response operations in the event of an actual spill
Dynamic viscosity	The dynamic viscosity of a fluid expresses its resistance to shearing flows, where adjacent layers move parallel to each other with different speeds.
Floating oil exposure	Contact by floating oil on the sea surface at concentrations equal to or exceeding defined threshold concentrations. The consequence will vary depending on the threshold and the receptors
HYCOM	Hybrid Coordinate Ocean Model. A data-assimilative, three-dimensional ocean model
HYDROMAP	Advanced ocean/coastal tidal model used to predict tidal water levels, current speed and current direction.
IMCRA	Integrated marine and coastal regionalisation areas
KEF	Key Ecological Feature
LGA	Local Government Areas
MAHs	Monoaromatic Hydrocarbons
MNP	Marine National Park
MP	Marine Park
MS	Marine Sanctuary
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NP	National Park

NR	Nature Reserve
PAH	Polynuclear Aromatic Hydrocarbons
Pour Point	The pour point of a liquid is the temperature below which the liquid loses its flow characteristics
Ramsar site	A site listed under the Ramsar Convention on wetlands which is an international intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources.
RSB	Reefs, Shoals and Banks
Shoreline accumulation	Arrival of oil at or near shorelines at on-water concentrations equal to or exceeding defined threshold concentrations. Shoreline contact is judged for floating oil arriving within a 2 km buffer zone from any shoreline as a conservative measure
SIMAP	Spill Impact Model Application Package. SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for surface or subsea releases
Stochastic (multiple) oil spill modelling	Stochastic oil spill modelling is created by overlaying and statistically analysing the outcomes of many single oil-spill simulations of a defined spill scenario, where each simulation was subject to a different sequence of metocean conditions, selected objectively (typically by random selection) from a long sequence of historic conditions for the study area. Analysis of this larger set of simulations provides a more accurate indication of the environment that maybe affected (EMBA) and indicates which locations are more likely to be affected (as well as other statistics). Stochastic oil spill modelling avoids biases that affect single oil spill modelling (due to the reliance on only one possible sequence of conditions). However, when interpreting stochastic modelling, which is based on a wide range of potential conditions that might happen to occur, it is essential to understand that calculations will encompass a much larger area than could be affected in any single spill event, where a more limited set of conditions will occur. Consequently, it is misleading to imply that the region derived from stochastic modelling indicate the outcomes expected from a single spill event (NOPSEMA, 2017) Stochastic modelling is generally used for risk assessment and preparedness planning by indicating locations that could be exposed and may require response or subsequent impact assessment
Sub-LGA	Sub-Local Government Areas
Shoreline accumulation	Arrival of oil at or near shorelines at on-water concentrations equal to or exceeding defined threshold concentrations.

EXECUTIVE SUMMARY

Background

To support the Offshore Gas Victoria EP, Beach commissioned a detailed oil spill modelling study assessing the following hypothetical scenarios:

- A 434,752 stb [69,118 m^3] subsea release of condensate over 86 days from a loss of well control at the Northern Release Location;
- A 603.7 m^3 surface release of marine diesel over 6 hours from a loss of containment from vessel collision at the Northern Release Locatio;
- A 102,576 stb [16,308 m^3] subsea release of condensate over 86 days from a loss of well control at the TW1; and
- A 603.7 m^3 surface release of marine diesel over 6 hours from a loss of containment from vessel collision at the TW1.

The modelling assessment was undertaken on a seasonal basis as follows:

- Summer (November through to March); and
- Winter (April to October)

The purpose of the modelling is to provide an understanding of a conservative ‘outer envelope’ of the potential area that may be affected in the unlikely event of hydrocarbon spill. The modelling does not take into consideration any of the spill prevention, mitigation and response strategies that would be implemented in response to a spill. Therefore, the modelling results represent the maximum extent that the released hydrocarbon may influence.

The spill modelling was performed using an advanced three-dimensional trajectory and fates model; Spill Impact Model Application Program (SIMAP). The SIMAP model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties.

Methodology

The modelling study was carried out in several stages. Firstly, a 10-year wind and current dataset (2010–2019) was generated and the currents included the combined influence of three-dimensional large-scale ocean currents and tidal currents. Secondly, the currents, winds and detailed hydrocarbon characteristics were used as inputs in the three-dimensional oil spill model (SIMAP) to simulate the drift, spread, weathering and fate of the spilled hydrocarbons.

As spills can occur during any set of wind and current conditions, modelling was conducted using a stochastic (random or non-deterministic) approach, which involved running 100 randomly selected single trajectory simulations per season, with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start times. This ensured that each spill simulation was subject to a unique set of wind and current conditions.

The SIMAP system, the methods and analysis presented herein, use modelling algorithms which have been anonymously peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the ASTM Standard F2067-13 “*Standard Practice for Development and Use of Oil Spill Models*”.

Oil Properties

Thylacine condensate has an API of 44.3 and a density of 804.6 kg/m^3 (at 15ºC) with a viscosity value (0.87.0 cP) classifying it as a Group I (not-persistent) oil according to the International Tankers Owners Pollution Federation (ITOPF, 2020) and US EPA/USCG classifications.

The condensate is a mixture of volatile and persistent hydrocarbons with high proportions of volatile and semi- to low-volatile components. In favourable evaporation conditions, 64.0% of the oil mass should evaporate within the first 12 hours (BP < 180°C), a further 19.0% is expected to evaporate within the first 24 hours (180°C < BP < 265°C) and a further 16.0% should evaporate over several days (265°C < BP < 380°C). Approximately 1.0% of the condensate is shown to be persistent.

Marine diesel (MDO) has an API of 37.6 and a density of 829.1 kg/m^3 (at 25ºC) with a viscosity value (4.0 cP) classifying it as a Group II (light-persistent) oil according to the International Tankers Owners Pollution Federation (ITOPF, 2014) and US EPA/USCG classifications.

The MDO is a mixture of volatile and persistent hydrocarbons with high proportions of volatile and semi- to low-volatile components. In favourable evaporation conditions, about 6.0% of the oil mass should evaporate within the first 12 hours (BP < 180°C); a further 34.6% should evaporate within the first 24 hours (180°C < BP < 265°C); and a further 54.4% should evaporate over several days (265°C < BP < 380°C). Approximately 5.0% of the oil is shown to be persistent.

Results

Scenario 1: 86-day Loss of Well Control at the Northern Release Location

- The maximum distances from the release location to the low (1–10 g/m^2) and moderate (10–50 g/m^2) exposure zones were 54.03 km (east) and 5.83 km (east-southeast), both during winter conditions. No contact was predicted for the high threshold (> 50 g/m^2).
- Outside of the receptors that the Northern Release Location resides within, floating oil exposure above the low threshold was predicted at the Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait), being 6% and 9% during summer and winter respectively.
- The probability of accumulation to any shoreline at, or above, the low level (10 g/m^2) threshold was 99% during summer conditions and 96% during winter conditions.
- The maximum volume ashore for a single spill trajectory during the summer and winter conditions was 67.91 m^3 and 87.54 m^3, respectively, whilst the maximum length of shoreline accumulation at the low threshold was 104.17 km and 114.39 km, respectively.
- Outside of the receptors that the Northern Release Location resides within, the highest concentration of dissolved hydrocarbon was predicted for Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area) BIA and Corangamite (VIC) NRMR (summer – 570.15 ppb, winter – 1,332.51 ppb).
- Outside of the receptors that the Northern Release Location resides within, the highest concentration of entrained hydrocarbon was predicted for Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area) (summer – 358.93 ppb, winter – 527.26 ppb).

Scenario 2: Loss of Marine Diesel Containment at the Northern Release Location

- The maximum distance from the release location to the low (1–10 g/m^2), moderate (10–50 g/m^2) and high (> 50 g/m^2) exposure zones was 32.65 km (east-southeast), 19.85 km (southeast) and 10.53 km (southeast) all during winter conditions.
- The maximum volume ashore for a single spill trajectory during the summer and winter conditions was 30.86 m^3 and 58.33 m^3, respectively, whilst the maximum length of shoreline accumulation at the low threshold was 29.23 km and 43.19 km, respectively.
- Only the receptors that the Northern Release Location resides within were contacted by dissolved hydrocarbon at the low threshold. The maximum dissolved hydrocarbon concentration was 101.35 ppb and 65.67 ppb during summer and winter respectively.

- Outside of the receptors that the Northern Release Location resides within, the highest concentration of entrained hydrocarbon was predicted for Short-tailed Shearwater - Foraging BIA (summer – 745.77 ppb, winter – 1,391.43 ppb), which also presented the highest probability of low entrained hydrocarbon exposure (summer – 60%, winter – 97%).

Scenario 3: 86-day Loss of Well Control at TW1

- The maximum distance from the release location to the low (1–10 g/m^2) exposure zone was 24.49 km (southeast) during summer conditions and 18.35 km (south) during winter conditions, respectively. No contact was predicted for the moderate (10–50 g/m^2) or high (> 50 g/m^2) thresholds.

- Outside of the receptors that the Northern Release Location resides within, the highest probability of floating oil exposure above the low threshold was predicted at the Pygmy Blue Whale – Foraging BIA (28% summer, 25% winter).

- The probability of accumulation to any shoreline at, or above, the low level (10 g/m^2) threshold was 32% during summer conditions and 57% during winter conditions.

- The maximum volume ashore for a single spill trajectory during the summer and winter conditions was 6.15 m^3 and 8.36 m^3, respectively, whilst the maximum length of shoreline accumulation at the low threshold was 12.62 km and 13.90 km, respectively.

- Outside of the receptors that the Northern Release Location resides within, the highest concentration of dissolved hydrocarbon was 553.15 ppb during summer and 528.54 ppb during winter.
- Outside of the receptors that the Northern Release Location resides within, the highest concentration of entrained hydrocarbon was predicted for White Shark – Distribution (Between 120 – 1,000 m depth contour) (summer – 338.67 ppb, winter – 328.89 ppb).

Scenario 4: Loss of Marine Diesel Containment at TW1

- The maximum distance from the release location to the low (1–10 g/m^2), moderate (10–50 g/m^2) and high (> 50 g/m^2) exposure zones was 64.97 km (southeast), 49 km (southeast) and 10.08 km (south-southeast) all during winter.

- No shoreline contact was forecast during summer conditions. The probability of accumulation to any shoreline at, or above, the low level (10 g/m^2) threshold was 9% during winter conditions.

- The maximum volume ashore for a single spill trajectory was 9.67 m^3, whilst the maximum length of shoreline accumulation at the low threshold was 17.67 km.

- Outside of the receptors that the Northern Release Location resides within, the highest concentration of dissolved hydrocarbon was predicted for the White Shark - Distribution (Between the 120 - 1,000m depth contour) BIA, being 23.94 ppb in summer and 23.23 ppb in winter.

- Outside of the receptors that the Northern Release Location resides within (refer to Table 12-1), the highest concentration of entrained hydrocarbon was predicted for Short-tailed Shearwater - Foraging BIA (summer – 6,692.22 ppb, winter – 6,075.03 ppb).

1 INTRODUCTION

1.1 Background

To support the Offshore Gas Victoria EP, Beach commissioned a detailed oil spill modelling study assessing the following hypothetical scenarios:

- A 434,752 stb [69,118 m^3] subsea release of condensate over 86 days from a loss of well control at the Northern Release Location;
- A 603.7 m^3 surface release of marine diesel over 6 hours from a loss of containment from vessel collision at the Northern Release Location;
- A 102,576 stb [16,308 m^3] subsea release of condensate over 86 days from a loss of well control at the TW1; and
- A 603.7 m^3 surface release of marine diesel over 6 hours from a loss of containment from vessel collision at the TW1.

The modelling assessment was undertaken on a seasonal basis as follows:

- Summer (November through to March); and
- Winter (April to October)

The purpose of the modelling is to provide an understanding of a conservative 'outer envelope' of the potential area that may be affected in the unlikely event of hydrocarbon spill. The modelling does not take into consideration any of the spill prevention, mitigation and response strategies that would be implemented in response to a spill. Therefore, the modelling results represent the maximum extent that the released hydrocarbon may influence.

The spill modelling was performed using an advanced three-dimensional trajectory and fates model; Spill Impact Model Application Program (SIMAP). The SIMAP model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties.

Table 1-1 Location of assessed release site.

Well	Latitude	Longitude	Water Depth (m)
Northern Release Location	38.8552° S	142.8381° E	71.5
TW1	39.2223° S	142.8386° E	105

GCS: WGS84

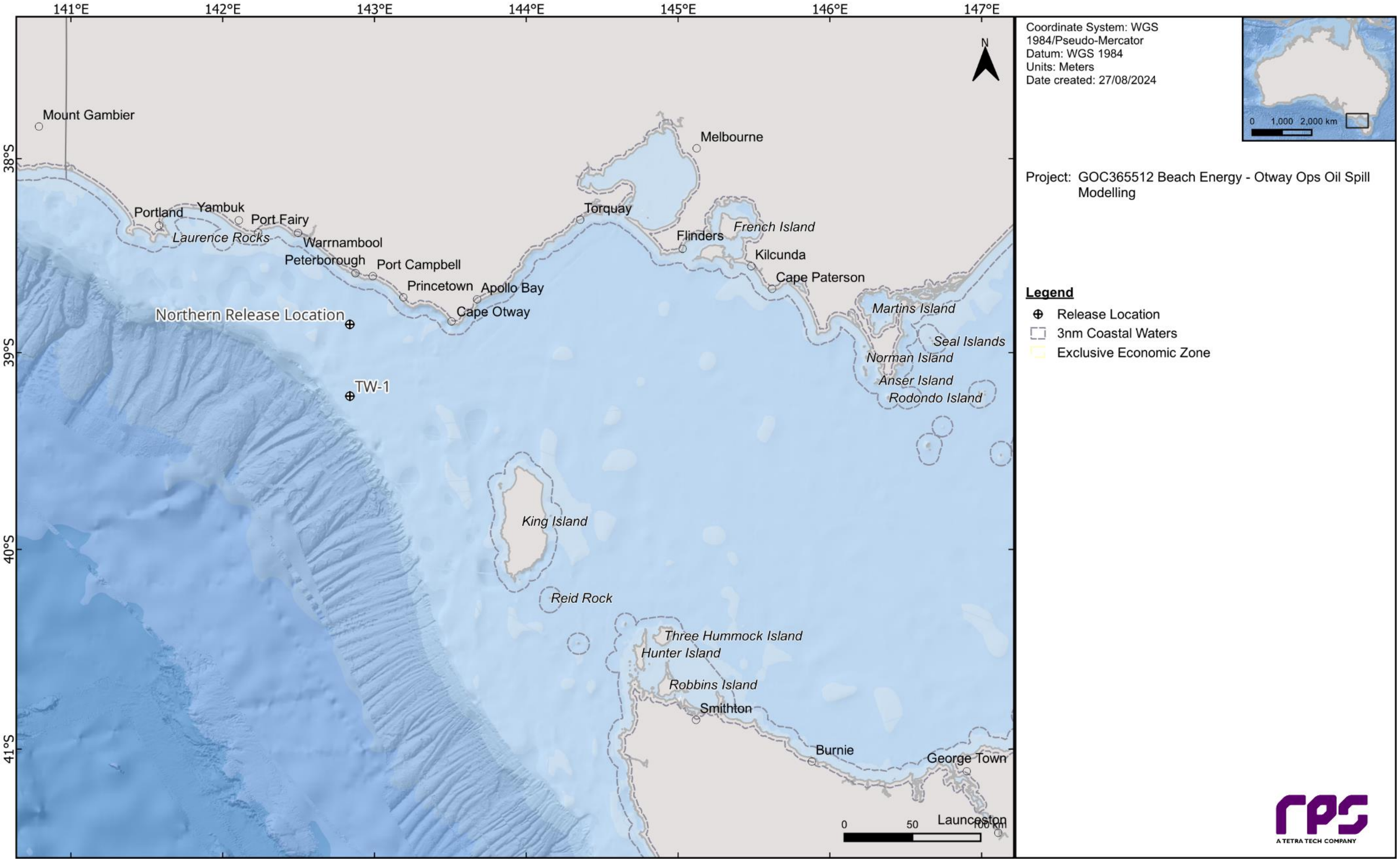


Figure 1-1 Map of the assessed release location.

1.2 What is Oil Spill Modelling?

Oil spill modelling is a valuable tool widely used for risk assessment, emergency response and contingency planning where it can be particularly helpful to proponents and decision makers. By modelling a series of the most likely oil spill scenarios, decisions concerning suitable response measures and strategic locations for deploying equipment and materials can be made, and the locations at most risk can be identified. The two types of oil spill modelling often used are stochastic (Section 1.2.1) and deterministic (Section 1.2.2) modelling.

1.2.1 Stochastic Modelling (Multiple Spill Simulations)

Stochastic oil spill modelling is created by overlaying a great number (often hundreds) of individual, computer-simulated hypothetical spills (NOPSEMA, 2018; Figure 1.2).

Stochastic modelling is a common means of assessing the potential risks from oil spills related to new projects and facilities. Stochastic modelling typically utilises hydrodynamic data for the location in combination with historic wind data. Typically, 100 iterations of the model will be run utilising the data that is most relevant to the season or timing of the project.

The outcomes are often presented as a probability of exposure and is primarily used for risk assessment purposes in view to understand the range of environments that may be affected or impacted by a spill. Elements of the stochastic modelling can also be used in oil spill preparedness and planning.

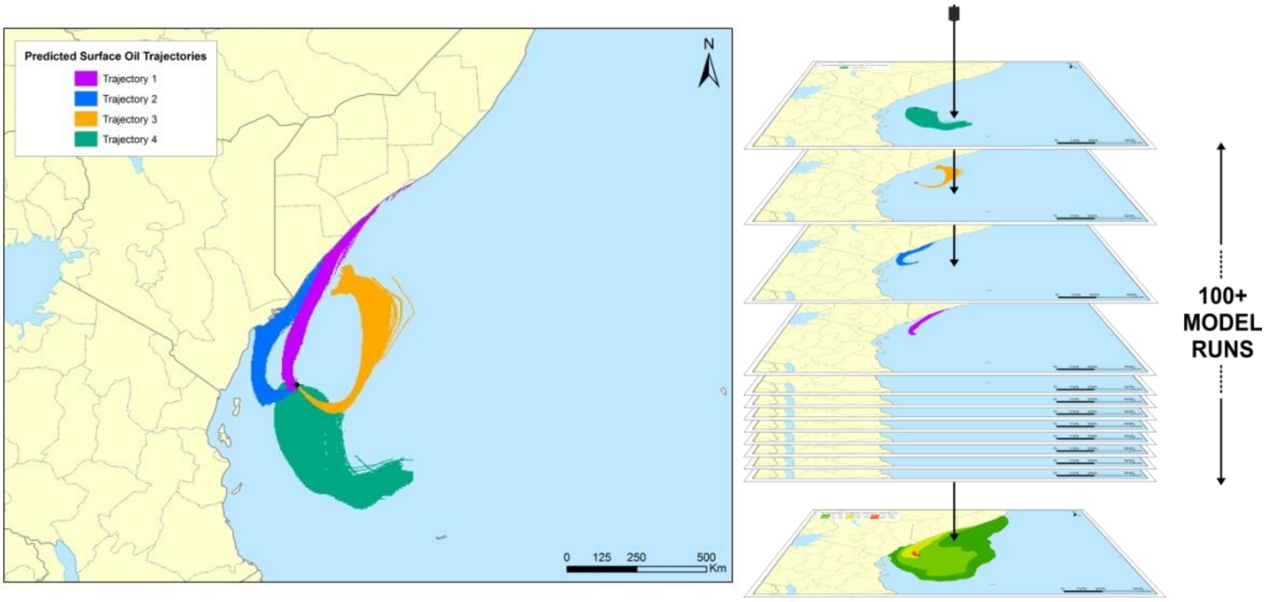


Figure 1-2 Examples of four individual spill trajectories (four replicate simulations) predicted by SIMAP for a spill scenario. The frequency of contact with given locations is used to calculate the probability of impacts during a spill. Essentially, all model runs are overlain (shown as the stacked runs on the right) and the number of times that trajectories contact a given location at a concentration is used to calculate the probability.

1.2.2 Deterministic Modelling (Single Spill Simulation)

Deterministic modelling is the predictive modelling of a single incident subject to a single sample of wind and weather conditions over time (NOPSEMA, 2018; Figure 1-3).

Deterministic modelling is often paired with stochastic modelling to place the large stochastic footprint into perspective. This deterministic analysis is generally a single run selected from the stochastic analysis and serves as the basis for developing the plans and equipment needs for a realistic spill response. Deterministic spills can be selected on several basis such as minimum time to shoreline, largest swept area, maximum volume ashore, longest length of shoreline contacted by oil or largest area of entrained or dissolved hydrocarbons.

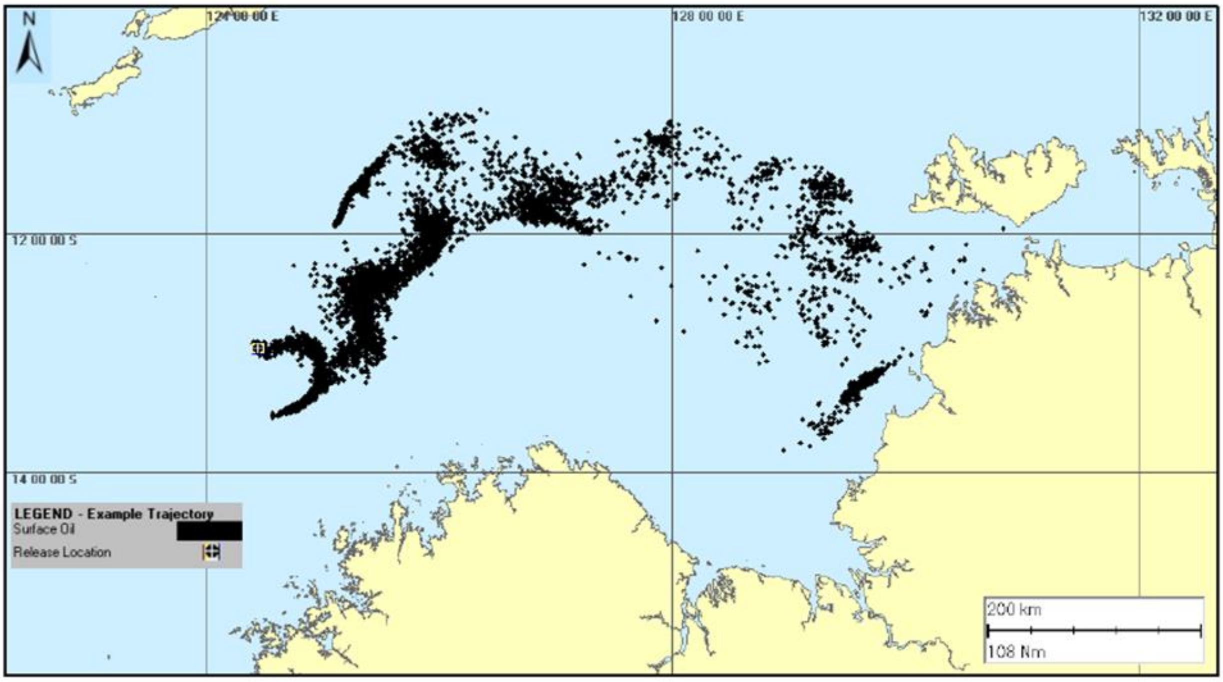


Figure 1-3 Example of an individual spill trajectory predicted by SIMAP for a spill scenario. Note, this image represents surface oil as spillets and do not take any thresholds into consideration.

2 SCOPE OF WORK

The scope of work included the following components:

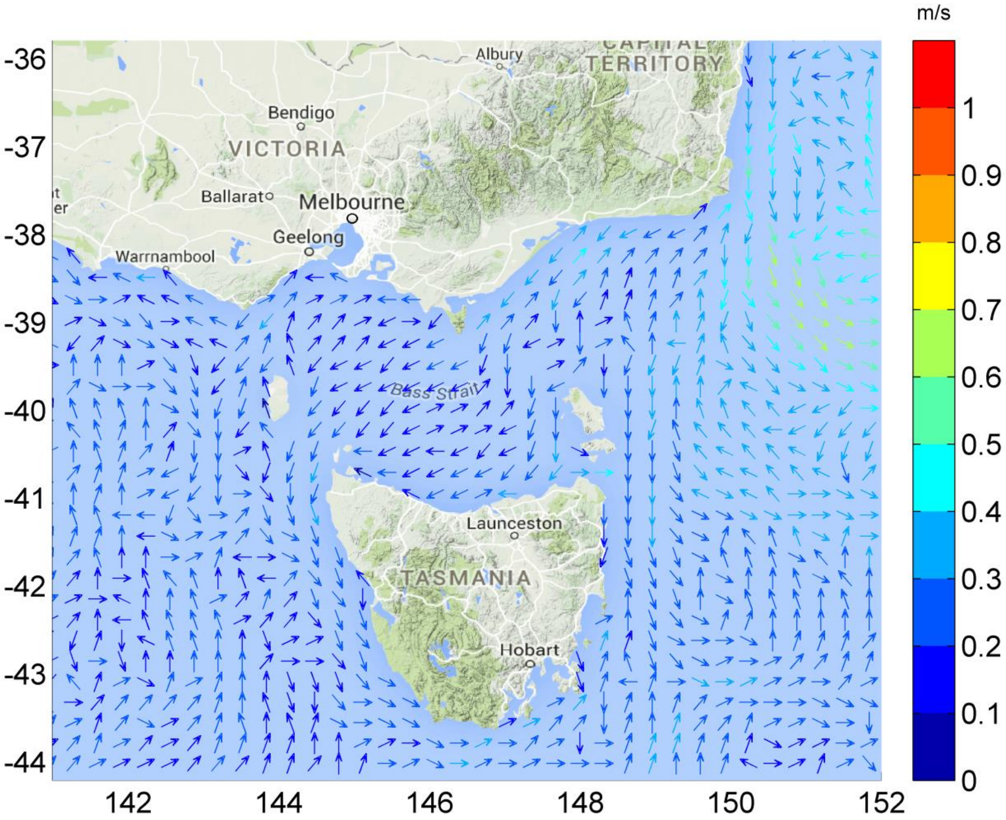
- Generate 10-years of winds and three-dimensional currents from 2010 to 2019 (inclusive). The currents included the combined influence of tidal and ocean currents.
- Include the wind and current data and characteristics of the released hydrocarbons as input into the three-dimensional oil spill model (SIMAP), to model the movement, spreading, weathering and shoreline contact by hydrocarbons over time.
- Use SIMAP's stochastic model (also known as a probability model) to calculate exposure to surrounding waters and shorelines. This involved running 100 randomly selected single trajectory simulations per season, with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start times. This ensured that each spill simulation was subject to a unique set of wind and current conditions.
- Results were assessed to determine the exposure to surrounding waters and contact to shorelines based upon the NOPSEMA thresholds.

3 REGIONAL CURRENTS

Bass Strait is a body of water separating Tasmania from the southern Australian mainland, specifically the state of Victoria. The strait is a relatively shallow area of the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. Currents within the straight are primarily driven by tides, winds, incident continental shelf waves and density driven flows; high winds and strong tidal currents are frequent within the area (Jones, 1980).

The varied geography and bathymetry of the region, in addition to the forcing of the south-eastern Indian Ocean and local meteorology lead to complex shelf and slope circulation patterns (Middleton & Bye, 2007). Figure 3-1 displays seasonal current trends within the Bass Strait. During winter there is a strong eastward water flow due to the strengthening of the South Australian Current (fed by the Leeuwin Current in the Northwest Shelf), which bifurcates with one extension moving though the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery & Kämpf, 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward, as the coastal current develops due to south-easterly winds.

To accurately describe the variability in currents between the inshore and offshore region, a hybrid regional dataset was developed by combining deep ocean predictions obtained from HYCOM (Hybrid Coordinate Ocean Model) with surface tidal currents developed by RPS. The following sections provide a summary of the hybrid regional dataset.



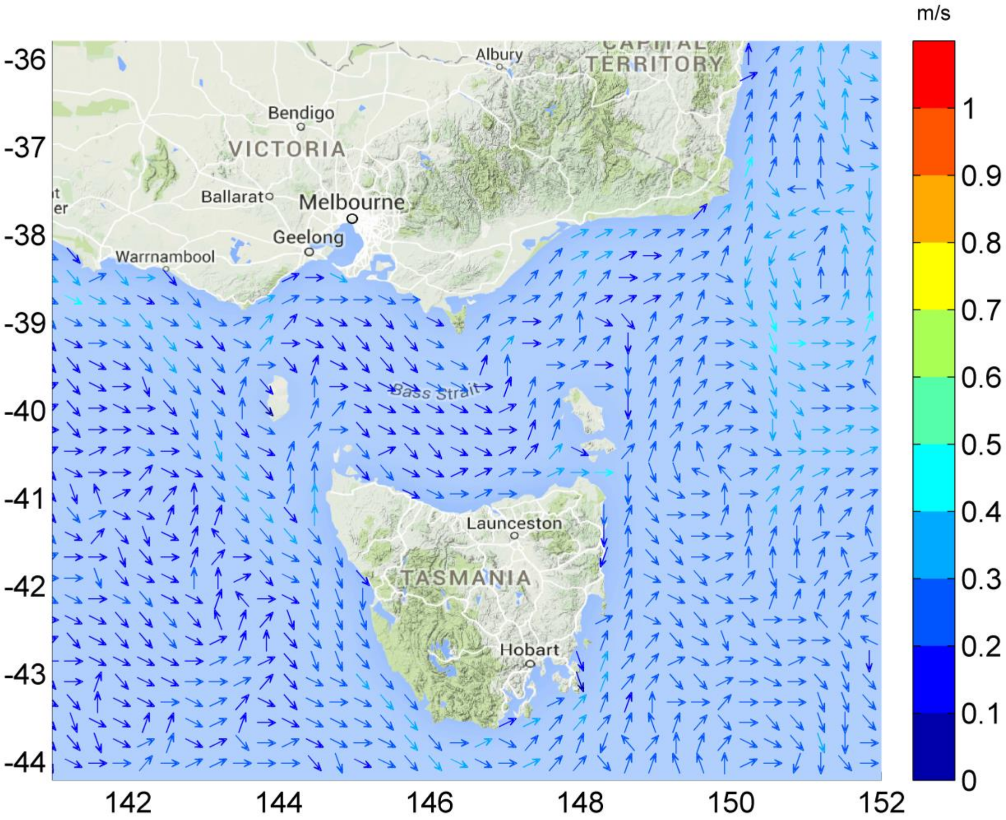


Figure 3-1 HYCOM averaged seasonal surface drift currents during summer (upper image) and winter (lower image).

3.1 Tidal Current Model

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world for more than 30 years (Isaji & Spaulding, 1984; Isaji, et al., 2001; Zigic, et al., 2003). HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

HYDROMAP employs a sophisticated sub-gridding strategy, which supports up to six levels of spatial resolution, halving the grid cell size as each level of resolution is employed. The sub-gridding allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, and/or of interest to a study.

The numerical solution methodology follows that of Davies (1977a and 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Isaji et al. (2001).

3.1.1 Grid Setup

The tidal model domain is sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids are progressively allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 3-2 shows the tidal model grid covering the study domain.

A combination of datasets was used and merged to describe the shape of the seabed within the grid domain (Figure 3-3). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

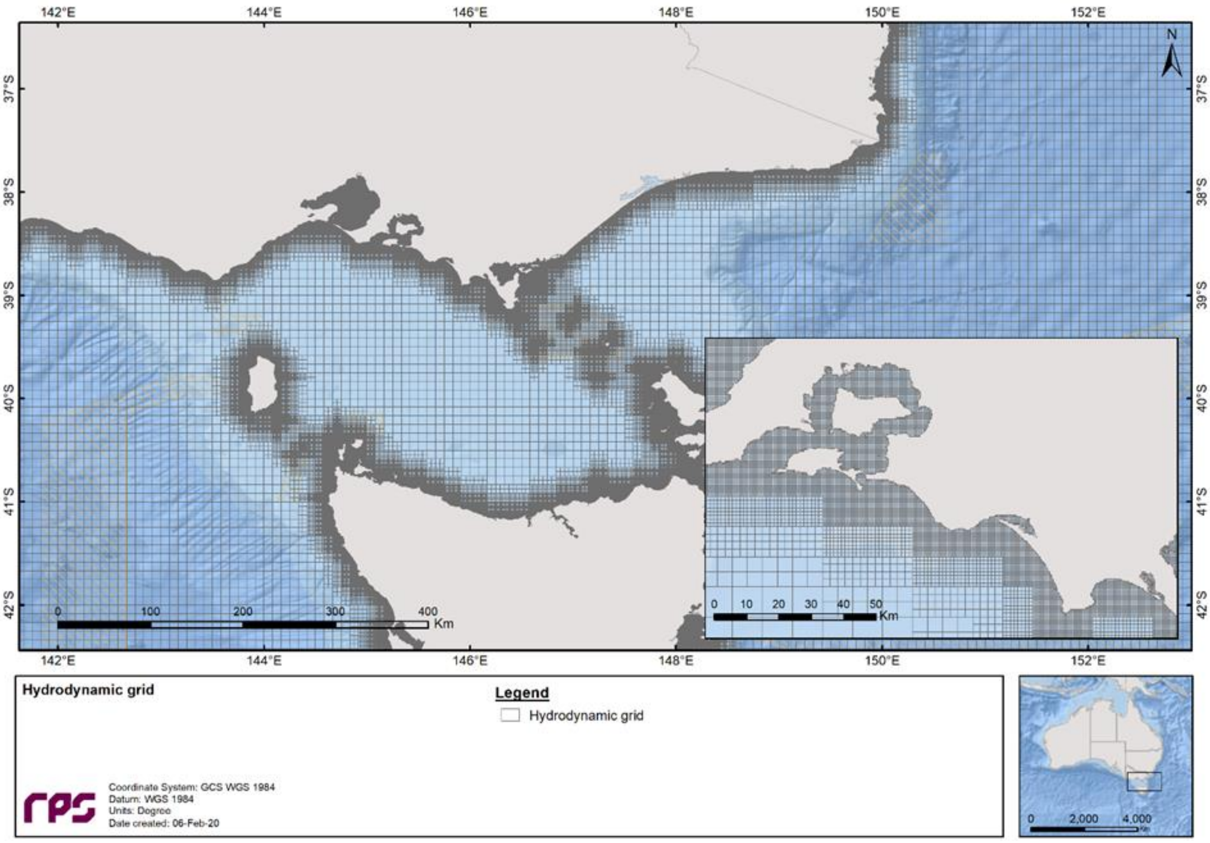


Figure 3-2 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

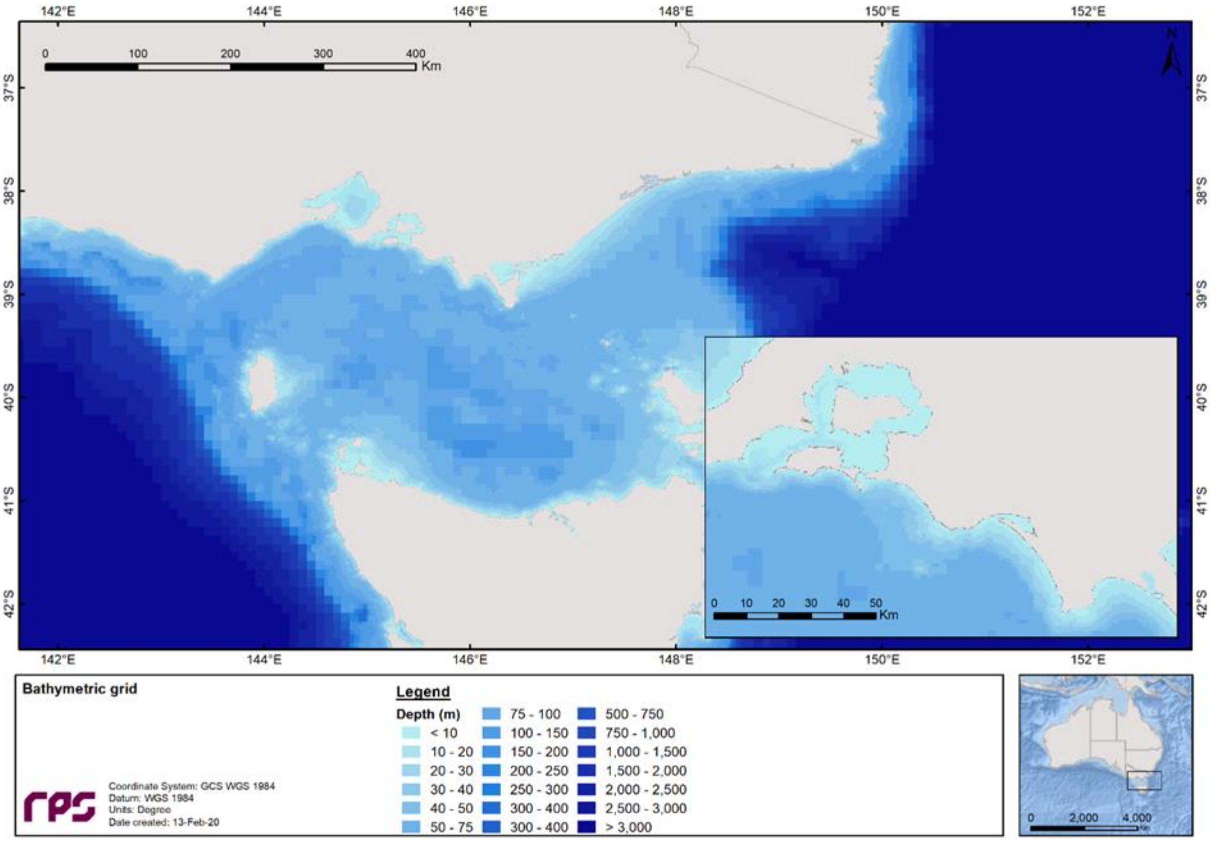


Figure 3-3 Bathymetry defined throughout the tidal model domain.

3.1.2 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 8.0) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were K_2, S_2, M_2, N_2, K_1, P_1, O_1 and Q_1. Using the tidal data, time series surface heights were calculated along the open boundaries for the simulation period.

The Topex/Poseidon satellite data has a resolution of 0.25 degrees globally, with higher resolution in coastal regions, and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The data capturing satellites, equipped with two altimeters capable of taking sea level measurements accurate to less than ± 5 cm, measured oceanic surface elevations (and the resultant tides) for the period 1992–2005. In total these satellites carried out 62,000 orbits of the planet. The Topex/Poseidon tidal data has been widely used amongst the oceanographic community, being referenced in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk & Tangdong, 2004; Qiu & Chen 2010). The Topex/Poseidon tidal data is considered suitably accurate for this study.

3.1.3 Surface Elevation Validation

To ensure that tidal predictions were accurate, predicted surface elevations were compared to data observed at a location situated within the study area (Figure 3-4).

To provide a statistical measure of the model performance, the Index of Agreement (IOA – Willmott, 1981) and the Mean Absolute Error (MAE – Willmott, 1982; Willmott & Matsuura, 2005) were used.

The MAE (Eq.1) is simply the average of the absolute values of the difference between the model-predicted (P) and observed (O) variables. It is a more natural measure of the average error (Willmott and Matsuura, 2005) and more readily understood. The MAE is determined by:

$$MAE = N^{-1} \sum_{i=1}^{N} |P_i - O_i| \qquad \text{Eq.1}$$

Where: N = Number of observations

P_i = Model predicted surface elevation

O_i = Observed surface elevation

The Index of Agreement (IOA; Eq. 2) in contrast, gives a non-dimensional measure of model accuracy or performance. A perfect agreement between the model predicted and observed surface elevations exists if the index gives an agreement value of 1, and complete disagreement between model and observed surface elevations will produce an index measure of 0 (Wilmott, 1981). Willmott et al. (1985) also suggests that values larger than 0.5 may represent good model performance. The IOA is determined by:

$$IOA = 1 - \frac{\sum |X_{model} - X_{obs}|^2}{\sum (|X_{model} - \overline{X_{obs}}| + |X_{obs} - \overline{X_{obs}}|)^2} \qquad \text{Eq.2}$$

Where: X_{model} = Model predicted surface elevation

X_{obs} = Observed surface elevation

Clearly, a greater IOA and lower MAE represent a better model performance.

Figure 3-5 and Figure 3-6 illustrate a comparison of the predicted and observed surface elevations in February 2017. As shown on the graph, the model accurately reproduced the phase and amplitudes throughout the spring and neap tidal cycles.

Table 3-1 shows the IOA and MAE values for the selected tide station locations indicating that the model is performing well.

Table 3-1 Statistical comparison between the observed and HYDROMAP predicted surface elevations.

Tide Station	IOA	MAE (m)
Gabo Island	0.98	0.08
Port MacDonnell	0.98	0.05
Port Welshpool	0.92	0.30
Portland	0.97	0.07
Stack Island	0.96	0.22

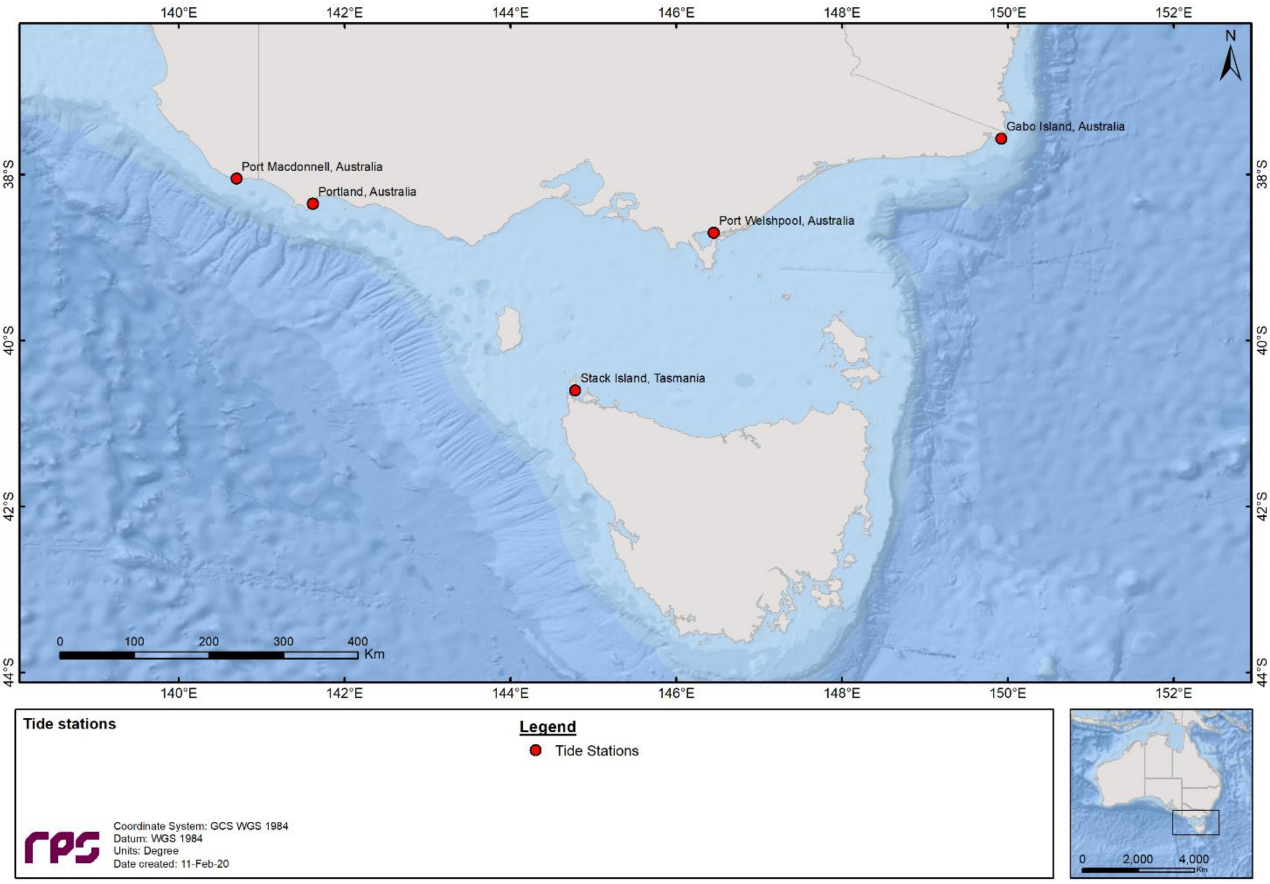


Figure 3-4 Location of the tide stations used in the surface elevation validation.

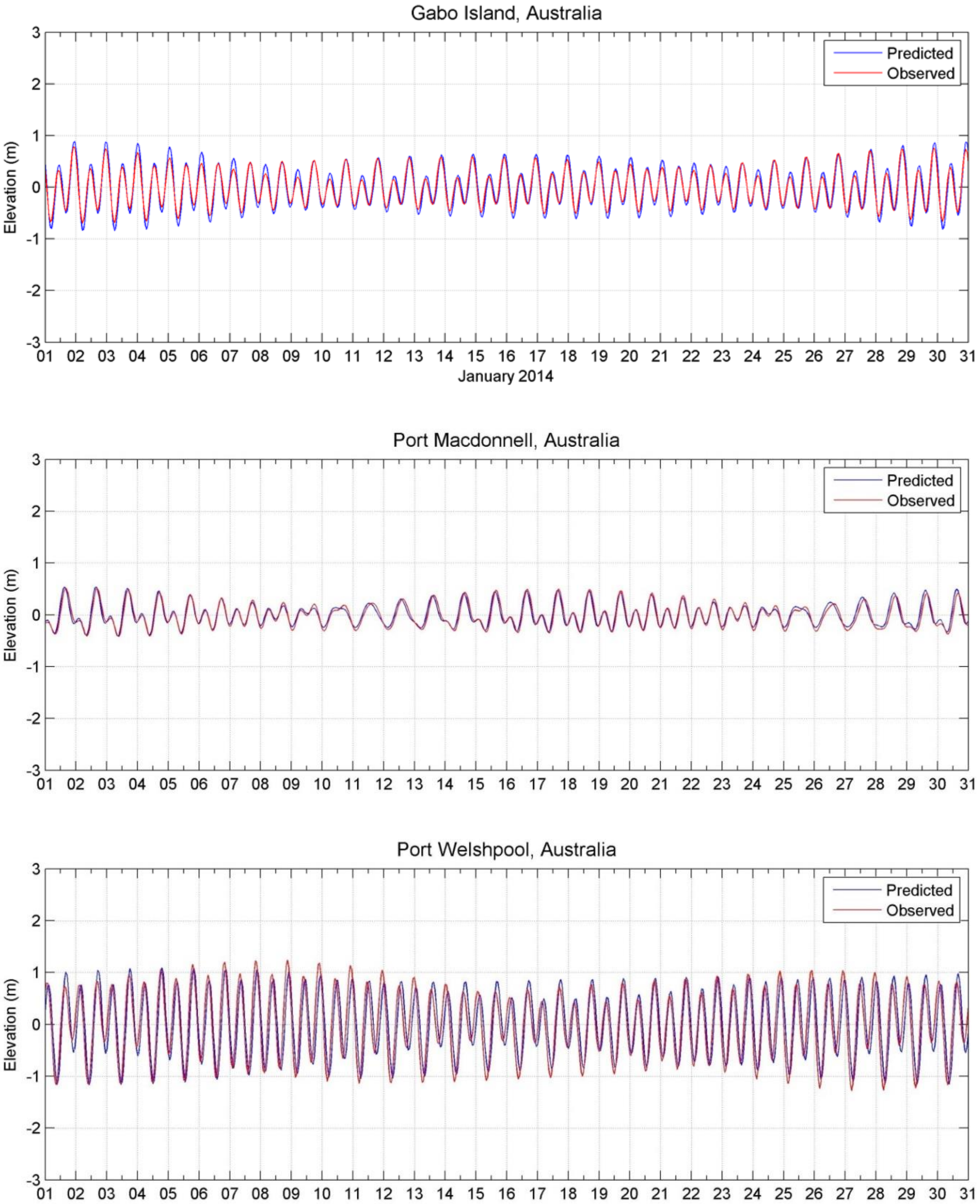


Figure 3-5 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).

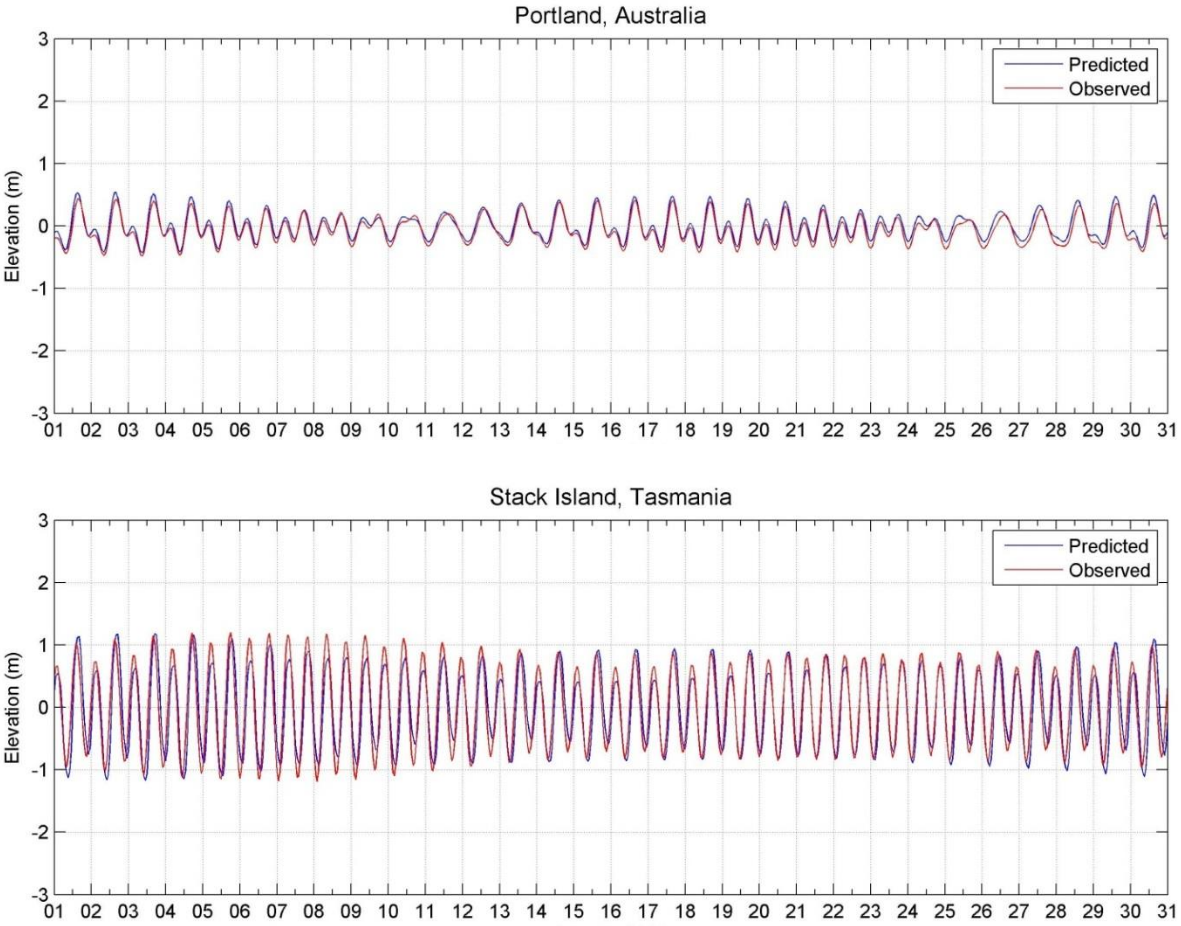


Figure 3-6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).

3.2 Ocean Current Model

Data describing the flow of ocean currents for the years 2010 to 2019 (inclusive) was obtained from HYCOM (Hybrid Coordinate Ocean Model, (Chassignet et al., 2007), which is operated by the HYCOM Consortium, sponsored by the Global Ocean Data Assimilation Experiment (GODAE). HYCOM is a data-assimilative, three-dimensional ocean model that is run as a hindcast (for a past period), assimilating time-varying observations of sea surface height, sea surface temperature and in-situ temperature and salinity measurements (Chassignet et al., 2009). The HYCOM predictions for drift currents are produced at a horizontal spatial resolution of approximately 8.25 km (1/12th of a degree) over the region, at a frequency of every 3 hours. HYCOM uses isopycnal layers in the open, stratified ocean, but uses the layered continuity equation to make a dynamically smooth transition to a terrain-following coordinate in shallow coastal regions, and to z-level coordinates in the mixed layer and/or unstratified seas.

3.3 Surface Currents

Table 3-2 and Table 3-3 present the monthly average and maximum net surface current speeds nearby the Northern Release Location and TW1, respectively, by combining the ocean and tidal currents.

Current speeds near the Northern Release Location varied throughout the year with monthly maximum current speeds ranging between 0.69 m/s (December) and 1.21 m/s (July). The dominant surface current directions throughout the year were identified as (towards) east.

Current speeds near TW1 varied throughout the year with maximum current speeds ranging between approximately 0.81 m/s (October) and 1.15 m/s (August). The dominant surface current directions throughout the year were identified as (towards) east-southeast and west-northwest.

Figure 3-7 and Figure 3-8 show the monthly and total surface current rose distributions nearby the Northern Release Location.

Figure 3-9 and Figure 3-10 show the monthly and total surface current rose distributions nearby TW1.

Note the convention for defining current direction is the direction the current flows towards, which is used to reference current direction throughout this report. Each branch of the rose represents the currents flowing to that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent the current speed ranges for each direction. Speed intervals of 0.1 m/s are predominantly used in these current roses. The length of each coloured segment is relative to the proportion of currents flowing within the corresponding speed and direction.

Table 3-2 Predicted monthly average and maximum surface current speeds nearby the Northern Release Location. The data was derived by combining the HYCOM ocean data and HYDROMAP tidal data from 2010–2019 (inclusive).

Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction(s) (towards)
January	0.15	0.73	West
February	0.16	0.70	West
March	0.16	0.96	West
April	0.15	0.94	East
May	0.20	1.12	East
June	0.21	1.05	East
July	0.26	1.21	East
August	0.25	1.11	East
September	0.21	1.01	East
October	0.19	0.98	East
November	0.17	0.83	East
December	0.18	0.69	East
Minimum	0.15	0.69	-
Maximum	0.26	1.21	-

Table 3-3 Predicted monthly average and maximum surface current speeds nearby TW1. The data was derived by combining the HYCOM ocean data and HYDROMAP tidal data from 2010–2019 (inclusive).

Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction(s) (towards)
January	0.20	0.90	East-northeast and West-southwest
February	0.21	1.00	East-northeast and West-southwest
March	0.22	1.14	East-northeast and West-southwest
April	0.22	0.90	East
May	0.27	1.03	East
June	0.25	0.99	East
July	0.29	0.94	East
August	0.26	1.15	East
September	0.23	0.98	East
October	0.22	0.81	East
November	0.21	0.83	East
December	0.22	0.82	East-northeast and West-southwest
Minimum	**0.20**	**0.81**	-
Maximum	**0.29**	**1.15**	-

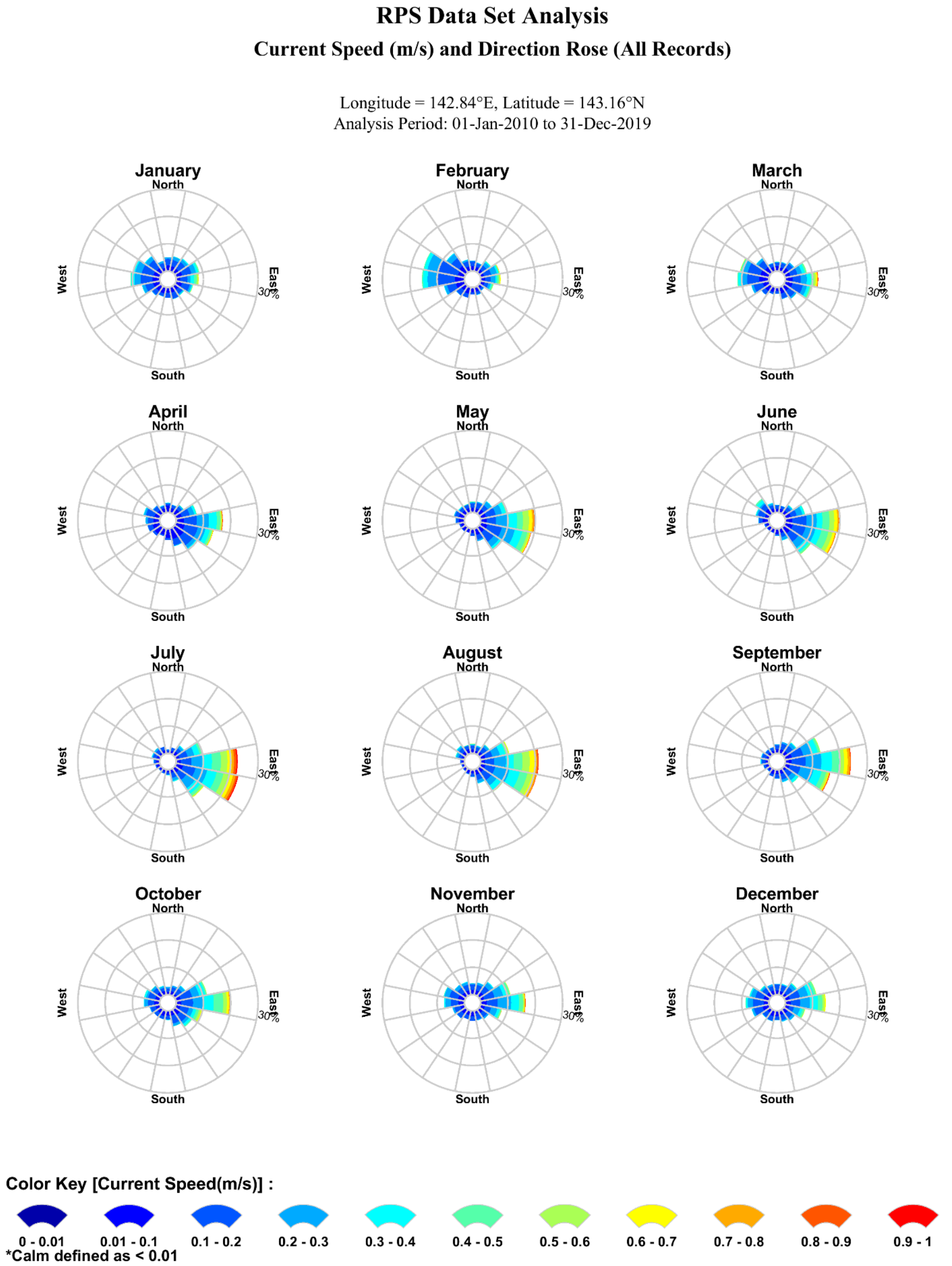


Figure 3-7 Monthly surface current rose plots nearby the Northern Release Location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).

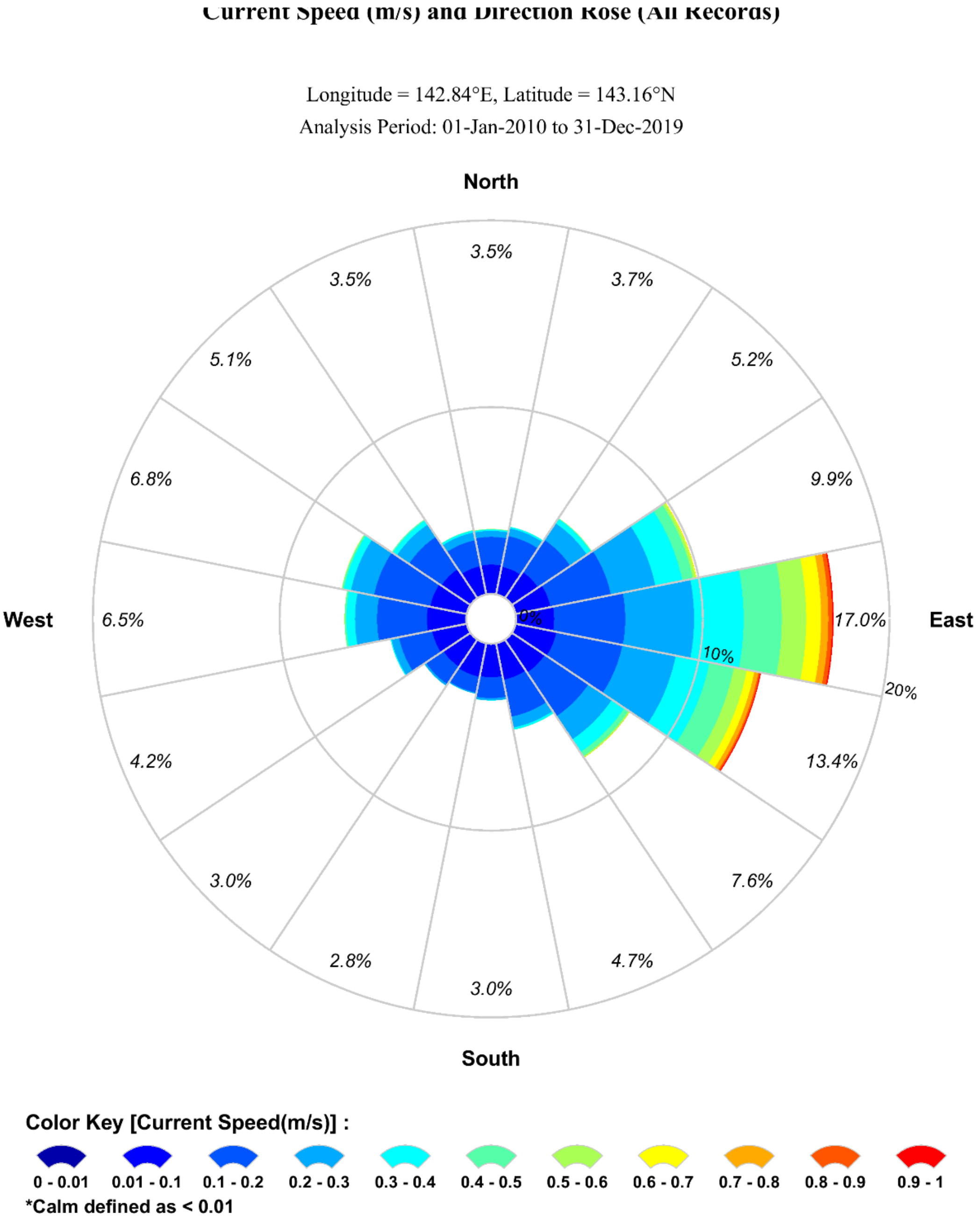


Figure 3-8 Total surface current rose plot nearby the Northern Release Location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).

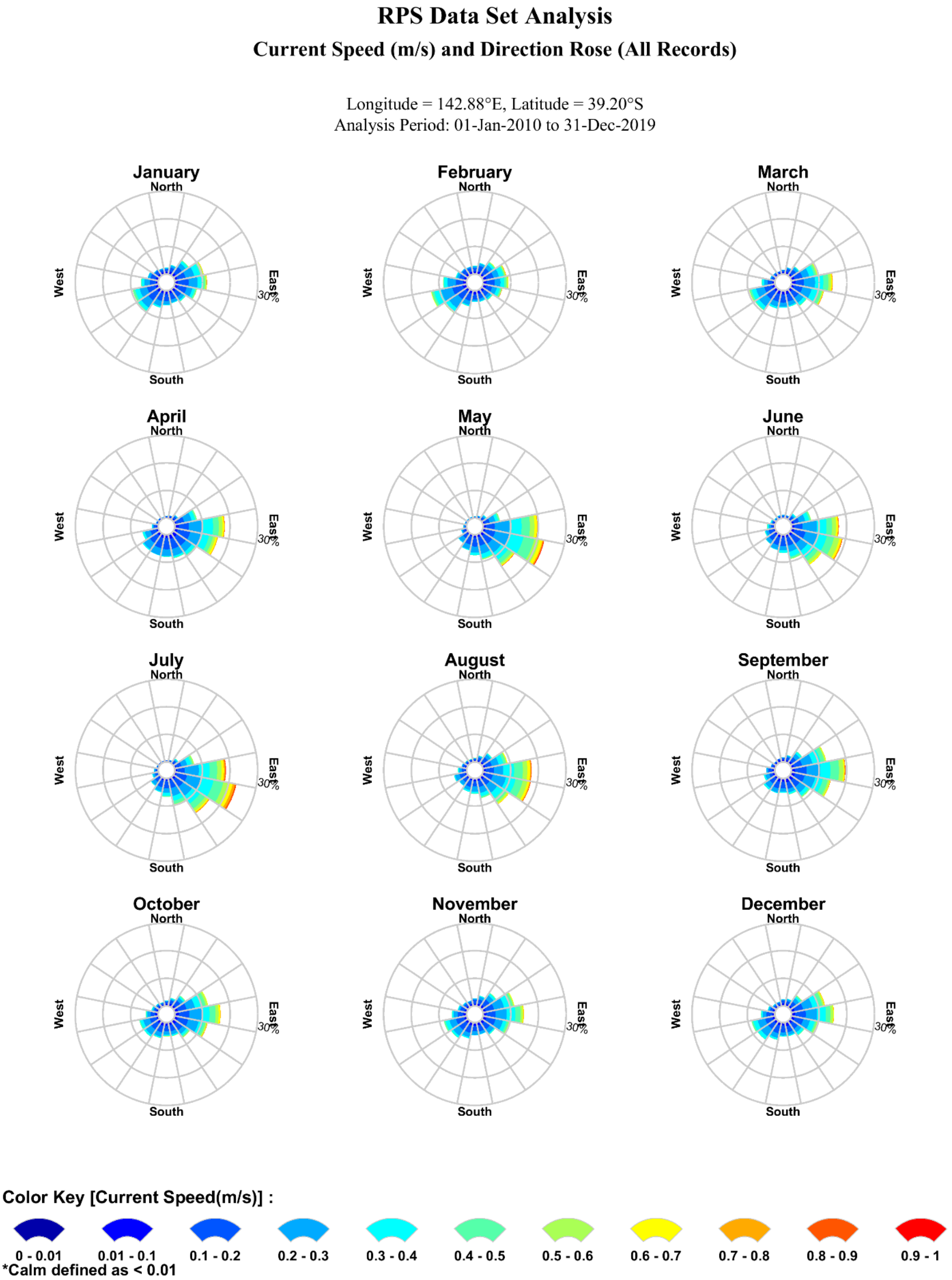


Figure 3-9 Monthly surface current rose plots nearby TW1 (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).

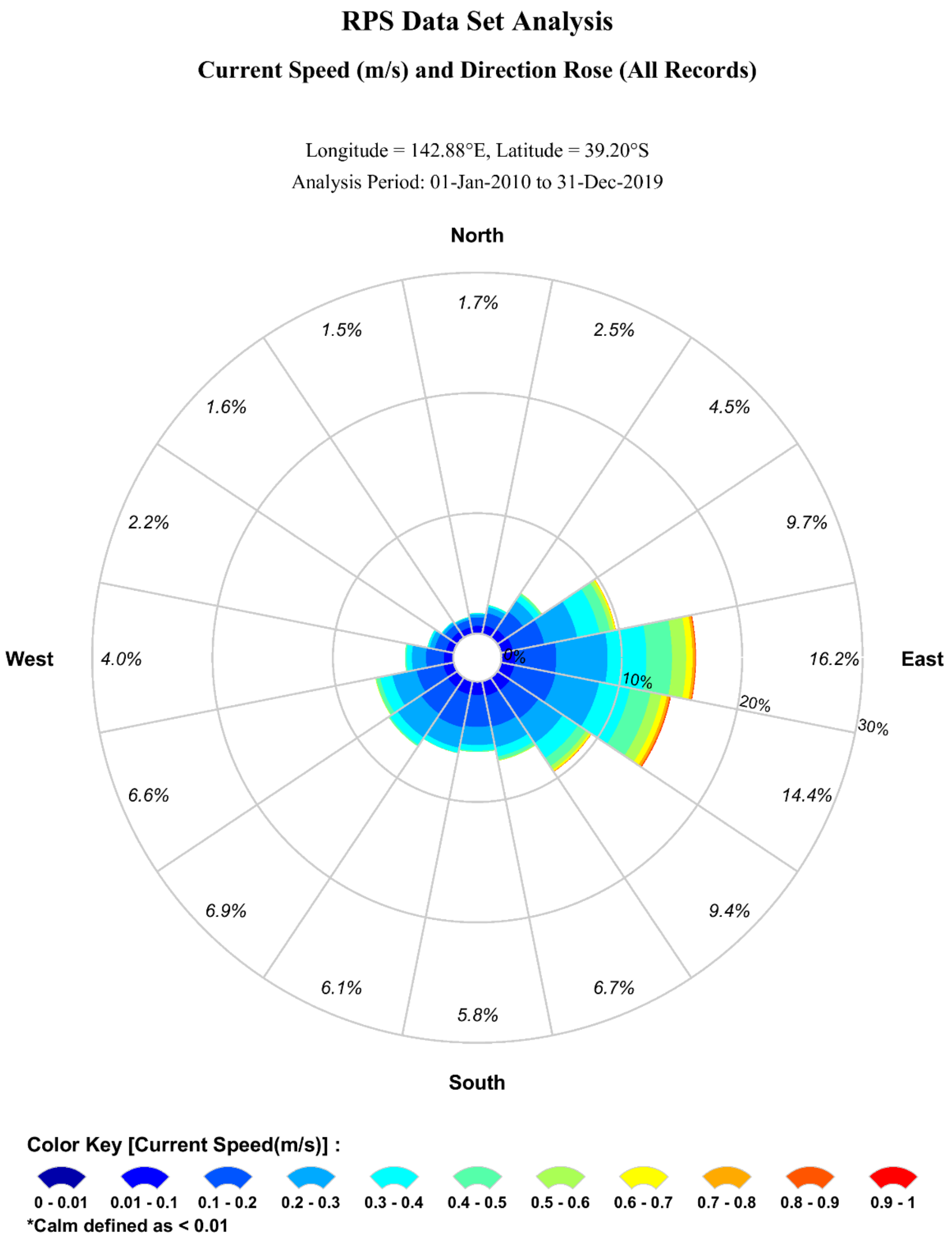


Figure 3-10 Total surface current rose plot nearby TW1 (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2010–2019 (inclusive).

4 WIND DATA

High resolution wind data for the years 2010 to 2019 (inclusive) was sourced from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis dataset (CFSR; see Saha et al., 2010). The CFSR wind model is a fully coupled, data-assimilative hindcast model representing the interaction between the earth's oceans, land and atmosphere. The gridded wind data output is available at ¼ of a degree resolution (~33 km) and 1-hourly time intervals. Figure 4-1 shows the spatial resolution of the wind field used as input into the oil spill model.

Table 4-1 and Table 4-2 present the monthly average and maximum winds derived from a CFSR wind node nearby the Northern Release Location and TW1, respectively.

The wind data demonstrated for the Northern Release Location the average monthly wind speeds ranging from 13.75 knots (January) and 19.35 knots (July), whilst maximums ranged from 38.87 knots (January) to 52.61 knots (June).

The wind data demonstrated for TW1 the average monthly wind speeds ranging from 14.2 knots (January) to 20.1 knots (July) with maximums ranging between 58.9 knots (February) and 65.8 knots (December).

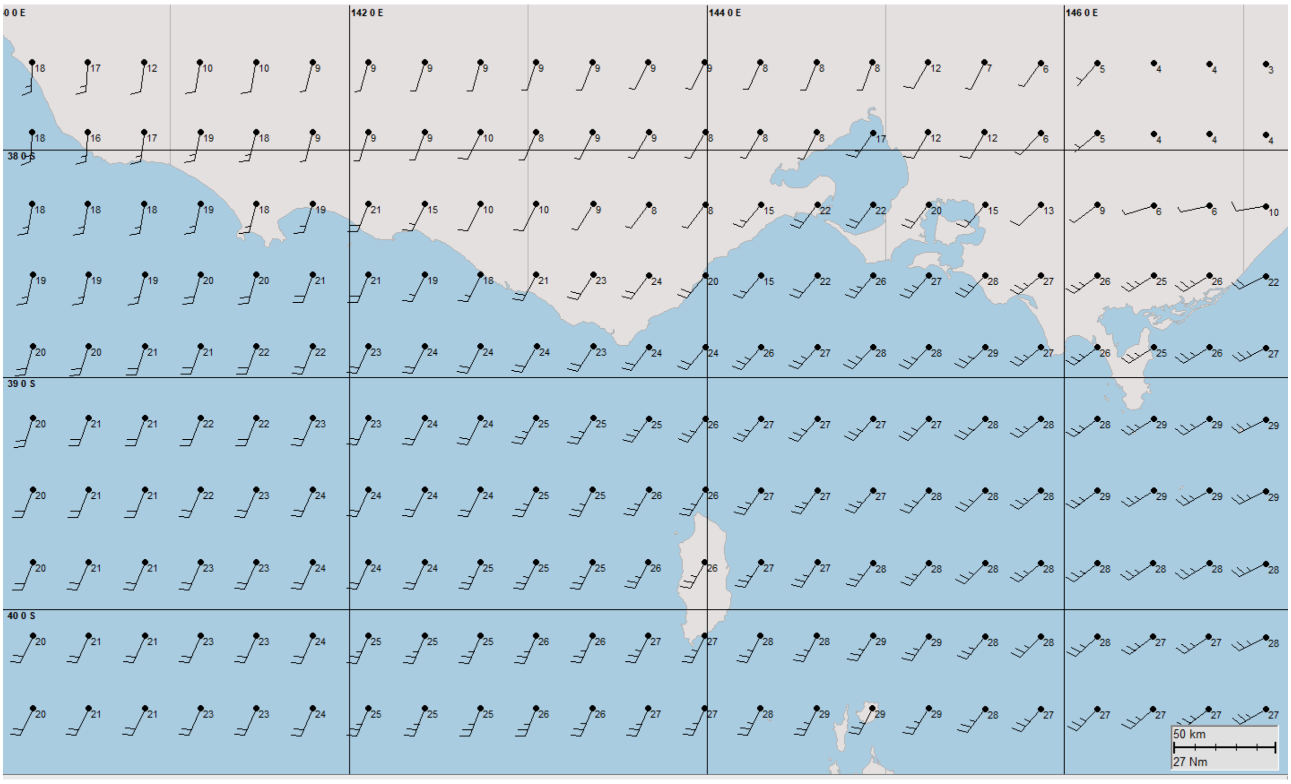


Figure 4-1 Spatial resolution of the CFSR modelled wind data used as input into the oil spill model.

Figure 4-2 and Figure 4-3 show the monthly and total wind rose distributions derived from the CFSR data for the node closest to the Northern Release Location.

Figure 4-4 and Figure 4-5 show the monthly and total wind rose distributions derived from the CFSR data for the node closest to TW1.

Note that the atmospheric convention for defining wind direction, that is, the direction the wind blows from, is used to reference wind direction throughout this report. Each branch of the rose represents wind coming from that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent wind speed ranges from that direction. Speed ranges of 5 knots are predominantly used in these wind roses. The length of each segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction.

Table 4-1 **Predicted average and maximum winds representative for the selected node closest to the Northern Release Location. Data derived from CFSR hindcast model from 2010–2019 (inclusive).**

Month	Average wind speed (knots)	Maximum wind speed (knots)	General direction(s) (from)
January	13.75	38.87	South
February	14.28	41.67	Southeast
March	14.25	44.22	West
April	13.88	42.13	West
May	16.59	45.38	West
June	16.71	52.61	Northwest
July	19.35	45.77	Northwest
August	18.75	47.47	Northwest
September	16.71	48.61	West
October	15.80	44.58	West
November	14.79	43.66	West
December	14.34	40.23	West
Minimum	13.75	38.87	-
Maximum	19.35	52.61	-

Table 4-2 **Predicted average and maximum winds representative for the selected node closest to TW1. Data derived from CFSR hindcast model from 2010–2019 (inclusive).**

Month	Average wind speed (knots)	Maximum wind speed (knots)	General direction(s) (from)
January	14.2	62.8	East-southeast and West-southwest
February	14.8	58.9	Southeast
March	14.8	64.7	East and West
April	14.6	61.2	West
May	17.3	62.2	West
June	17.5	60.5	West to North
July	20.1	60.5	West to North
August	19.5	65.1	West to North
September	17.4	60.8	West
October	16.4	61.8	West
November	15.3	60.8	West
December	14.9	65.8	West and East-southeast
Minimum	**14.2**	**58.9**	-
Maximum	**20.1**	**65.8**	-

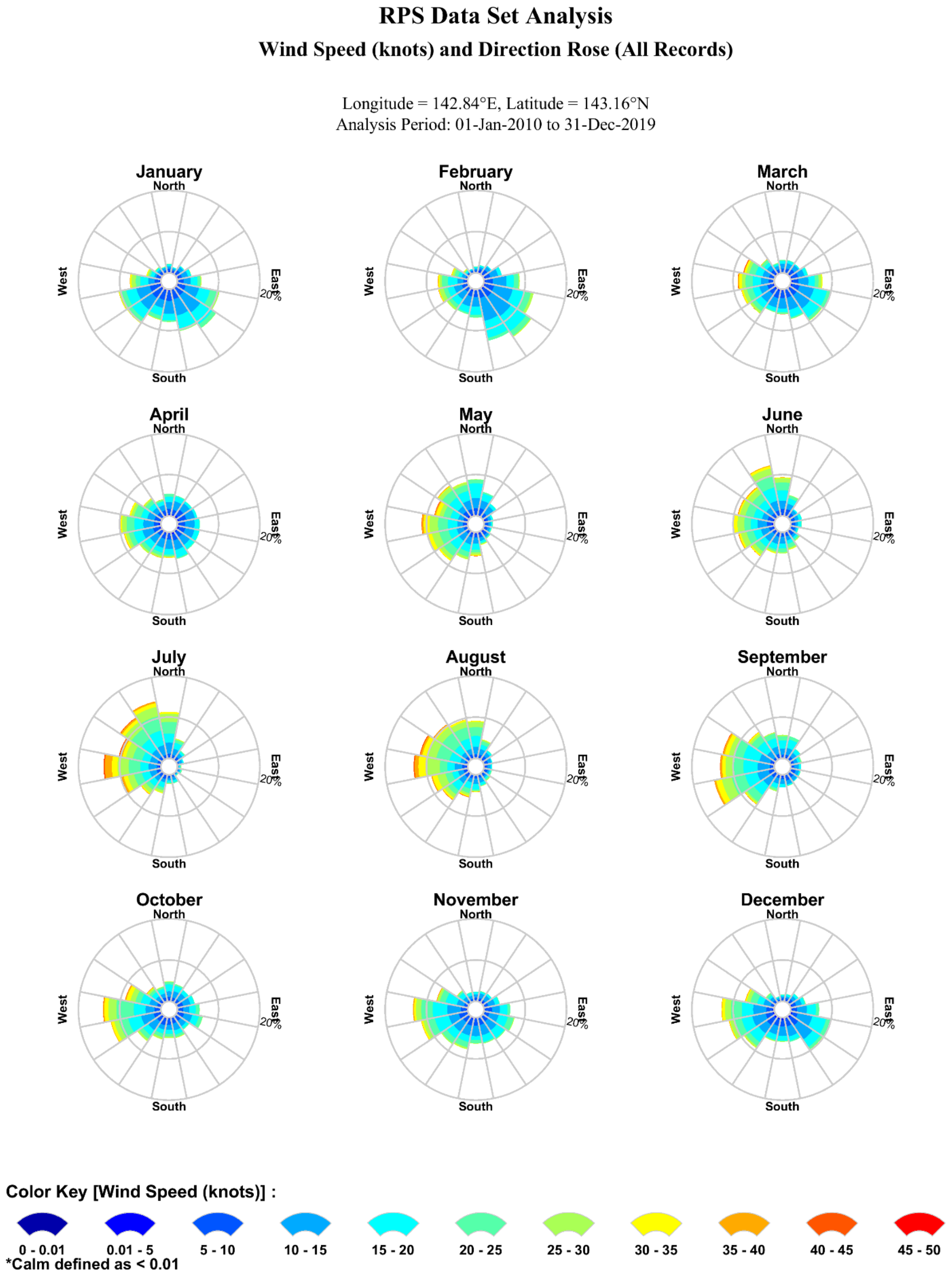


Figure 4-2 **Modelled monthly wind rose distributions from 2010–2019 (inclusive) for the node nearby the Northern Release Location.**

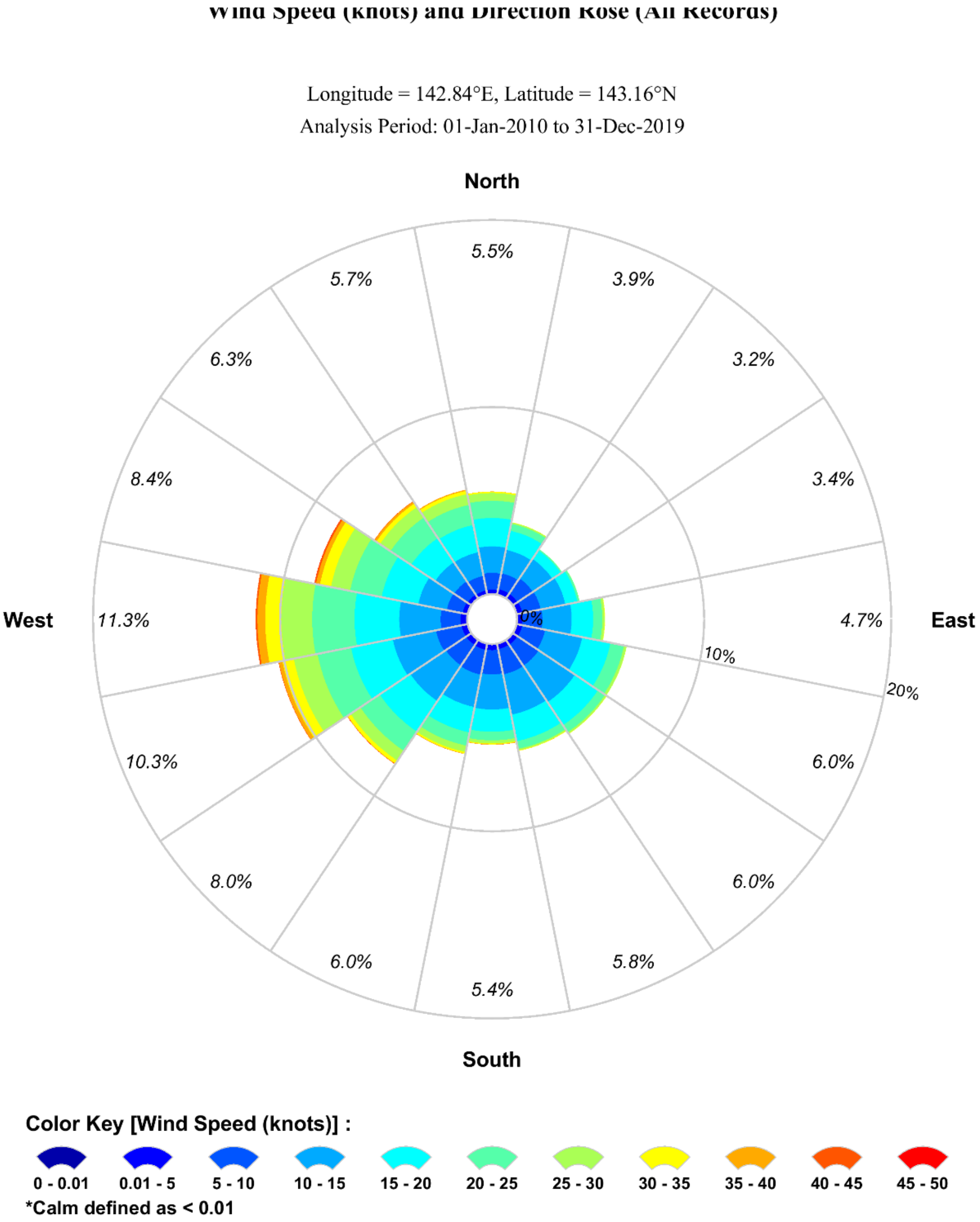


Figure 4-3 Modelled total wind rose distributions from 2010–2019 (inclusive) for the node nearby the Northern Release Location.

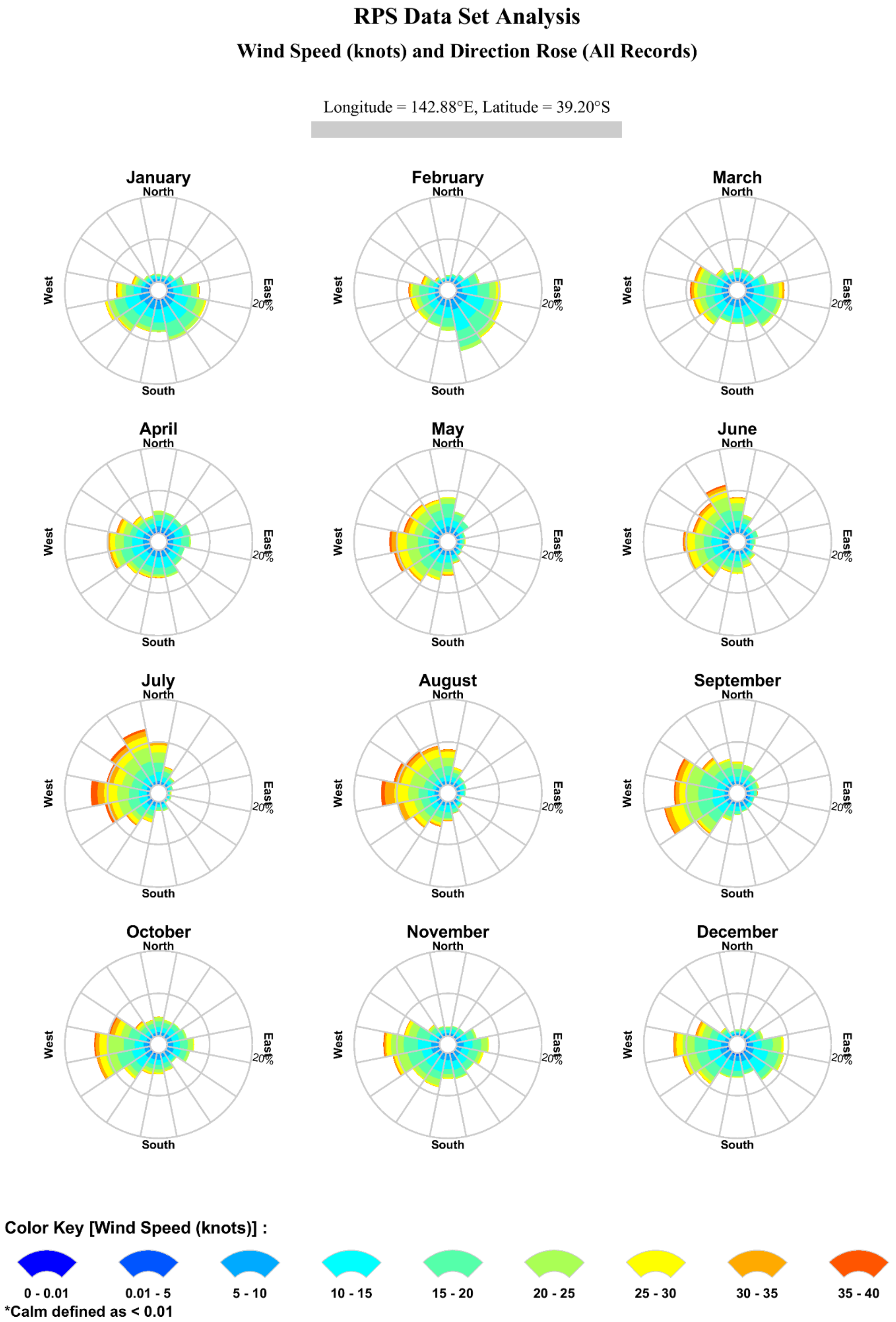
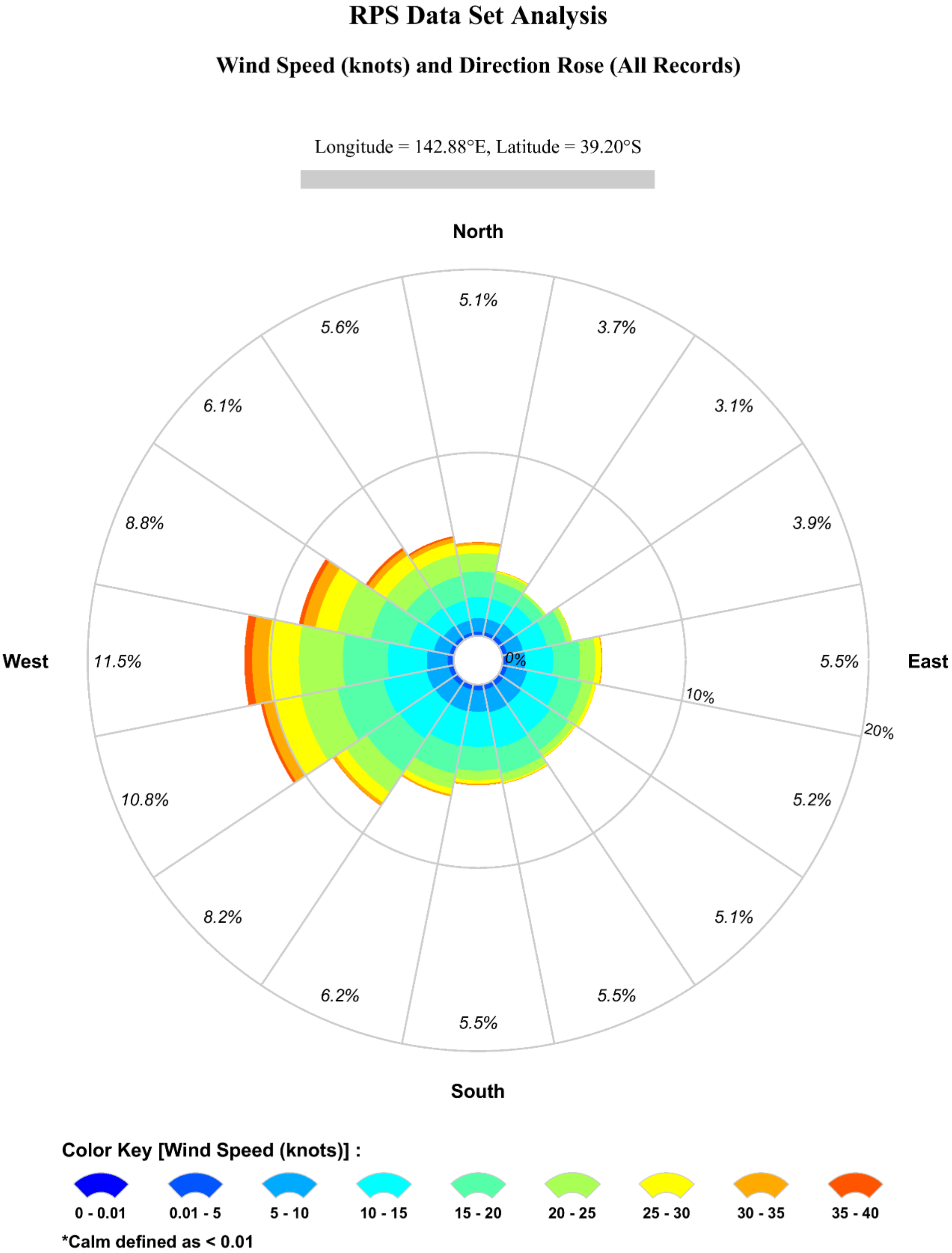


Figure 4-4 Modelled monthly wind rose distributions from 2010–2019 (inclusive) for the node nearby TW1.

Figure 4-5 Modelled total wind rose distributions from 2010–2019 (inclusive) for the node nearby TW1.



5 WATER TEMPERATURE AND SALINITY

The monthly spatially varying water temperature and salinity profiles across the model domain were obtained from the HYCOM model (Section 3.2).

Figure 5-1 and Figure 5-2 illustrate the vertical profile of sea temperature and salinity at the Northern Release Location and TW1, respectively.

Table 5-1 and Table 5-2 present the sea temperature and salinity of the surface layer nearby the Northern Release Location and TW1, respectively.

At the Northern Release Location temperatures varied from 13.5°C (September) to 19.0°C (February) while the monthly average salinity values remain relatively consistent ranging between 35.3 psu and 35.5 psu.

At TW1 temperatures varied from 13.2°C (September) to 17.8°C (February) while the monthly average salinity values remain relatively consistent ranging between 35.1 psu and 35.6 psu.

Table 5-1 Monthly average sea surface temperature and salinity at the Northern Release Location.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (ºC)	18.2	19.0	18.9	17.1	15.9	15.2	14.7	14.1	13.5	13.9	14.6	15.9
Salinity (psu)	35.4	35.4	35.4	35.3	35.4	35.4	35.5	35.5	35.4	35.4	35.4	35.3

Table 5-2 Monthly average sea surface temperature and salinity at TW1.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (ºC)	17.7	17.2	17.8	16.3	16.0	16.0	14.8	13.5	13.2	14.3	14.3	15.9
Salinity (psu)	35.3	35.1	35.4	35.3	35.3	35.4	35.6	35.3	35.3	35.4	35.4	35.4

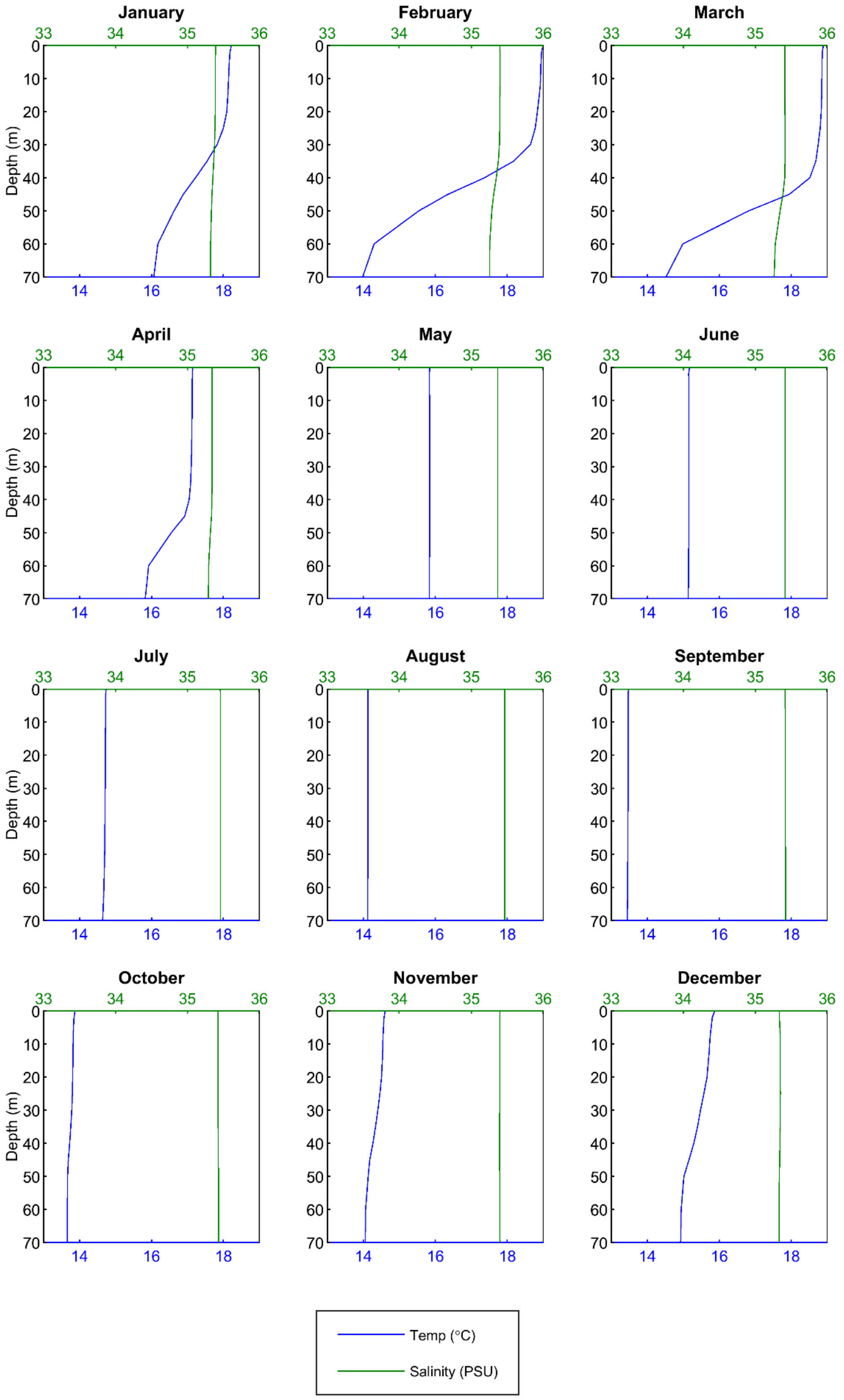
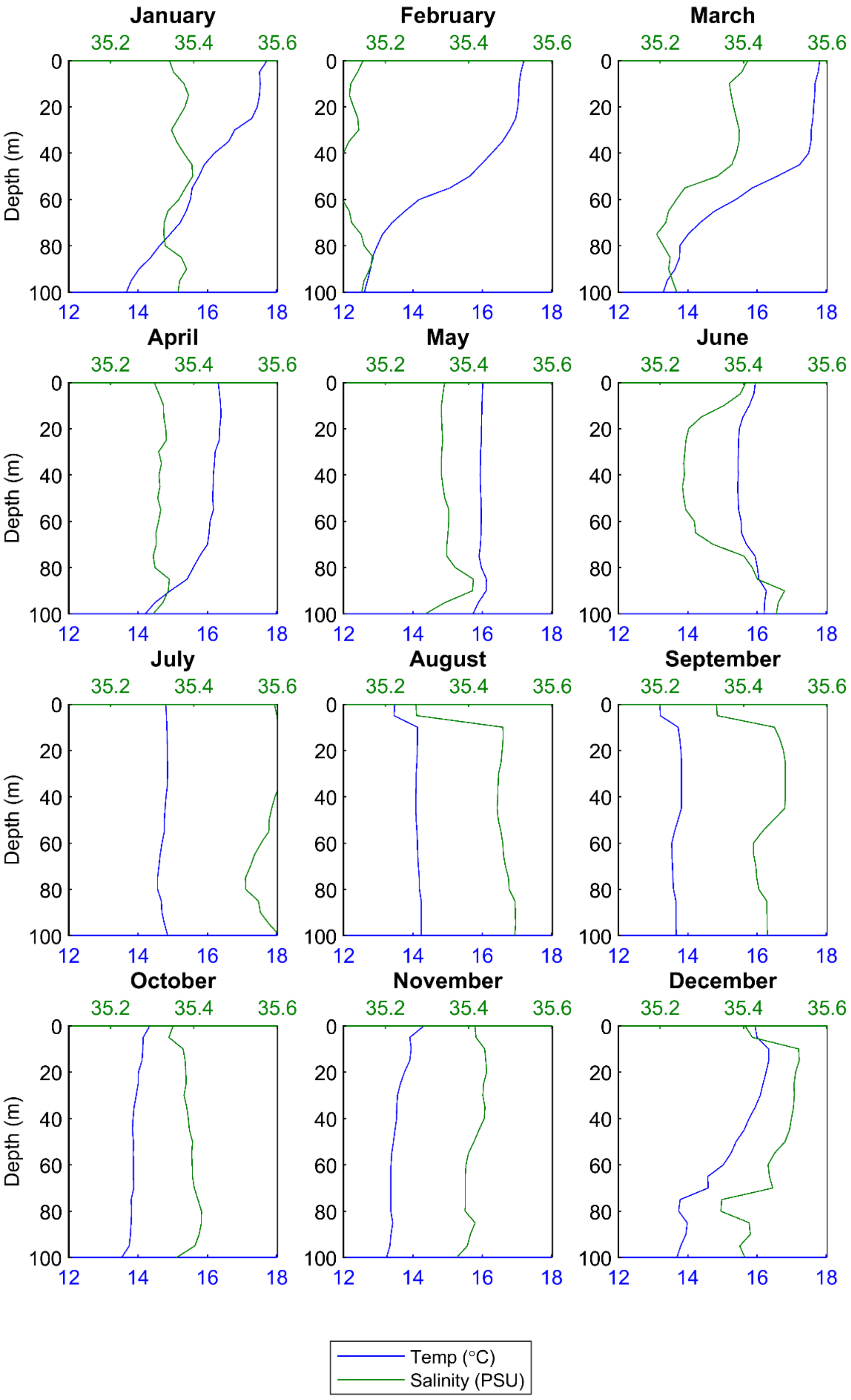


Figure 5-1 Temperature and salinity profiles at the Northern Release Location.

Figure 5-2 Temperature and salinity profiles at TW1.



6 SUBSEA PLUME MODEL – OILMAP DEEP

In the event of a subsea release, the gas and condensate will initially behave like a jet, which dissipates in the water column over a short distance (<10 m). The escaping condensate shear into small droplets due to turbulence generated by passing through the exit hole and subsequent turbulence generated in the plume jet. The size-distribution of the droplets will vary with the exit velocity and viscosity of the condensate. Following this phase, the density and buoyancy difference of the gas and condensate mixture relative to the surrounding waters, forces the plume upward. As the plume rises, the volume of gas will increase due to reduction of water pressure, with gas bubbles dividing into an increasing number of bubbles due to the shearing effect exerted by the water column.

In shallow water (<200 m) the rising plume will tend to reach the sea surface before deflecting away from the centre of the plume (Spaulding et al., 2000). Figure 6-1 conceptually illustrates the various stages of a subsea release of oil and gas.

The OILMAP Deep model (Spaulding et al. 2015) was used to simulate the near-field behaviour of the gas-condensate subsea release in two phases – the initial jet phase and the buoyant plume phase. The initial jet phase is predominately driven by the exit velocity. During this phase, the condensate droplet-size-distributions are calculated for a range of classes or bins. Next, the plume model predicts the rise dynamics of the condensate and gas plume to calculate at which point gas lift will be lost (i.e., the trapping height).

Outputs which include the plume trapping height, plume diameter and droplet size distribution are used as input to the SIMAP model to simulate the rise and dispersion of the condensate droplets from this point onwards.

More details on the OILMAP-DEEP model, can be found in Spaulding et al. (2015). The model has been validated against observations from Deepwater Horizon as well as small and large-scale laboratory studies on subsurface oil releases (Brandvik et al 2013, 2014; Belore 2014; Spaulding et al. 2015; Li et al. 2017).

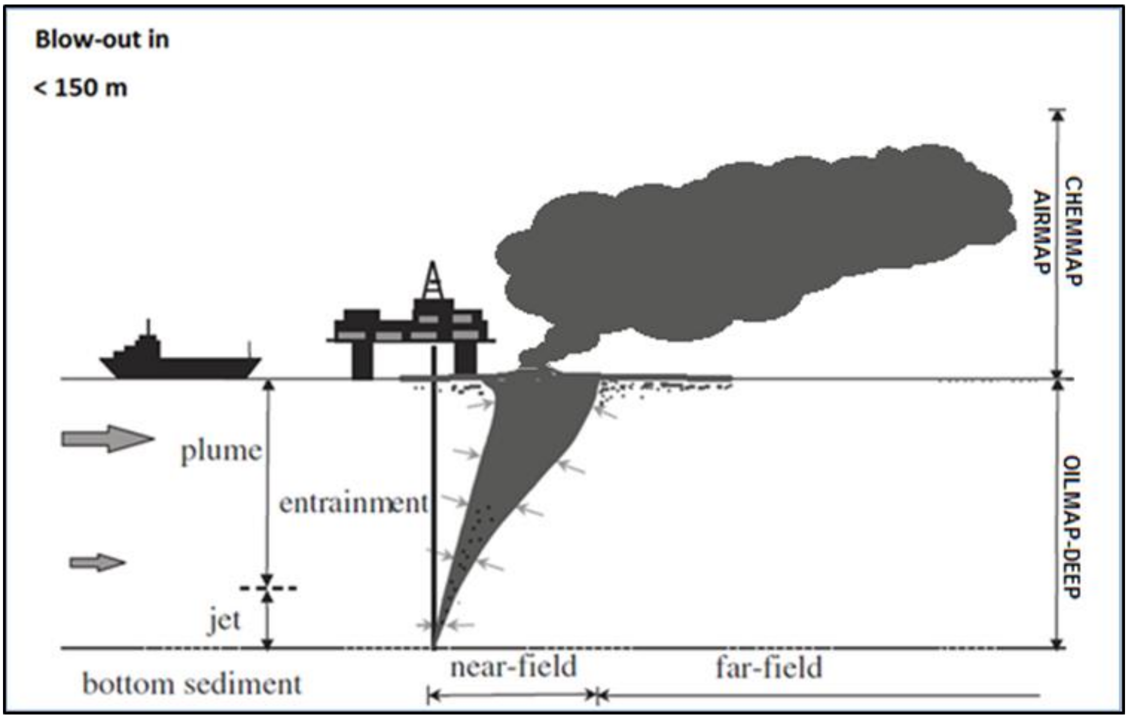


Figure 6-1 Schematic of the various stages of the plume in the water column (Source: ASA, 2011).

Table 6-1 presents the input parameters and key results for the subsea plume modelling.

Figure 6-2 and Figure 6-3 illustrate the time-varying release rate used for the LOWC scenarios for Northern Release Location and TW1, respectively.

The blowout modelling showed that in the event of a loss of well control at the Northern Release Location (Scenario 1), the amalgamated gas and condensate would propel rapidly upward from the seabed and breach the sea surface. Droplet sizes would initially range from 108 µm to 466 µm on day-1 and increase in size to 203 µm to 878 µm by day-86.

The blowout modelling showed that in the event of a loss of well control at TW1 (Scenario 3), the amalgamated gas and condensate would propel rapidly upward from the seabed and breach the sea surface. Droplet sizes would initially range from 81 µm to 351 µm on day-1 and increase in size to 102 µm to 442 µm by day-86.

Table 6-1 Input data and key results for the subsea plume modelling.

Input Variable	Northern Release Location	TW1
Scenario	Loss of well control	Loss of well control
Water depth	71.5 m	105 m
Tubing diameter	8.5”	8.5”
Condensate discharge rate	Day-1: 6,813 STB/day Day-86: 3,592 STB/day	Day-1: 1,337 STB/day Day-86: 1,071 STB/day
Gas discharge rate	Day-1: 407 MMscf/day Day-86: 224 MMscf/day	Day-1: 138 MMscf/day Day-86: 111 MMscf/day
Formation water discharge rate	Day-1: 363 STB/day Day-86: 267 STB/day	NIL
Key Results		
Plume execution depth (m BMSL)	0 (Breach the sea surface)	0 (Breach the sea surface)
Droplet sizes (µm)	Day-1: 108 to 466 Day-86: 203 to 878	Day-1: 81 to 351 Day-86: 102 to 442

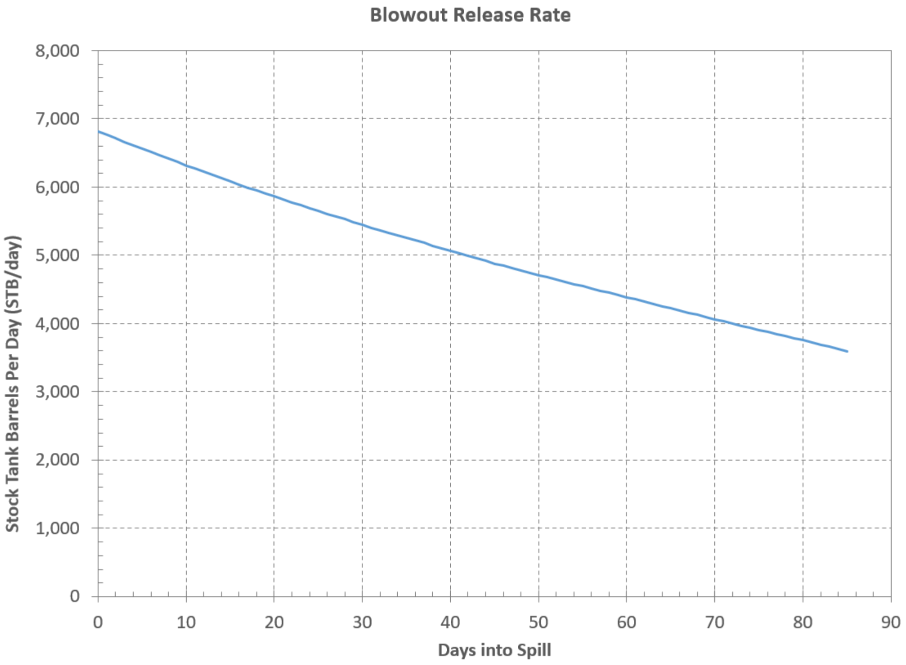


Figure 6-2 Plot of time-varying release rate for the Northern Release Location.

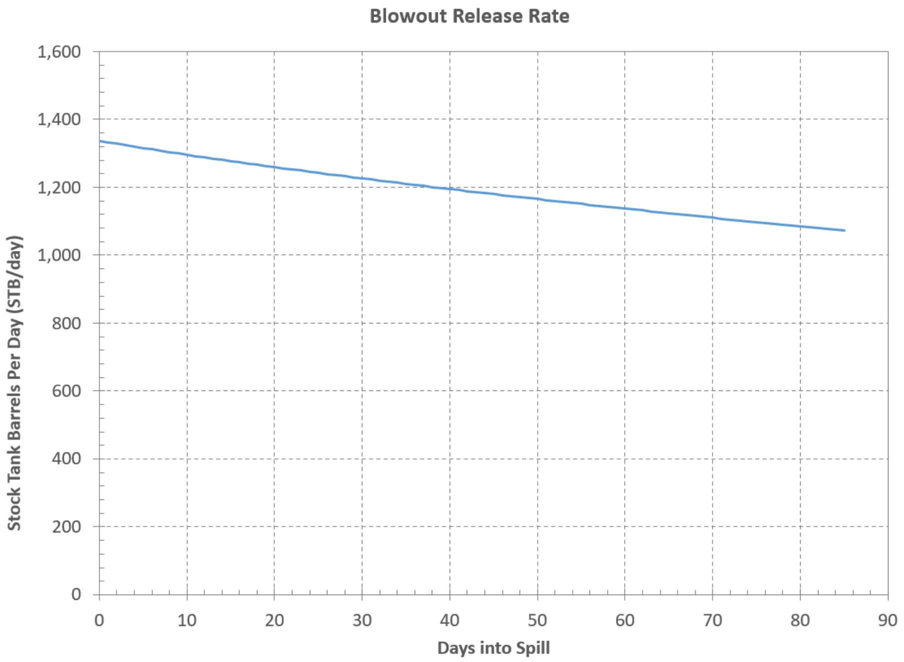


Figure 6-3 **Plot of time-varying release rate for TW1.**

7 OIL SPILL MODEL – SIMAP

Modelling of the fate of oil was performed using the Spill Impact Model Application Program (SIMAP). SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for both the surface and subsurface releases (Spaulding et al., 1994; French et al., 1999; French-McCay, 2003, 2004; French-McCay et al., 2004).

SIMAP has been used to predict the weathering and fate of oil spills during and after major incidents including: Montara (Australia) well blowout August 2009 in the Timor Sea (Asia-Pacific ASA, 2010); Macondo (USA) well blowout April 2010 in the Gulf of Mexico; Bohai Bay (China) oil spill August 2011; and the pipeline oil spill July 2013 in the Gulf of Thailand.

The SIMAP model calculates the transport, spreading, entrainment, evaporation and decay of surface hydrocarbon slicks as well as the entrained and dissolved oil components in the water column, either from surface slicks or from oil discharged subsea. The movement and weathering of the spilled oil is calculated for specific oil types. Input specifications for oil mixtures include the density, viscosity, pour point, distillation curve (volume lost versus temperature) and the aromatic/aliphatic component ratios within given boiling point (BP) ranges.

SIMAP is a three-dimensional model that allows for various response actions to be modelled including oil removal from skimming, burning, or collection booms, and surface and subsurface dispersant application.

The SIMAP oil spill model includes advanced weathering algorithms, specifically focussed on unique oils that tend to form emulsions and/or tar balls. The weathering algorithms are based on 5 years of extensive research conducted in response to the Deepwater Horizon oil spill in the Gulf of Mexico (French-McCay et al., 2015).

Biodegradation is included in the oil spill model. In the model, SIMAP, degradation is calculated for the surface slick, deposited oil on the shore, the entrained oil and dissolved constituents in the water column, and oil in the sediments. For surface oil, water column oil and sedimented oil a first order degradation rate is specified. Biodegradation rates are relatively high for hydrocarbons in dissolved state or in dispersed small droplets.

7.1 Stochastic Modelling

For the stochastic modelling presented herein, 200 simulations (100 per season) were modelled for each of the scenarios using the same spill information (release location, spill volume, duration and oil type) but with varied start dates per scenario. During each simulation, the model records whether any grid cells are exposed to any oil concentrations, the concentrations involved and the elapsed time before exposure. The results of all 100 oil spill simulations per season (per scenario) were analysed to determine the following statistics for every grid cell:

- Exposure load (concentrations).
- Minimum time before exposure.
- Maximum duration of exposure.
- Probability of contact above defined concentrations.
- Volume of oil that may accumulate on shorelines from any single simulation.
- Concentration that might occur on sections of individual shorelines.
- Exposure (instantaneous) to dissolved hydrocarbons in the water column.
- Exposure (instantaneous) to entrained hydrocarbons in the water column.
- Residence time, or the longest continuous period floating oil, and dissolved and entrained hydrocarbons persisted at a point above a threshold.

8 THRESHOLDS

The thresholds and their relationship to exposure for the sea surface, shoreline and water column (entrained and dissolved hydrocarbons) are presented in Sections 8.1 to 8.3. Supporting justifications of the adopted thresholds applied during the study and additional context relating to the area of influence are also provided. It is important to note that the thresholds herein are based on NOPSEMA (2019).

8.1 Floating Oil Exposure Thresholds

The modelling results can be presented to any levels; therefore, thresholds have been specified (based on scientific literature) to record floating oil exposure to the sea-surface at meaningful levels only, described in the following paragraphs.

The low threshold to assess the potential for floating oil exposure, was 1 g/m^2, which equates approximately to an average thickness of 1 µm, referred to as visible oil. Oil of this thickness is described as rainbow sheen in appearance, according to the Bonn Agreement Oil Appearance Code (Bonn Agreement, 2009; AMSA, 2014) (see Table 8-1). Figure 8-1 shows photographs highlighting the difference in appearance between a silvery sheen, rainbow sheen and metallic sheen. This threshold is considered below levels which would cause environmental harm and it is more indicative of the areas perceived to be affected due to its visibility on the sea surface and potential to trigger temporary closures of areas (i.e. fishing grounds) as a precautionary measure. Table 8-1 provides a description of the appearance in relation to exposure zone thresholds used to classify the zones of floating oil exposure.

Ecological impact has been estimated to occur at 10 g/m^2 (a film thickness of approximately 10 µm or 0.01 mm) according to French et al. (1996) and French-McCay (2009) as this level of fresh oiling has been observed to mortally impact some birds through adhesion of oil to their feathers, exposing them to secondary effects such as hypothermia. The appearance of oil at this average thickness has been described as a metallic sheen (Bonn Agreement, 2009).

Scholten et al. (1996) and Koops et al. (2004) indicated that at oil concentrations on the sea surface of 25 g/m^2 (or greater), would be harmful for all birds that have landed in an oil film due to potential contamination of their feathers, with secondary effects such as loss of temperature regulation and ingestion of oil through preening. The appearance of oil at this thickness is also described as metallic sheen (Bonn

Agreement, 2009). For this study the high exposure threshold was set to 50 g/m^2 and above based on NOPSEMA (2019). This threshold can also be used to inform response planning.

Table 8-2 defines the thresholds used to classify the zones of floating oil exposure reported herein.

Table 8-1 The Bonn Agreement Oil Appearance Code.

Code	Description Appearance	Layer Thickness Interval (g/m^2 or µm)	Litres per km^2
1	Sheen (silvery/grey)	0.04 – 0.30	40 – 300
2	Rainbow	0.30 – 5.0	300 – 5,000
3	Metallic	5.0 – 50	5,000 – 50,000
4	Discontinuous True Oil Colour	50 – 200	50,000 – 200,000
5	Continuous True Oil Colour	≥ 200	≥ 200,000

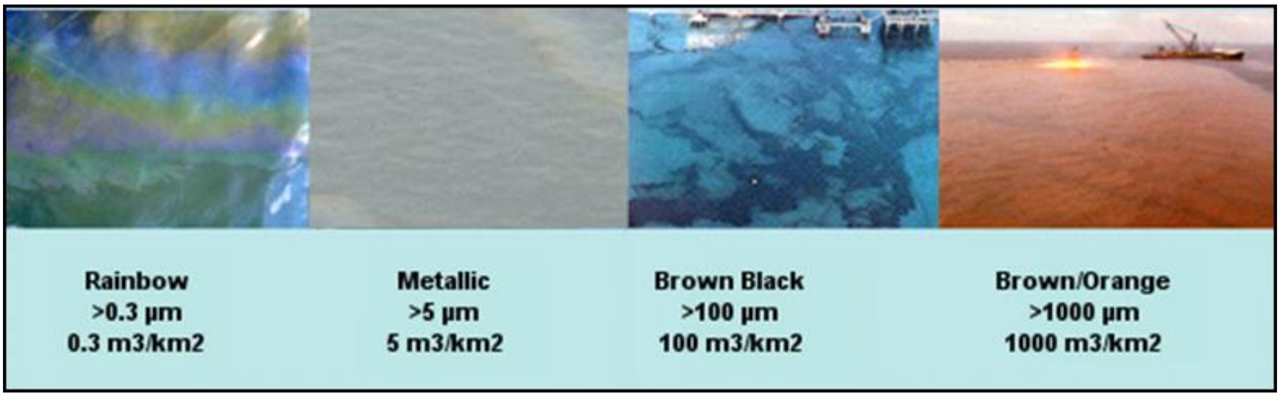


Figure 8-1 Photographs showing the difference between oil colour and thickness on the sea surface (source: adapted from Oil Spill Solutions, 2015).

Table 8-2 Floating oil exposure thresholds used in this report (in alignment with NOPSEMA, 2019).

Threshold level	Floating oil (g/m^2)	Description
Low	1	Approximates area of potential socioeconomic effects and establishes planning area for scientific monitoring and determination of any effects.
Moderate	10	Approximates lower limit for harmful exposures to birds and marine mammals
High	50	Approximates surface oil slick and informs response planning

8.2 Shoreline Accumulation Thresholds

There are many different types of shorelines, ranging from cliffs, rocky beaches, sandy beaches, mud flats and mangroves, and each of these influences the volume of oil that can remain stranded ashore and its thickness before the shoreline saturation point occurs. For instance, a sandy beach may allow oil to percolate through the sand, thus increasing its ability to hold more oil ashore over tidal cycles and various wave actions than an equivalent area of water; hence oil can increase in thickness onshore over time. A sandy beach shoreline was assumed as the default shoreline type for the modelling herein, as it allows for the highest carrying capacity of oil (of the available open/exposed shoreline types). Hence the results contained herein would be indicative of a worst-case scenario, where the highest volume of oil may be stranded on the shoreline (when compared to other shoreline types, such as exposed rocky shores).

In previous risk assessment studies, French-McCay et al. (2005a; 2005b) used a threshold of 10 g/m^2 to assess the potential for shoreline accumulation. This is a conservative threshold used to define regions of socio-economic impact, such as triggering temporary closures of adjoining fisheries or the need for shore clean-up on beaches or man-made features/amenities (breakwaters, jetties, marinas, etc.). It would equate to approximately 2 teaspoons of hydrocarbon per square meter of shoreline accumulation. The appearance is described as a stain/film. On that basis, the 10 g/m^2 shoreline accumulation threshold has been selected to define the zone of potential “low shoreline accumulation”.

French et al. (1996) and French-McCay (2009) define a shoreline oil accumulation threshold of 100 g/m^2, or above, would potentially harm shorebirds and wildlife (furbearing aquatic mammals and marine reptiles on or along the shore) based on studies for sub-lethal and lethal impacts. This threshold has been used in previous environmental risk assessment studies (see French-McCay, 2003; French-McCay et al., 2004, French-McCay et al., 2011; 2012; NOAA, 2013). Additionally, a shoreline concentration of 100 g/m^2, or above, is the minimum limit that the oil can be effectively cleaned according to the AMSA (2015) guideline. This threshold equates to approximately ½ a cup of oil per square meter of shoreline accumulation. The appearance is described as a thin oil coat. Therefore, 100 g/m^2 has been selected to define the zone of potential “moderate shoreline accumulation”.

Observations by Lin & Mendelssohn (1996) demonstrated that loadings of more than 1,000 g/m^2 of hydrocarbon during the growing season would be required to impact marsh plants significantly. Similar thresholds have been found in studies assessing hydrocarbon impacts on mangroves (Grant et al., 1993; Suprayogi & Murray, 1999). Hence, 1,000 g/m^2 has been selected to define the zone of potential “high shoreline accumulation”. It equates to approximately 1 litre of hydrocarbon per square meter of shoreline accumulation. The appearance is described as a hydrocarbon cover.

It is worth noting that the shoreline accumulation thresholds derived from extensive literature review (outlined in Table 8-3) agree with the commonly used threshold values for oil spill modelling specified in NOPSEMA (2019).

Table 8-3 Thresholds used to assess shoreline accumulation.

Threshold level	Shoreline loading (g/m^2)	Description
Low (socioeconomic/sublethal)	10	Loading predicts potential socio-economic impact
Moderate	100	Loading predicts area likely to require clean-up effort
High	> 1,000	Loading predicts area likely to require intensive clean-up effort

8.3 In-water Exposure Thresholds

Oil is a mixture of thousands of hydrocarbons of varying physical, chemical, and toxicological characteristics, and therefore, demonstrate varying fates and impacts on organisms. As such, for in-water exposure, the SIMAP model provides separate outputs for dissolved and entrained hydrocarbons from oil droplets. The consequences of exposure to dissolved and entrained components will differ because they have different modes and magnitudes of effect.

Entrained hydrocarbon concentrations were calculated based on oil droplets that are suspended in the water column, though not dissolved. The composition of this oil would vary with the state of weathering (oil age) and may contain soluble hydrocarbons when the oil is fresh. Calculations for dissolved hydrocarbons specifically calculates oil components which are dissolved in water, which are known to be the primary source of toxicity exerted by oil.

In addition to presenting the maximum instantaneous concentrations across the model domain, there are also figures presented for the residence time, which is the longest continuous period of exposure above each threshold. This helps provide context when considering exposure to sensitive receptors.

8.3.1 Dissolved Hydrocarbons

Laboratory studies have shown that dissolved hydrocarbons exert most of the toxic effects of oil on aquatic biota (Carls et al., 2008; Nordtug et al., 2011; Redman, 2015). The mode of action is a narcotic effect, which is positively related to the concentration of soluble hydrocarbons in the body tissues of organisms (French-McCay, 2002). Dissolved hydrocarbons are taken up by organisms directly from the water column by absorption through external surfaces and gills, as well as through the digestive tract. Thus, soluble hydrocarbons are termed “bioavailable”.

Hydrocarbon compounds vary in water-solubility and the toxicity exerted by individual compounds is inversely related to solubility, however bioavailability will be modified by the volatility of individual compounds (Nirmalakhandan & Speece, 1988; Blum & Speece, 1990; McCarty, 1986; McCarty et al., 1992a, 1992b; Mackay et al., 1992; McCarty & Mackay, 1993; Verhaar et al., 1992, 1999; Swartz et al., 1995; French-McCay, 2002; McGrath and Di Toro, 2009). Of the soluble compounds, the greatest contributor to toxicity for water-column and benthic organisms are the lower-molecular-weight aromatic compounds, which are both volatile and soluble in water. Although they are not the most water-soluble hydrocarbons within most oil types, the polynuclear aromatic hydrocarbons (PAHs) containing 2-3 aromatic ring structures typically exert the largest narcotic effects because they are semi-soluble and not highly volatile, so they persist in the environment long enough for significant accumulation to occur (Anderson et al., 1974, 1987; Neff & Anderson, 1981; Malins & Hodgins, 1981; McAuliffe, 1987; NRC, 2003). The monoaromatic hydrocarbons (MAHs), including the BTEX compounds (benzene, toluene, ethylbenzene, and xylenes), and the soluble alkanes (straight chain hydrocarbons) also contribute to toxicity, but these compounds are highly volatile, so that their contribution will be low when oil is exposed to evaporation and higher when oil is discharged at depth where volatilisation does not occur (French-McCay, 2002).

French-McCay (2002) reviewed available toxicity data, where marine biota was exposed to dissolved hydrocarbons prepared from oil mixtures, finding that 95% of species and life stages exhibited 50% population mortality (LC_{50}) between 6 and 400 ppb total PAH concentration after 96 hrs exposure, with an average of 50 ppb. Hence, concentrations lower than 6 ppb total PAH value should be protective of 97.5% of species and life stages even with exposure periods of days (at least 96 hours). Early life-history stages of fish appear to be more sensitive than older fish stages and invertebrates.

Exceedances of 10, 50 or 400 ppb over a 1-hour timestep (see Table 8-4) was applied to indicate increasing potential for sub-lethal to lethal toxic effects (or low to high), based on NOPSEMA (2019).

8.3.2 Entrained Hydrocarbons

Entrained hydrocarbons consist of oil droplets that are suspended in the water column and insoluble. As such, insoluble compounds in oil cannot be absorbed from the water column by aquatic organisms, hence are not bioavailable through absorption of compounds from the water. Exposure to these compounds would require routes of uptake other than absorption of soluble compounds. The route of exposure of organisms to whole oil alone include direct contact with tissues of organisms and uptake of oil by direct consumption, with potential for biomagnification through the food chain (NRC, 2005).

The 10 ppb threshold represents the very lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the ANZECC & ARMCANZ (2000) water quality guidelines. Due to the requirement for relatively long exposure times (> 24 hours) for these concentrations to be significant, they are likely to be more meaningful for juvenile fish, larvae and planktonic organisms that might be entrained (or otherwise moving) within the entrained plumes, or when entrained hydrocarbons adhere to organisms or trapped against a shoreline for periods of several days or more.

This exposure zone is not considered to be of significant biological impact and is therefore outside the adverse exposure zone. This exposure zone represents the area contacted by the spill. This area does not define the area of influence as it is considered that the environment will not be affected by the entrained hydrocarbon at this level.

Thresholds of 10 ppb and 100 ppb were applied over a 1-hour time exposure (Table 8-4), to cover the range of thresholds outlined in ANZECC & ARMCANZ (2000) water quality guidelines, the incremental change for greater potential effect and is per NOPSEMA (2019). Additionally, a threshold of 1,000 ppb (French-McCay, 2023) was applied over a 1-hour time exposure.

A complicating factor that should be considered when assessing the consequence of dissolved and entrained oil distributions is that there will be some areas where both physically entrained oil droplets and dissolved hydrocarbons co-exist. Higher concentrations of each will tend to occur close to the source where sea conditions can force mixing of relatively unweathered oil into the water column, resulting in more rapid dissolution of soluble compounds.

Table 8-4 Dissolved and entrained hydrocarbon exposure values assessed over a 1-hour time step, as per NOPSEMA (2019).

Threshold level	Dissolved hydrocarbon concentration (ppb)	Entrained hydrocarbon concentrations (ppb)
Low	10	10
Moderate	50	100
High	400	1,000

9 DISPERSION COEFFICIENTS AND MIXED LAYER DEPTH

A horizontal dispersion coefficient of 10 m^2/s was used to account for dispersive processes acting on the floating oil that are at scales finer than the modelled wind and currents, based on typical values for open waters (Okubo, 1971).

Vertical dispersion coefficients (*Dv)* of 115 cm^2/s and 120 cm^2/s were used to represent the turbulent mixing and diffusion processes in the wave-mixed layer in the upper water column at Northern Release Location and TW1, respectively. Those are site-specific values computed using the 50th percentile wind speed at each of the release sites, derived from the 10-year dataset (at 10 m above the sea surface, W_{10}) based on French-McCay (2004).

The mixed layer depth corresponds to the top layer of the water column, where vertical mixing is strong enough to cause uniform temperature and salinity, and is influenced by factors like wind, ocean currents and waves. The 50th percentile value at the site was calculated using Copernicus' 10 years (2010 to 2019) of monthly-averaged mixed layer depth data and were found to be 32 m and 42 m for Northern Release Location and TW1, respectively.

10 OIL PROPERTIES

10.1 Oil Characteristics

Table 10-1 and Table 10-2 present the physical properties and boiling point ranges of Marine Diesel and Thylacine condensate, which was used as the proxy for the study.

Thylacine condensate has an API of 44.3 and a density of 804.6 kg/m^3 (at 15ºC) with a viscosity value (0.87.0 cP) classifying it as a Group I (not-persistent) oil according to the International Tankers Owners Pollution Federation (ITOPF, 2020) and US EPA/USCG classifications.

The condensate is a mixture of volatile and persistent hydrocarbons with high proportions of volatile and semi- to low-volatile components. In favourable evaporation conditions, about 64.0% of the oil mass should evaporate within the first 12 hours (BP < 180°C), a further 19.0% should evaporate within the first 24 hours (180°C < BP < 265°C) and a further 16.0% should evaporate over several days (265°C < BP < 380°C). Approximately 1.0% of the oil is shown to be persistent.

Marine diesel (MDO) has an API of 37.6 and a density of 829.1 kg/m^3 (at 25ºC) with a viscosity value (4.0 cP) classifying it as a Group II (light-persistent) oil according to the International Tankers Owners Pollution Federation (ITOPF, 2020) and US EPA/USCG classifications.

The MDO is a mixture of volatile and persistent hydrocarbons with high proportions of volatile and semi- to low-volatile components. In favourable evaporation conditions, about 6.0% of the oil mass should evaporate within the first 12 hours (BP < 180°C); a further 34.6% should evaporate within the first 24 hours (180°C < BP < 265°C); and a further 54.4% should evaporate over several days (265°C < BP < 380°C). Approximately 5.0% of the oil is shown to be persistent.

Table 10-1 Physical properties for Thylacine condensate.

Characteristic	Thylacine Condensate	MDO
Density (kg/m^3)	804.6 (at 15°C)	829.1 (at 25 °C)
API	44.3	37.6
Dynamic viscosity (cP)	0.87 (at 20°C)	4.0 (at 25 °C)
Pour point (°C)	-50	-14
Hydrocarbon property category	Group I	Group II
Hydrocarbon property classification	Not – Persistent	Light - Persistent

Table 10-2 Boiling point ranges for Thylacine condensate.

Oil Type	Component	Volatile (%)	Semi-volatile (%)	Low-volatile (%)	Residual (%)
	Boiling point (°C)	<180 C_4 to C_{10}	180-265 C_{11} to C_{15}	265-380 C_{16} to C_{20}	>380 $>C_{20}$
Thylacine Condensate	% of total	64.0	19.0	16.0	1.0
Marine Diesel	% of total	6.0	34.6	54.4	5.0

The BP are dictated by the length of the carbon chains, with the longer and more complex compounds having a higher boiling point, and therefore lower volatility and evaporation rate.

Typical evaporation times once the hydrocarbons reach the surface and are exposed to the atmosphere are:

- Up to 12 hours for the C_4 to C_{10} compounds (or <180°C BP).
- Up to 24 hours for the C_{11} to C_{15} compounds (180–265°C BP).
- Several days for the C_{16} to C_{20} compounds (265–380°C BP).
- Not applicable for the residual compounds (BP >380°C), which will resist evaporation, persist in the marine environment for longer periods, and be subject to relatively slow degradation.

The actual fate of oil will depend greatly on the amount that reaches the surface.

10.2 Weathering Characteristics

A series of model weather tests were conducted to illustrate the potential behaviour of Thylacine condensate and marine diesel when exposed to idealised and representative environmental conditions:

- A 50 m^3 surface release over 1-hour under calm wind conditions (constant 5 knots or 2.6 m/s), assuming low seasonal water temperature (15°C) and ambient tidal and drift currents; and

- A 50 m^3 surface release over 1-hour under variable wind conditions (1-12 knots or 1.9-23 m/s, drawn from representative data files), assuming low seasonal water temperature (15°C) and ambient tidal and drift currents.

Note, a surface release is used in the weathering test to solely focus on the weathering and fates of the hydrocarbons when exposed to atmospheric conditions.

The first case is indicative conditions that would not generate entrainment, while the second case may represent conditions that could cause a minor degree of entrainment. Both scenarios provide examples of potential behaviour during a spill once the oil reaches the surface.

Thylacine Condensate Mass Balance Forecasts

The mass balance for the condensate under the constant 5 knot wind case (Figure 10-1) shows that 82.5% of the oil is predicted to evaporate within 24 hours. Under calm conditions, the majority of the remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation shall cease when the residual compounds remain, and they will be subject to more gradual decay through biological and photochemical processes.

Under the variable-wind case (Figure 10-2), where the winds are of greater strength on average, entrainment of the condensate into the water column is predicted to increase. Approximately 24 hours after the spill, 22.1% of the oil mass is forecast to have entrained and a further 69.4% is forecast to have evaporated, leaving only a small proportion of the oil floating on the water surface (<0.1%).

The increased level of entrainment in the variable-wind case result in a higher percentage decaying at an approximate rate of 1.9% per day with or ~10.9% after 7 days, compared to <0.1% per day and a total of 0.8% after 7 days for the constant-wind case. Given the proportion of entrained oil and the tendency for it to remain mixed in the water column, the remaining hydrocarbons will decay over time scales of several weeks.

Marine Diesel Mass Balance Forecasts

The mass balance for the MDO under the constant 5 knot (~2.5 m/s) wind case (Figure 10-3) shows that 40.3% of the oil is predicted to evaporate within 24 hours. Under calm conditions, the majority of the remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation shall cease when the residual compounds remain, and they will be subject to more gradual decay through biological and photochemical processes.

Under the variable-wind case (Figure 10-4), where the winds are of greater strength on average, entrainment of MDO into the water column is predicted to increase. Approximately 24 hours after the spill, 60.1% of the oil mass is forecast to have entrained and a further 38.4% is forecast to have evaporated, leaving only a small proportion of the oil floating on the water surface (<0.1%).

The increased level of entrainment in the variable-wind case result in a higher percentage decaying at an approximate rate of 1.5% per day with or ~10.5% after 7 days, compared to <0.1% per day and a total of 0.9% after 7 days for the constant-wind case. Given the proportion of entrained oil and the tendency for it to remain mixed in the water column, the remaining hydrocarbons will decay over time scales of several weeks.

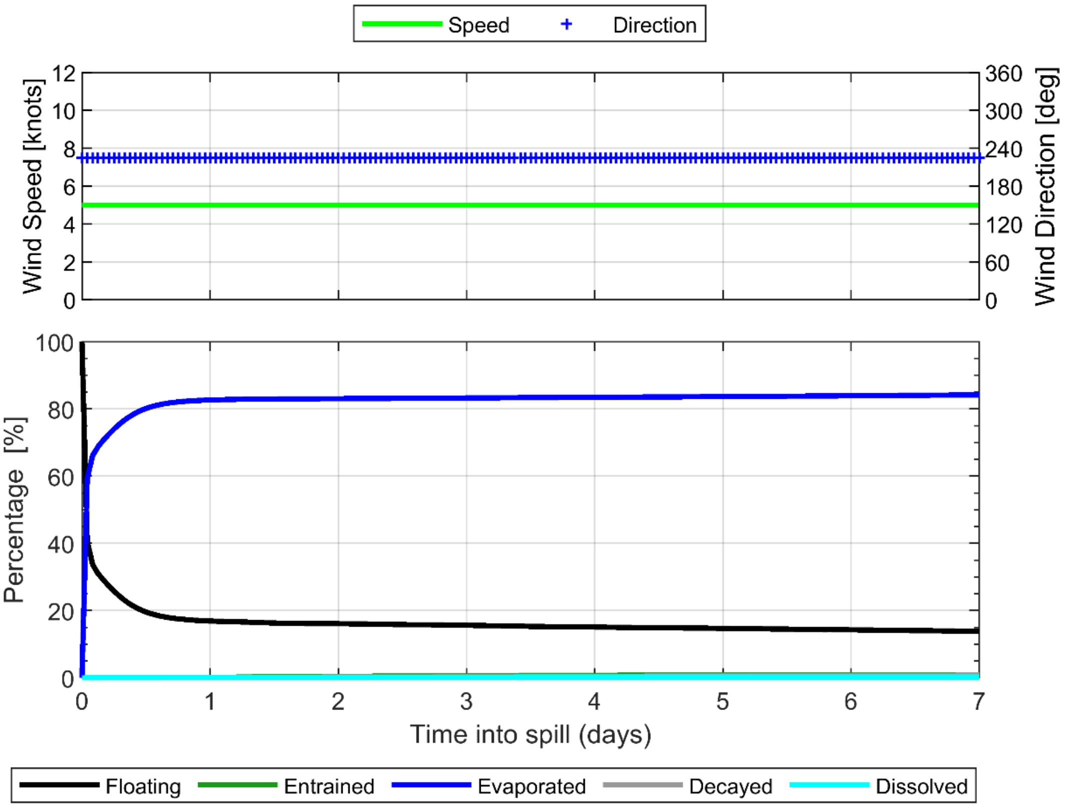


Figure 10-1 Proportional mass balance plot representing the weathering of Thylacine condensate spilled onto the water surface over 1 hour and subject to a constant 5 knots (2.6 m/s) wind speed at 15°C water temperature.

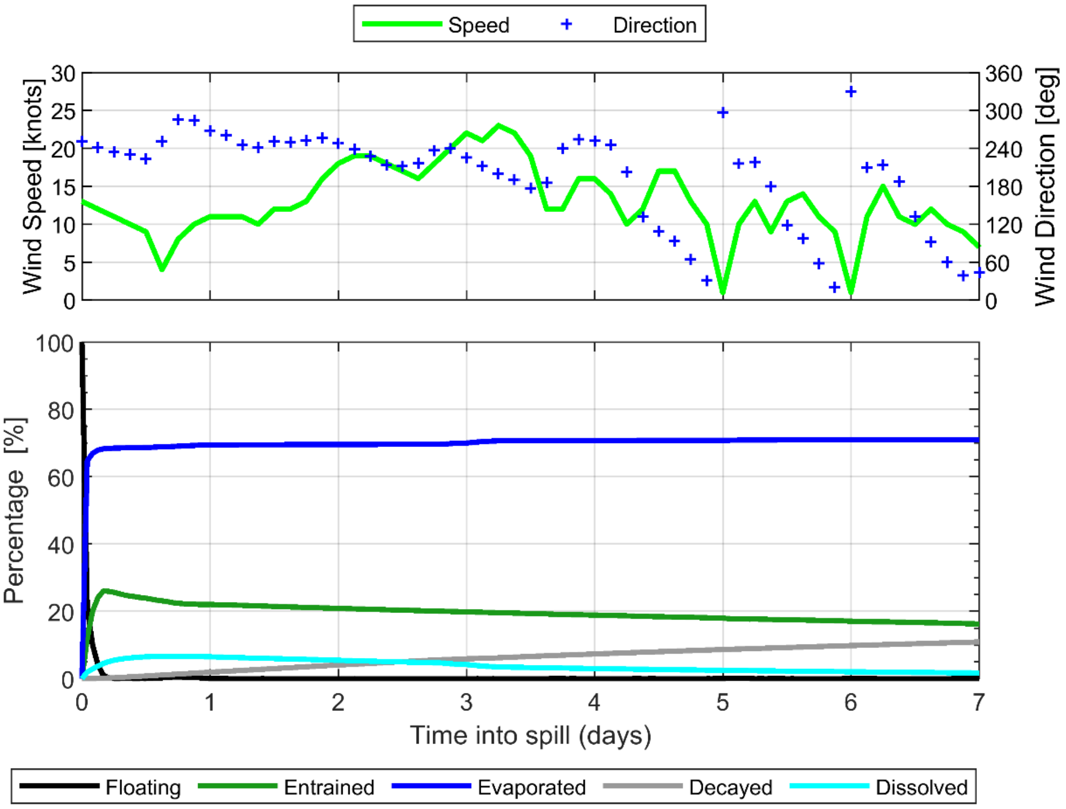


Figure 10-2 Proportional mass balance plot representing the weathering of Thylacine condensate spilled onto the water over 1 hour and subject to variable wind speeds (1-12 knots or 1.9-23 m/s) at 15°C water temperature.

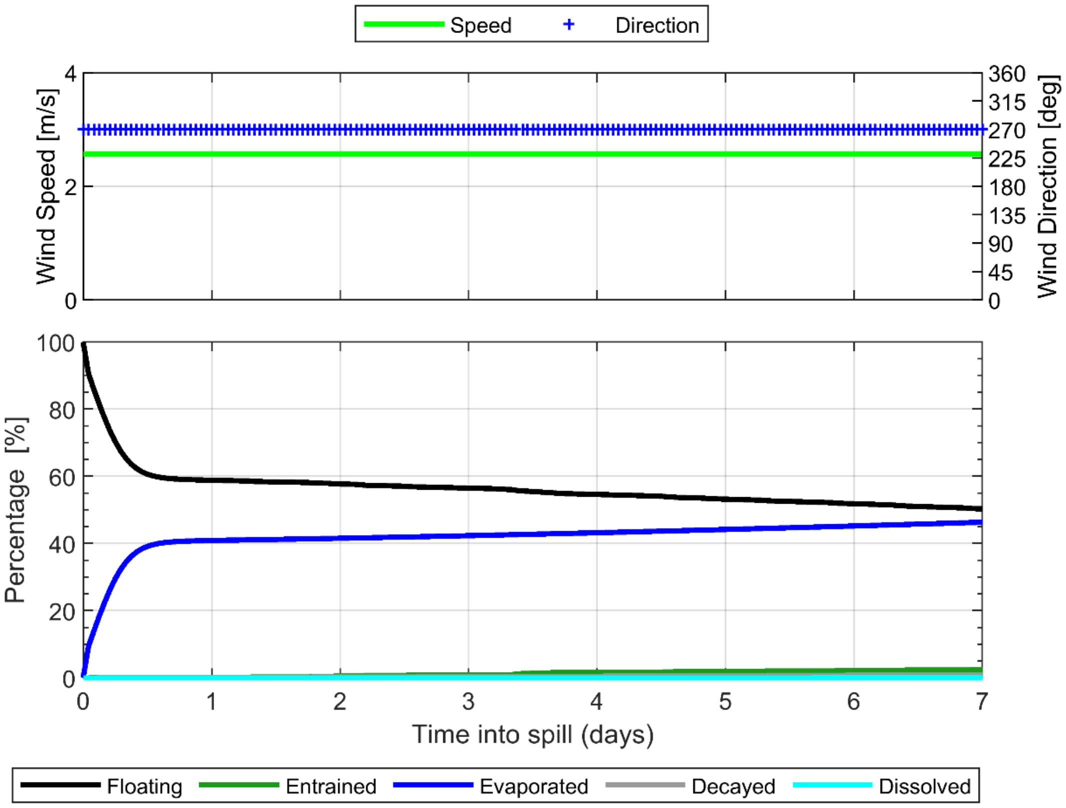


Figure 10-3 Proportional mass balance plot representing the weathering of MDO spilled onto the water surface over 1 hour and subject to a constant 5 knots (2.6 m/s) wind speed at 15°C water temperature.

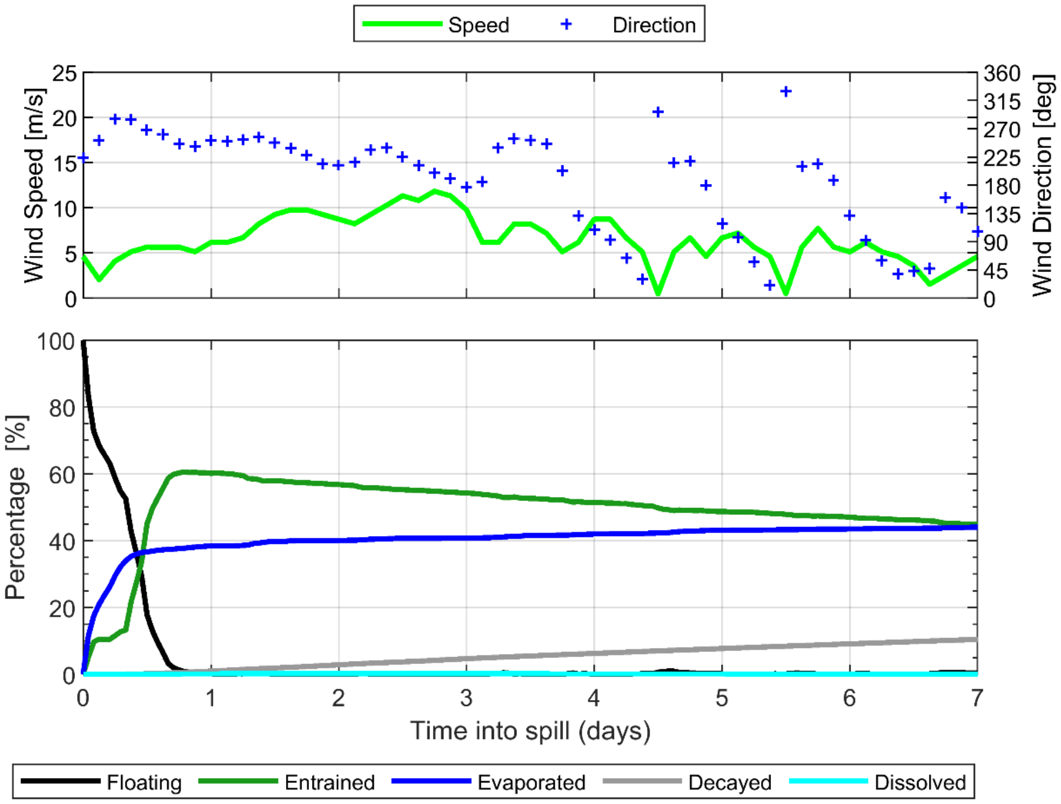


Figure 10-4 Proportional mass balance plot representing the weathering of MDO spilled onto the water over 1 hour and subject to variable wind speeds (1-12 knots) at 15°C water temperature.

11 OIL SPILL SCENARIOS

Table 11-1 provides a summary of the oil spill model settings.

Table 11-1 Summary of the oil spill model settings and thresholds used in this assessment.

Parameter	Northern Release Location		TW1	
Description	Loss of well control	Loss of containment	Loss of well control	Loss of containment
Number of randomly selected spill start times	100 per season	100 per season	100 per season	100 per season
Model period	Summer (November through to March) and Winter (April to October)			
Oil type	Thylacine condensate	Marine Diesel	Thylacine condensate	Marine Diesel
Spill volume	434,752 stb	603.7 m^3	102,576 stb	603.7 m^3
Release type	Subsea (71.5 m)	Surface	Subsea (105 m)	Surface
Release duration	86 days (variable release rate)	6 hours	86 days (variable release rate)	6 hours
Simulation length	100 days	30 days	100 days	30 days
Surface oil concentration thresholds (g/m^2)^	1 (low); 10 (moderate); 50 (high)			
Shoreline oil accumulation thresholds (g/m^2)^	10 (low); 100 (moderate); 1,000 (high)			
Dissolved hydrocarbon concentrations (ppb)^	10 (low); 50 (moderate); 400 (high)			
Entrained hydrocarbon concentrations (ppb)^	10 (low); 100 (moderate); 1,000 (high)			

^Thresholds based on NOPSEMA (2019)

12 PRESENTATION AND INTERPRETATION OF MODEL RESULTS

The results from the modelling study are presented in a number of tables and figures, which aim to provide an understanding of the predicted sea-surface and water column (subsurface) exposure and shoreline accumulation (if predicted).

12.1 Annual Analysis

12.1.1 Statistics

The statistics are based on the following principles:

- The ***greatest distance travelled by a spill trajectory*** – is determined by a) recording the maximum and b) second greatest distance travelled (or 99th percentile) by a single trajectory, within a scenario, from the release location to the identified exposure thresholds.

- The ***probability of oil exposure to a receptor*** – is determined by recording the number of spill trajectories to reach a specified sea surface or subsea threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.

- The ***minimum time before oil exposure to a receptor*** – is determined by ranking the elapsed time before sea surface exposure, at a specified threshold, to grid cells within a receptor polygon and recording the minimum value.

- The ***maximum residence time for oil exposure within a receptor*** – is determined by recording the longest continuous length of time a grid cell is exposed to either floating, entrained or dissolved hydrocarbon above each threshold, within each receptor.

- The ***probability of oil accumulation at a receptor*** – is determined by recording the number of spill trajectories to reach a specified shoreline accumulation threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.

- The ***maximum potential oil loading within a receptor*** – is determined by identifying the maximum loading to any grid cell within a receptor polygon, for a scenario.

- The ***dissolved and entrained hydrocarbon exposure*** – is determined by recording the maximum instantaneous concentrations at each grid cell.

- ***Maximum total volume ashore*** (found in shoreline statistics table) – is the total volume of oil stranded on the shorelines throughout the duration of the simulation, regardless of timing.

- ***Maximum instantaneous peak volume ashore*** (found in the deterministic analysis section and derived from the histogram) – is the peak volume of oil accumulated on shorelines at a single point in time. This peak value does not include oil that came ashore earlier in the simulation and was subsequently lost through evaporative or other weathering processes.

12.2 Receptors Assessed

A range of environmental receptors and shorelines were assessed for floating oil exposure, shoreline accumulation and water column exposure as part of the study. Receptors assessed include the Australian Government receptors, made available through the Protected Matters Search Tool (PMST), in addition to Biologically Important Areas (BIAs), State Waters and the Victorian Marine Pollution Risk Assessment shoreline segments. Some of these receptor groups are depicted in Figure 12-1 to Figure 12-11.

Risks of exposure were separately calculated for each receptor area and have been tabulated. Table 12-1 summarise the receptors that the Northern Release Location and TW1 reside within.

Table 12-1 Summary of the receptors that the release locations reside within.

Receptor Type	Receptor Name	Northern Release Location	TW1
BIA	Antipodean Albatross – Foraging	Yes	Yes
	Black-browed Albatross – Foraging	Yes	Yes
	Buller’s Albatross – Foraging	Yes	Yes
	Campbell Albatross – Foraging	Yes	Yes
	Common Diving-petrel – Foraging	Yes	Yes
	Indian Yellow-nosed Albatross – Foraging	Yes	Yes
	Pygmy Blue Whale – Distribution	Yes	Yes
	Pygmy Blue Whale - Foraging (annual high use area)	Yes	Yes
	Short-tailed Shearwater – Foraging	No	Yes
	Shy Albatross – Foraging	Yes	Yes
	Southern Right Whale - Known Core Range	Yes	Yes
	Wandering Albatross – Foraging	Yes	Yes
	Wedge-tailed Shearwater – Foraging	Yes	Yes
	White Shark – Distribution	Yes	Yes
IMCRA	Otway	Yes	Yes

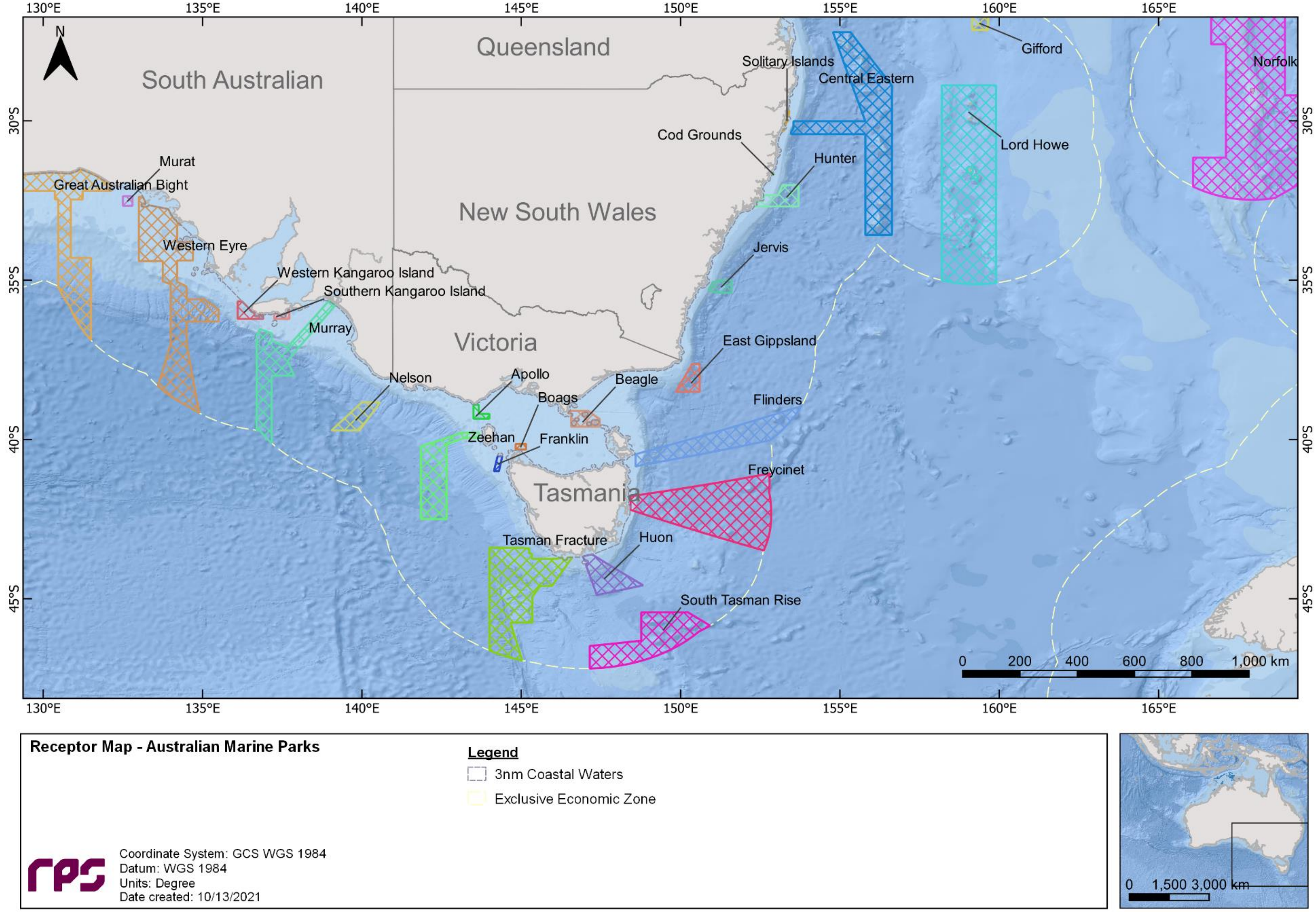


Figure 12-1 Receptor map for Australian Marine Parks (AMP).

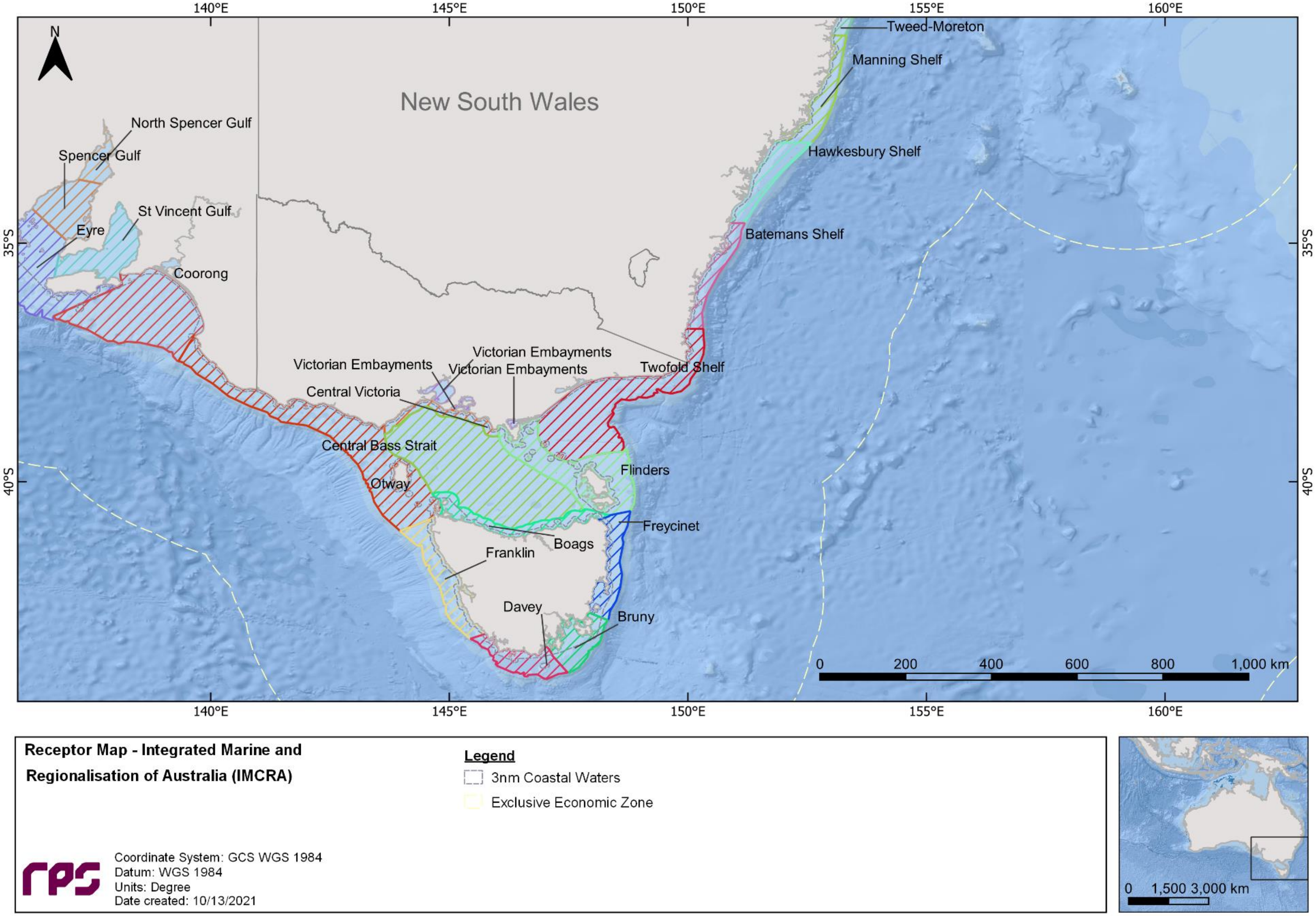


Figure 12-2 Receptor map for integrated marine and coastal regionalisation (IMCRA) areas.

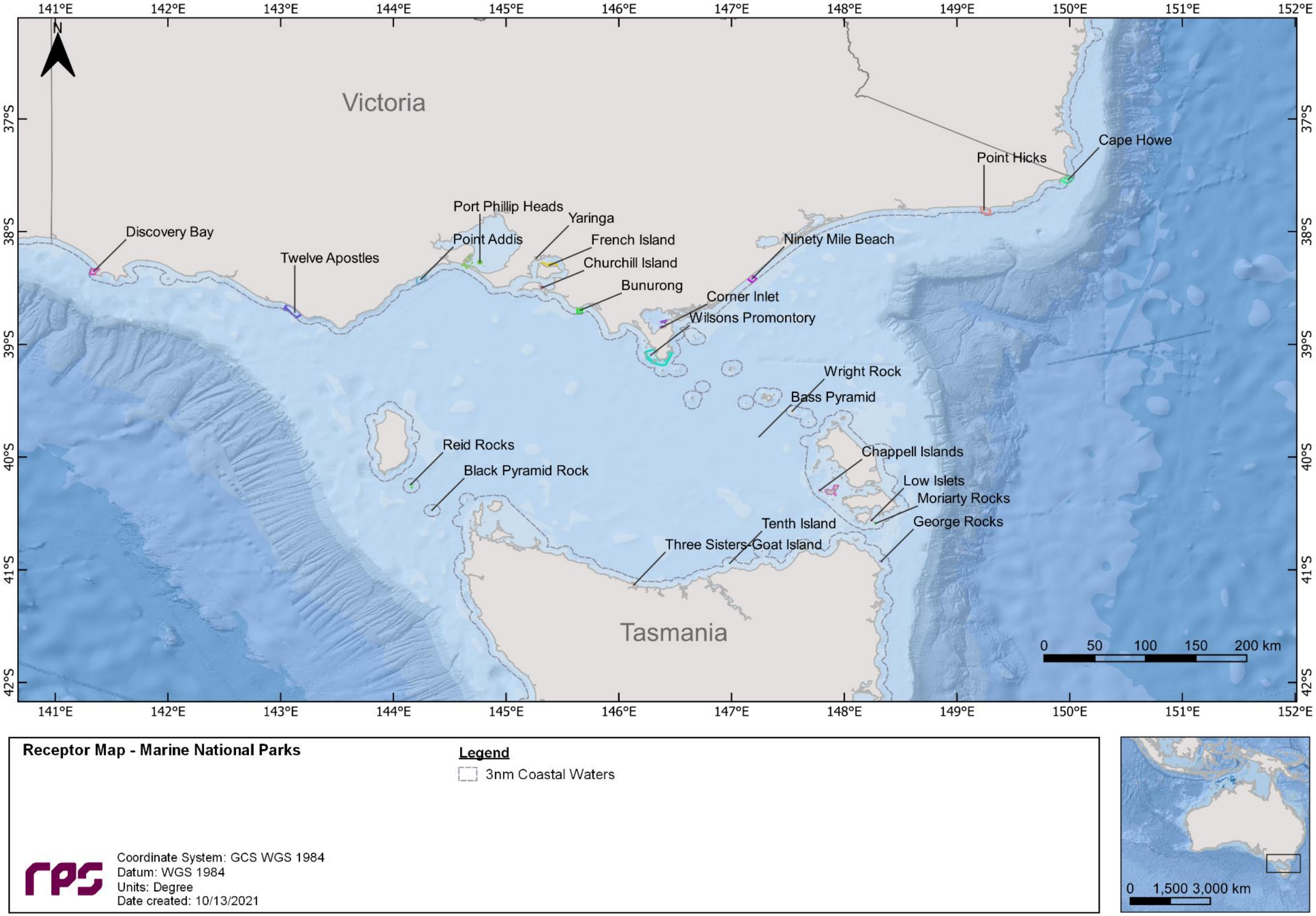


Figure 12-3 Receptor map for Marine National Parks (MNP).

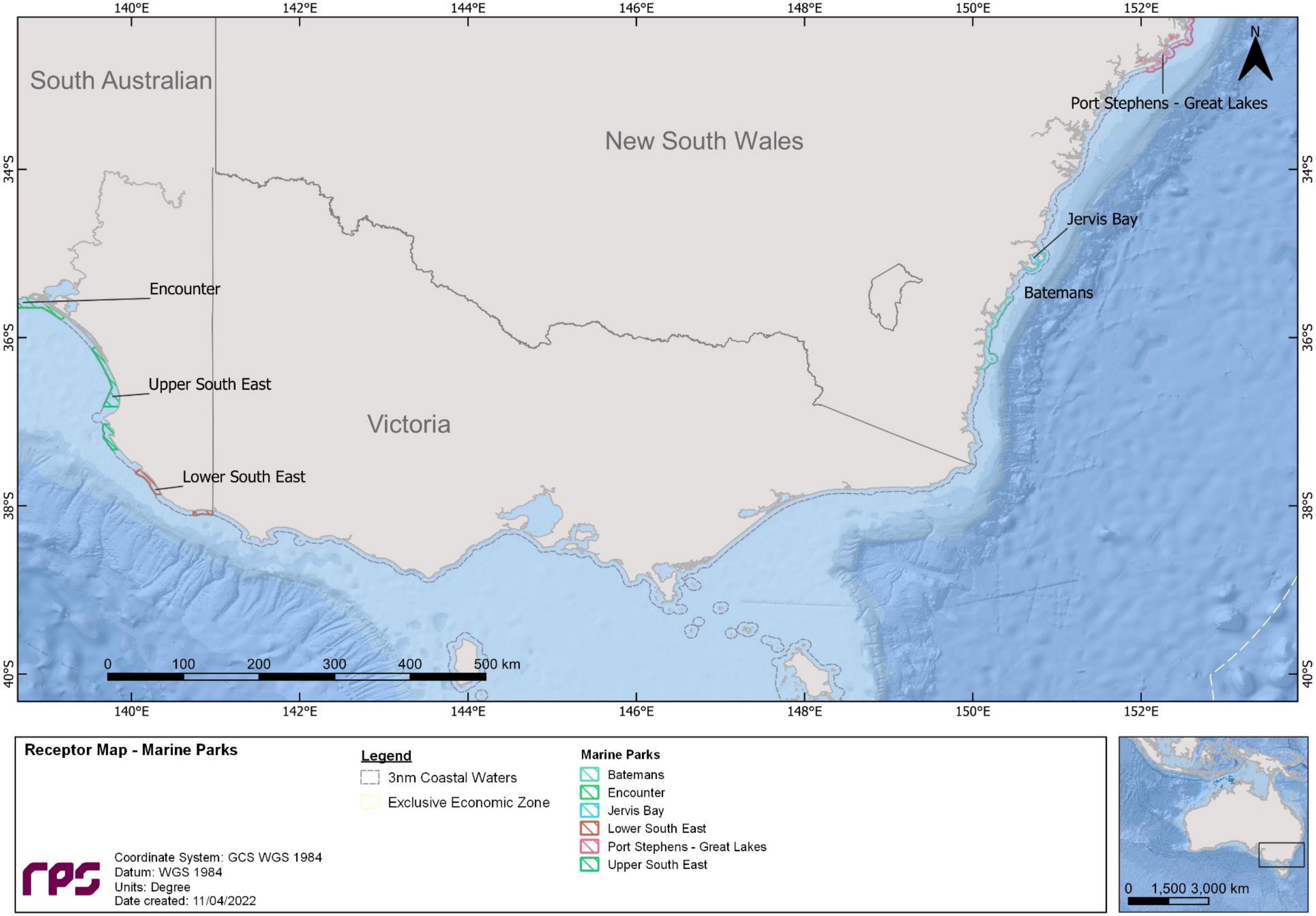


Figure 12-4 Receptor map for Marine Parks (MP).

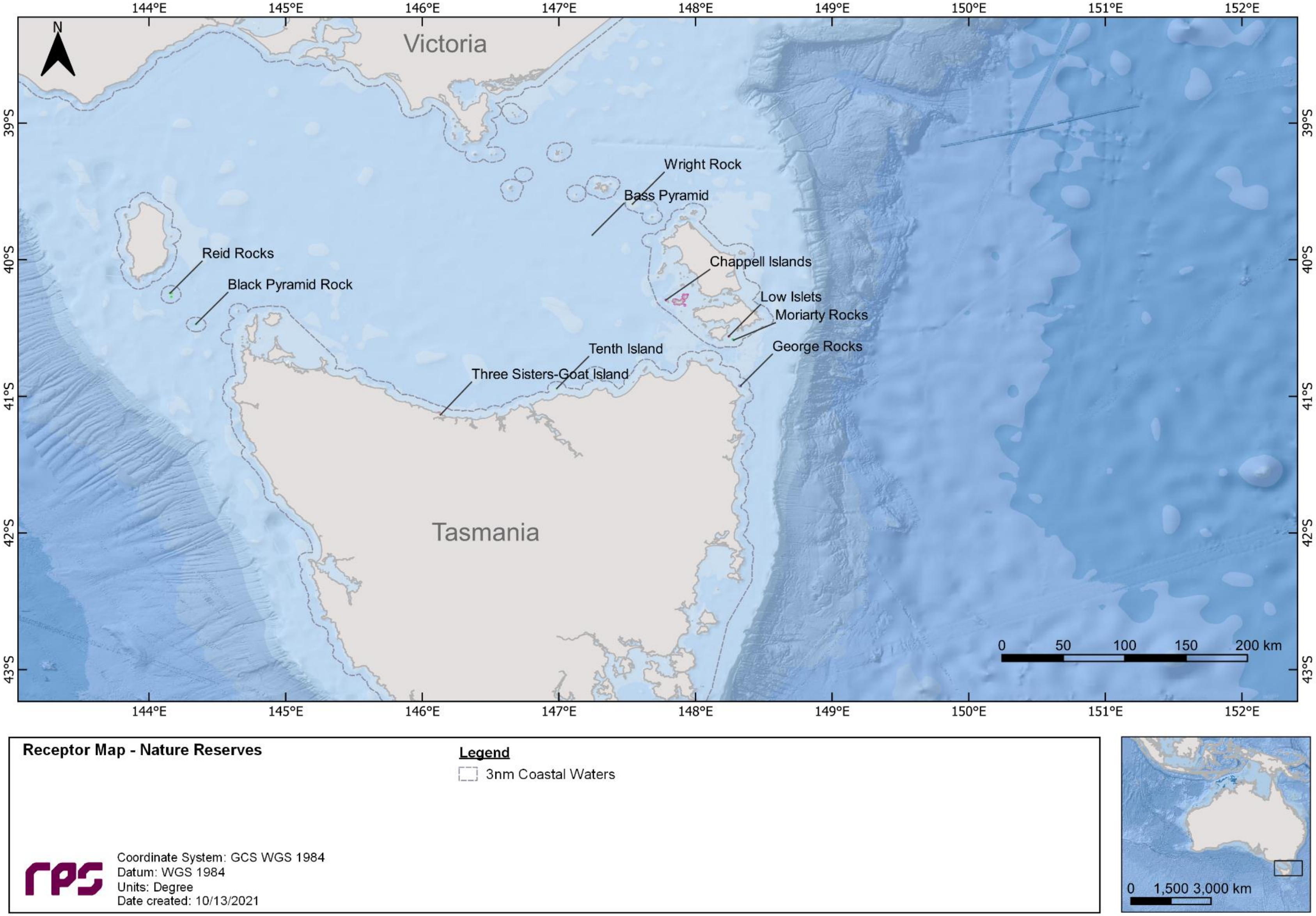


Figure 12-5 Receptor map for Nature Reserves (NR).

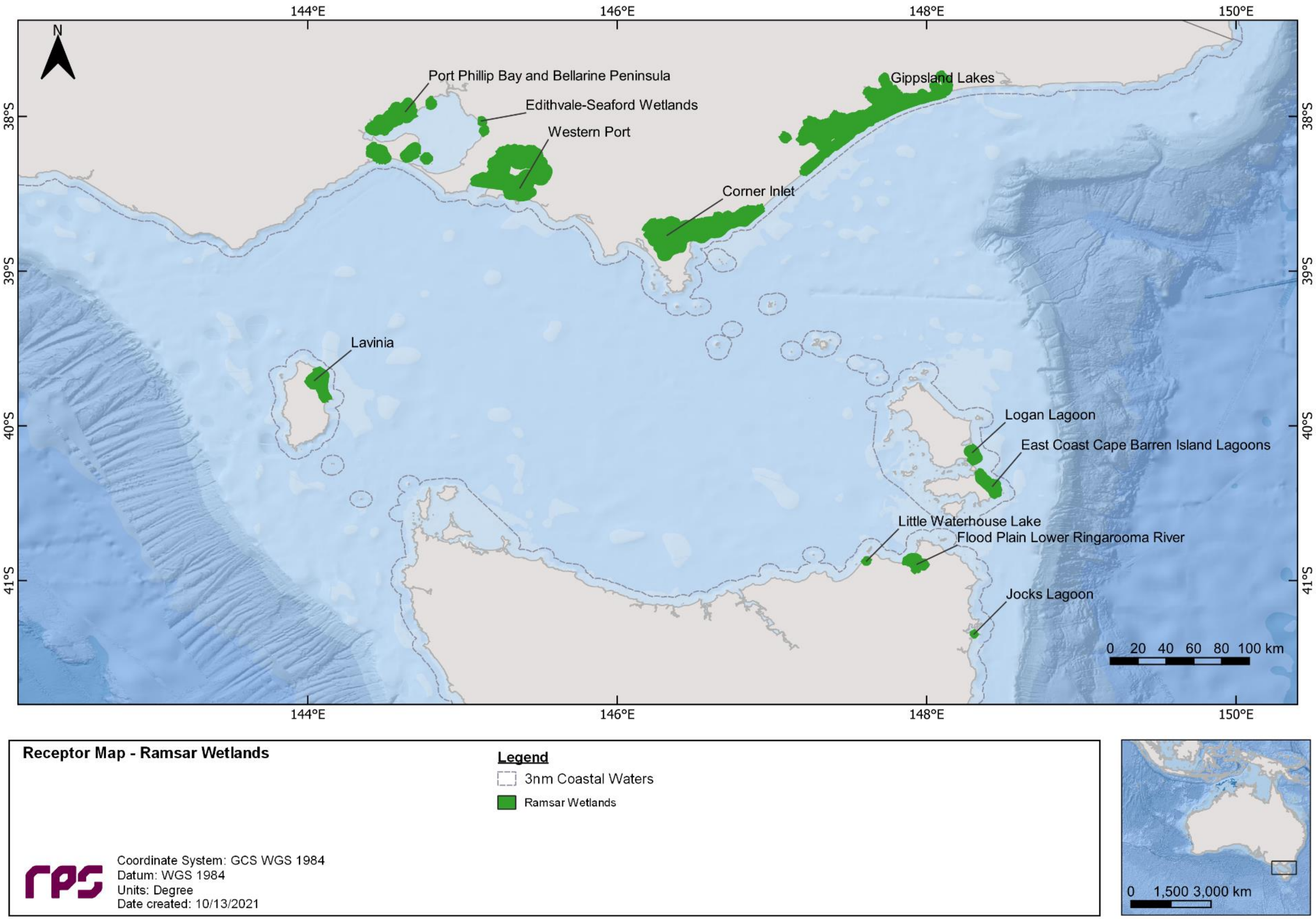


Figure 12-6 **Receptor map for Ramsar Sites (Ramsar).**

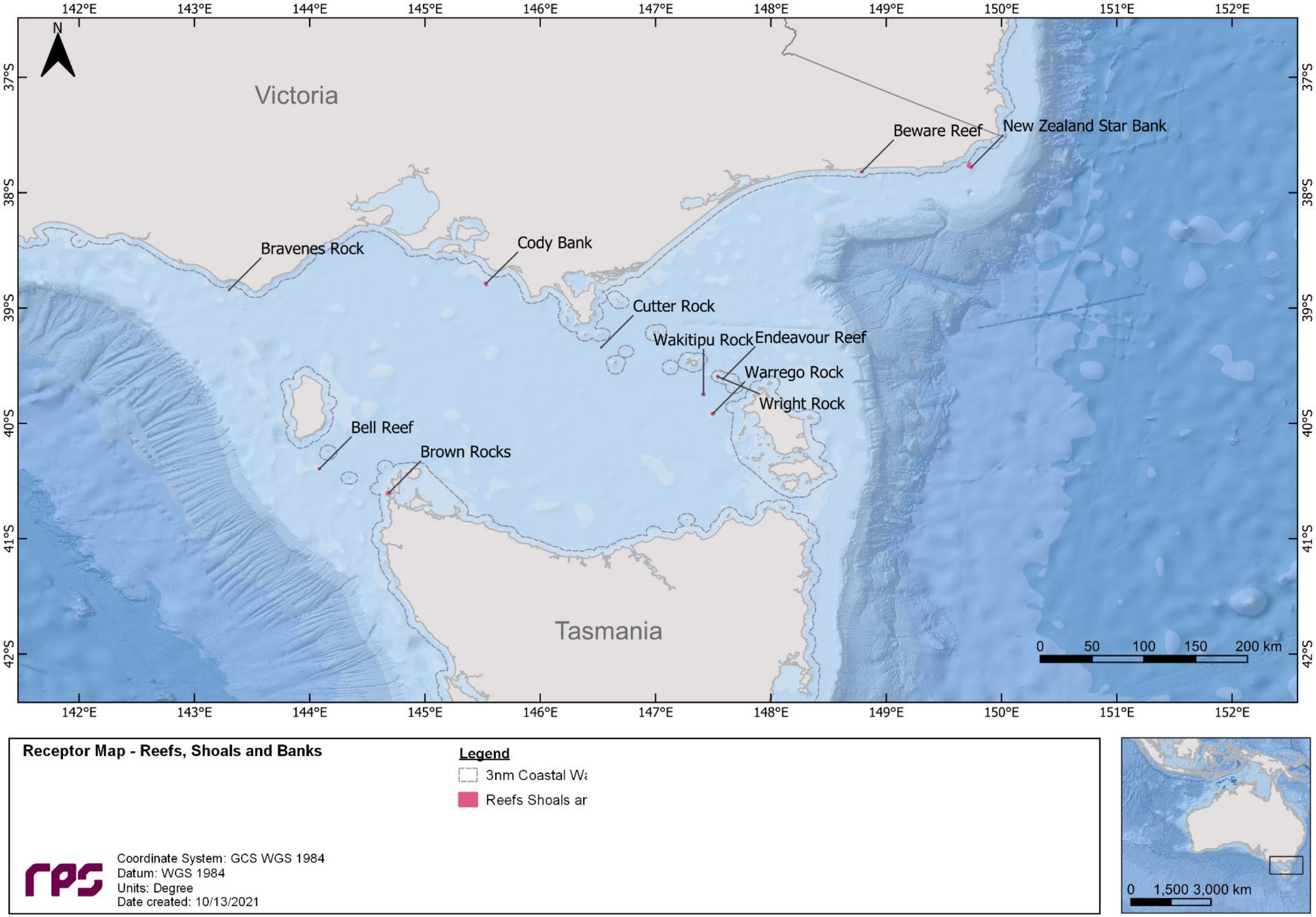


Figure 12-7 Receptor map for Reefs, Shoals and Banks (RSB).

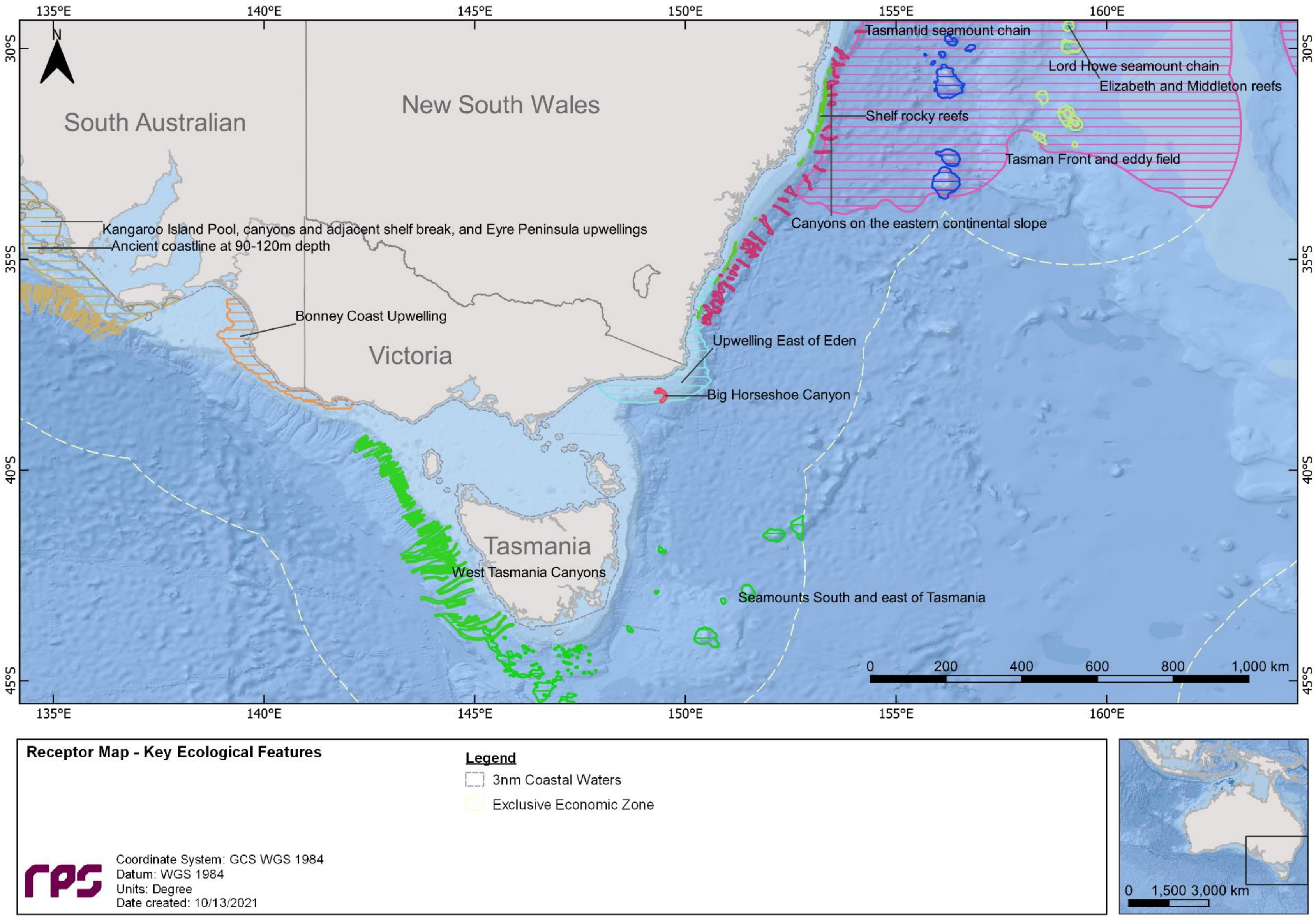


Figure 12-8 Receptor map for Key Ecological Features (KEF).

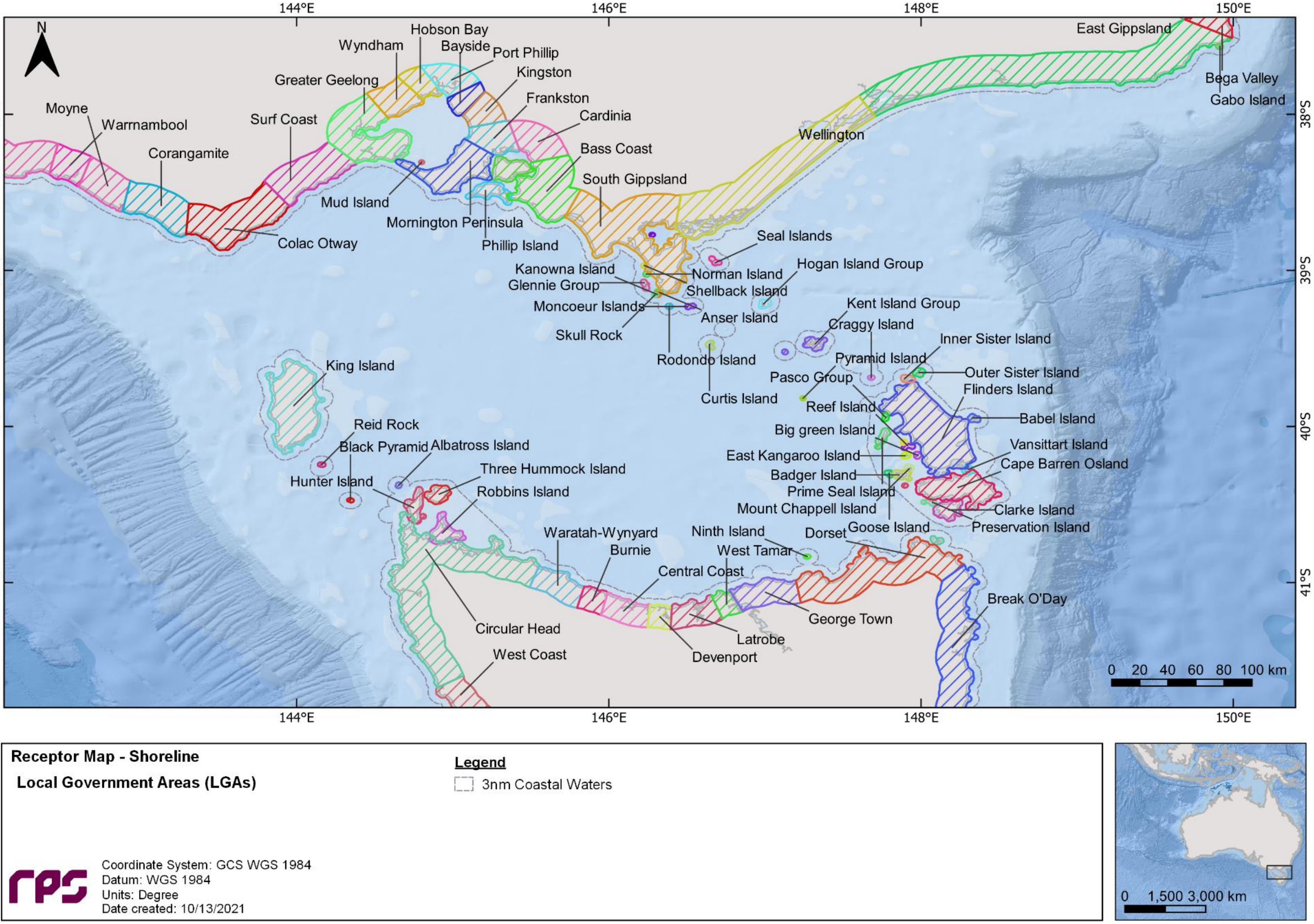


Figure 12-9 **Receptor map for shorelines (1 of 3).**

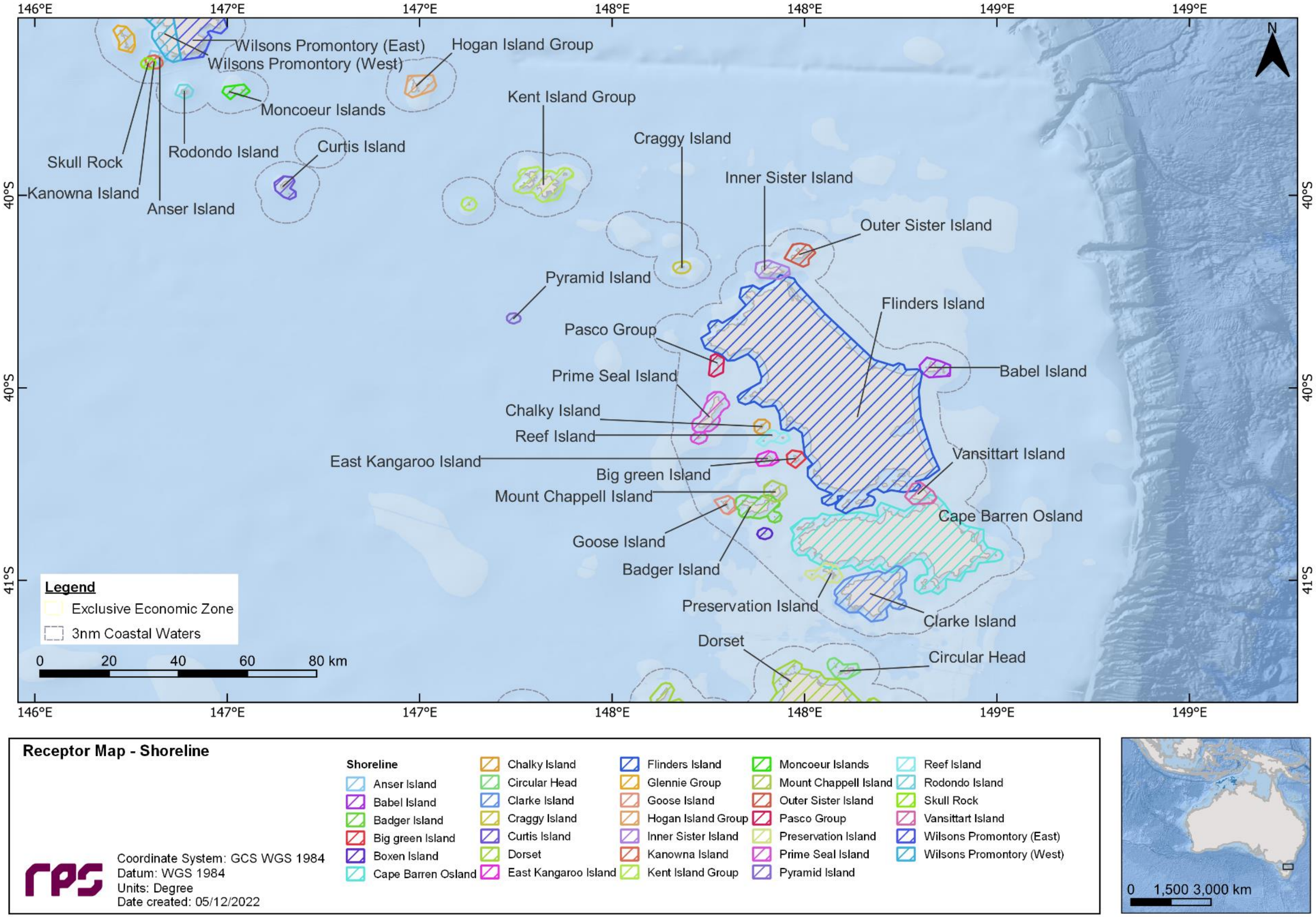


Figure 12-10 Receptor map for shorelines (2 of 3).

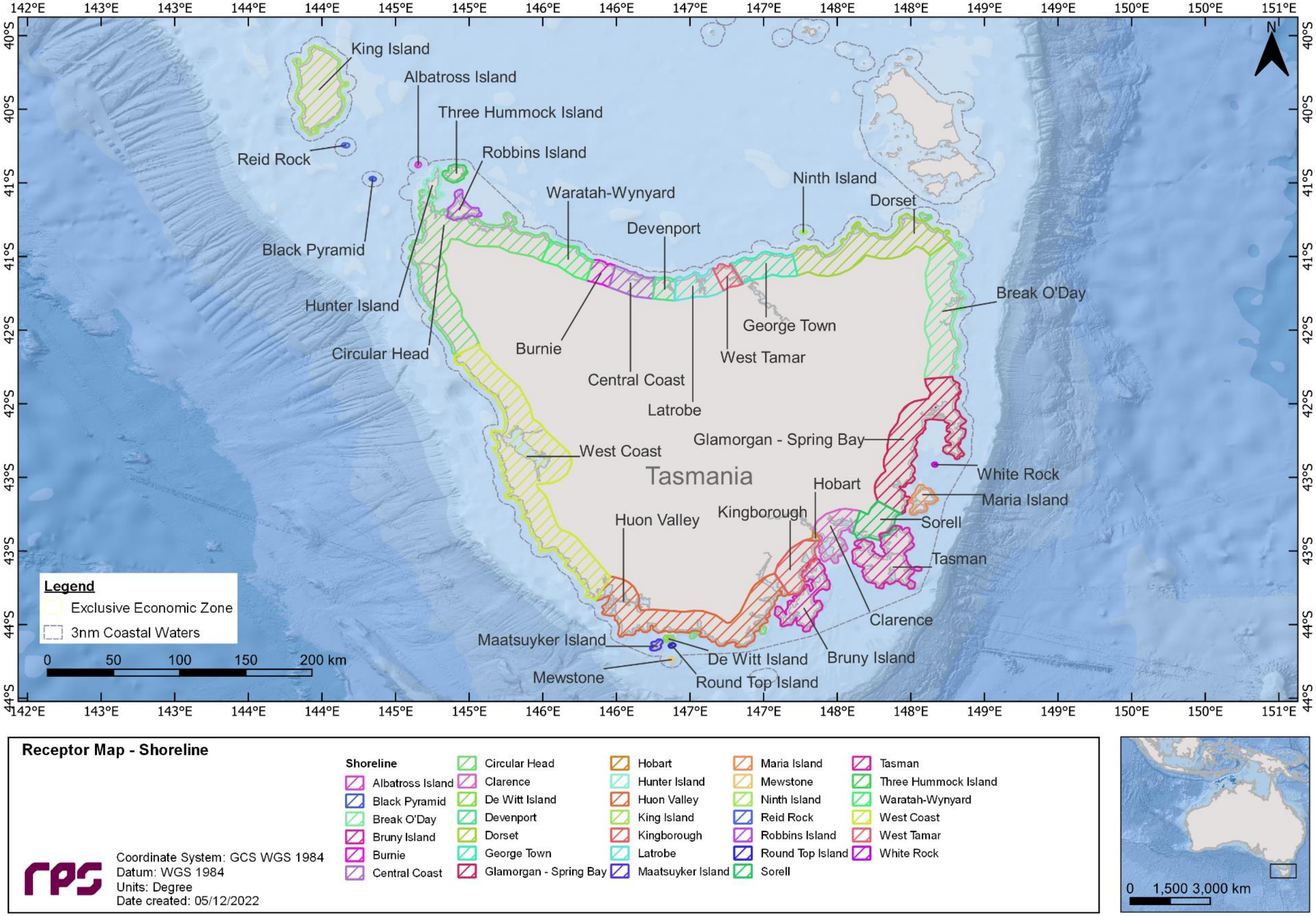


Figure 12-11 **Receptor map for shorelines (3 of 3).**

13 RESULTS – LOSS OF WELL CONTROL AT THE NORTHERN RELEASE LOCATION

This scenario examined a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. A total of 200 spill simulations were run (i.e., 100 spills per season) and tracked for 100 days. The results for all 100 simulations per season were combined and are presented on a seasonal basis (i.e., summer and winter).

13.1 Stochastic Analysis

13.1.1 Area of Exposure

Figure 13-1 presents the combined area of potential exposure for surface, shoreline, entrained and dissolved, by overlaying the results from all 200 simulations (i.e., 100 per season) during summer and winter conditions.

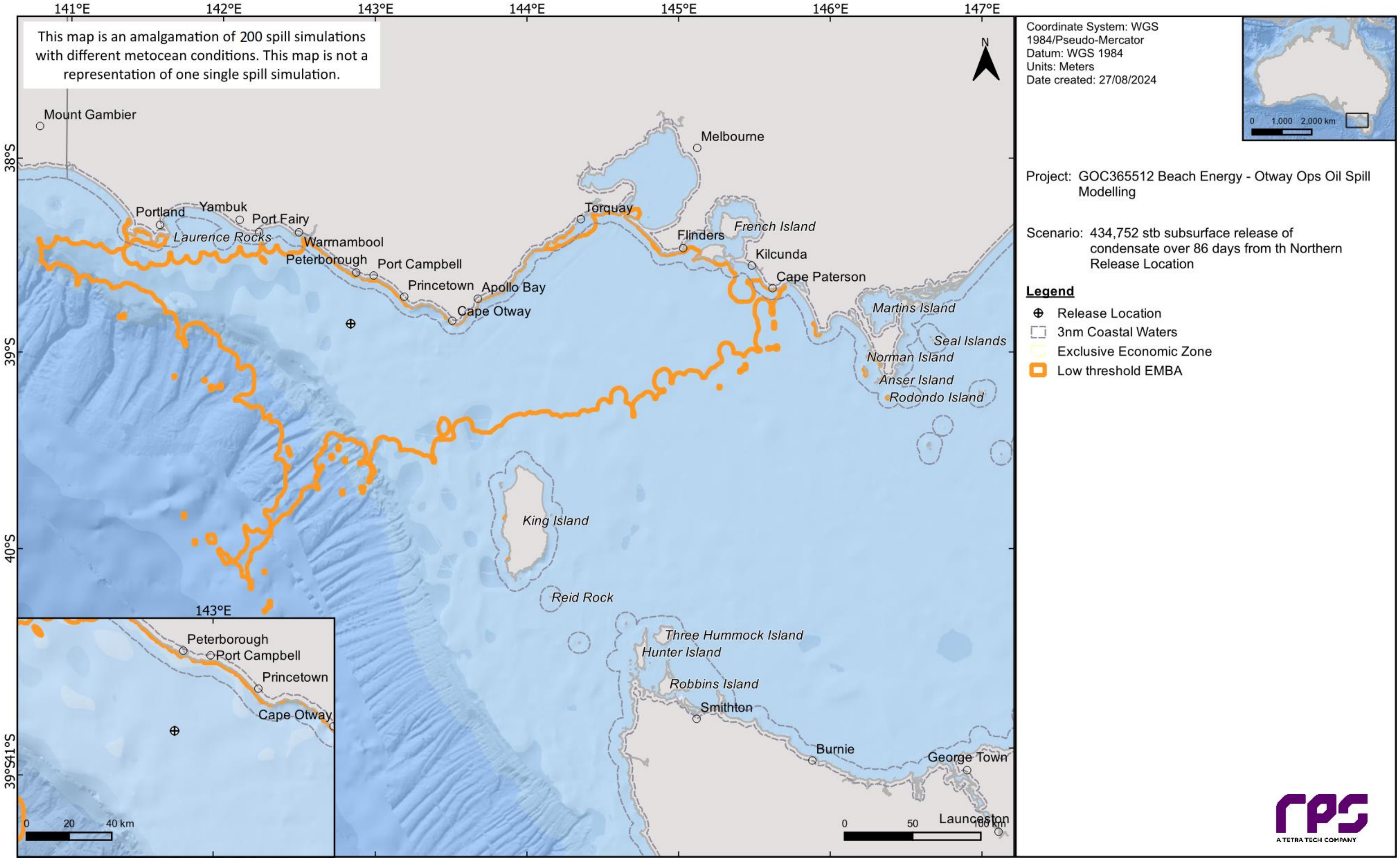


Figure 13-1 Predicted area of exposure for low thresholds produced by overlaying the results from all 200 simulations, resulting from a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location during summer and winter conditions.

13.1.2 Floating Oil Exposure

Table 13-1 summarises the maximum distance travelled by floating oil on the sea surface at each threshold. The maximum distances from the release location to the low (1–10 g/m^2) and moderate (10–50 g/m^2) exposure zones were 54.03 km (east) and 5.83 km (east-southeast), both during winter conditions. No contact was predicted for the high threshold (> 50 g/m^2).

Table 13-2 summarises the potential floating oil exposure to individual receptors during the summer and winter conditions. Outside of the receptors that the Northern Release Location resides within (refer to Table 12-1), floating oil exposure above the low threshold was predicted at the Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait), being 6% and 9% during summer and winter respectively.

Table 13-3 presents the maximum residence time of floating oil exposure for each individual grid cell within each individual receptor during summer and winter.

Figure 13-2 and Figure 13-3 present the zones of potential floating oil exposure for all thresholds under summer and winter conditions, respectively.

Figure 13-4 to Figure 13-7 present the minimum time before floating oil exposure for the NOPSEMA thresholds during summer and winter.

Table 13-1 Maximum distance and direction from the release location to the edge of floating oil exposure. Results are based on a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations per season.

Season	Distance and direction travelled	Zones of potential floating oil exposure		
		Low	Moderate	High
Summer	Maximum distance (km) from release location	31.4	3.93	-
	Direction	East	West	-
Winter	Maximum distance (km) from release location	54.03	5.83	-
	Direction	East	East-Southeast	-

Table 13-2 Summary of the potential floating oil exposure to individual receptors. Results are based on a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations per season.

Receptor		Summer (November through March)						Winter (April to October)					
		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)			Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	Pygmy Blue Whale - Distribution (None)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	5	-	-	6.21	-	-	6	-	-	10.73	-	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)	6	-	-	5.78	-	-	9	-	-	4.63	-	-
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area)	-	-	-	-	-	-	3	-	-	17.36	-	-
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer-Muttonbird Island (VIC))**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	White Shark - Distribution (Between the 60-120m depth contour)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
IMCRA-MESO	Otway**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
IMCRA-PROV	Western Bass Strait Shelf Transition**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
MR	South-east (Marine)**	100	96	-	0.02	0.16	-	100	96	-	0.02	0.09	-
NRMR	Corangamite (VIC)	-	-	-	-	-	-	3	-	-	17.36	-	-
SHORE-VIC-MPRA	Cape Otway West	-	-	-	-	-	-	3	-	-	17.36	-	-
State Waters	Victoria	-	-	-	-	-	-	3	-	-	17.36	-	-

*The release location resides within the receptor boundaries.

Table 13-3 Summary of the maximum residence time of floating oil exposure for each individual grid cell within each individual receptor. Results are based on a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations per season.

Receptor		Summer (November through to March)			Winter (April to October)		
		Maximum residence time of floating oil exposure (days)			Maximum residence time of floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	35.75	4.75	-	36.75	5.25	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	35.75	4.75	-	36.75	5.25	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	35.75	4.75	-	36.75	5.25	-
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	35.75	4.75	-	36.75	5.25	-
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	35.75	4.75	-	36.75	5.25	-
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	35.75	4.75	-	36.75	5.25	-
	Pygmy Blue Whale - Distribution (None)**	35.75	4.75	-	36.75	5.25	-
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	1	-	-	7.25	-	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	35.75	4.75	-	36.75	5.25	-
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)	1.5	-	-	7.25	-	-
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	35.75	4.75	-	36.75	5.25	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	35.75	4.75	-	36.75	5.25	-
	Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area)	-	-	-	7.25	-	-
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	35.75	4.75	-	36.75	5.25	-
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	35.75	4.75	-	36.75	5.25	-
	White Shark - Distribution (Between the 60-120m depth contour)**	35.75	4.75	-	36.75	5.25	-
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	35.75	4.75	-	36.75	5.25	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	35.75	4.75	-	36.75	5.25	-
IMCRA-MESO	Otway**	35.75	4.75	-	36.75	5.25	-
IMCRA-PROV	Western Bass Strait Shelf Transition**	35.75	4.75	-	36.75	5.25	-
MR	South-east (Marine)**	35.75	4.75	-	36.75	5.25	-
NRMR	Corangamite (VIC)	-	-	-	7.25	-	-
SHORE-VIC-MPRA	Cape Otway West	-	-	-	7.25	-	-
State Waters	Victoria	-	-	-	7.25	-	-

*The release location resides within the receptor boundaries.

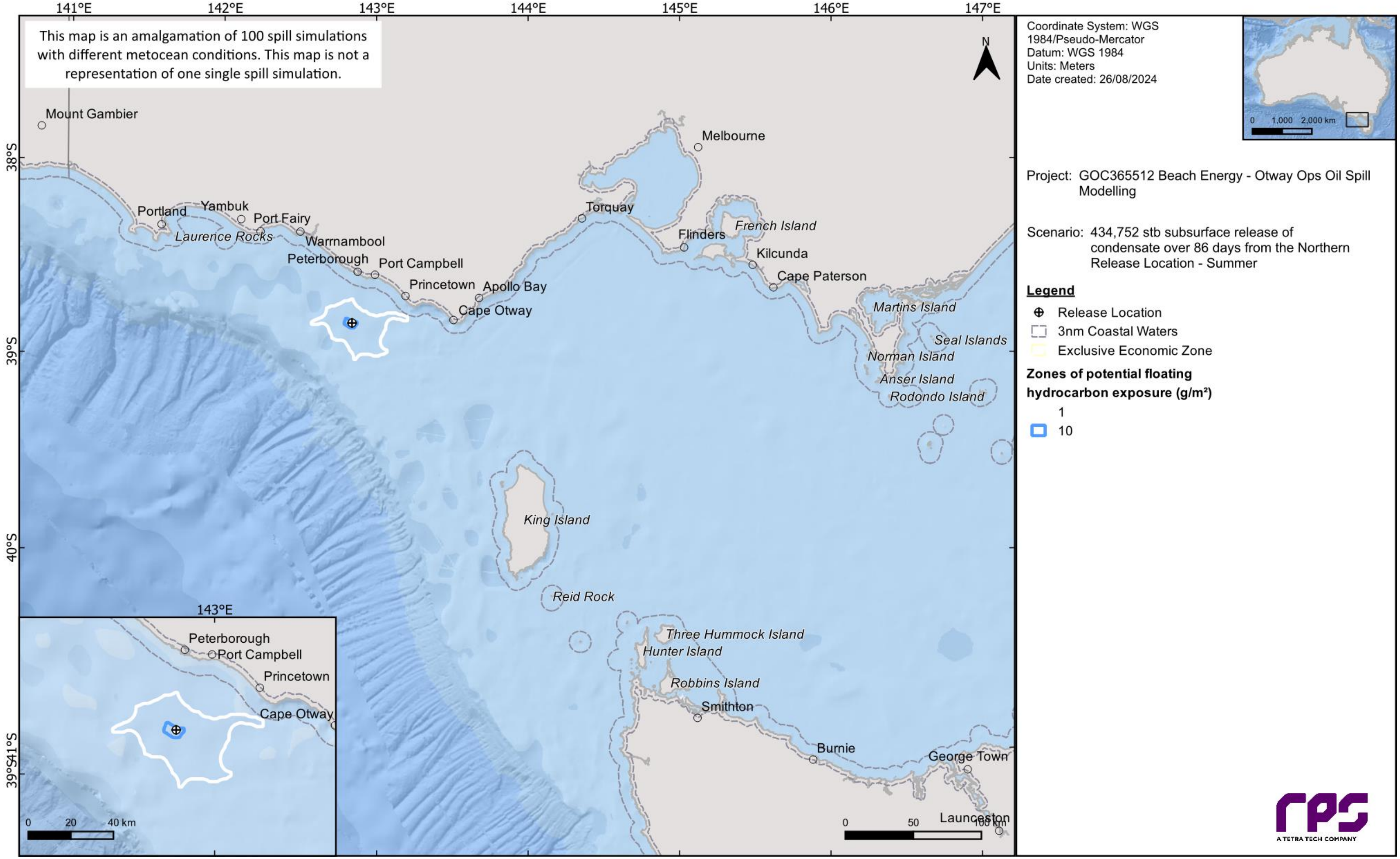


Figure 13-2 Zones of potential floating oil exposure in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

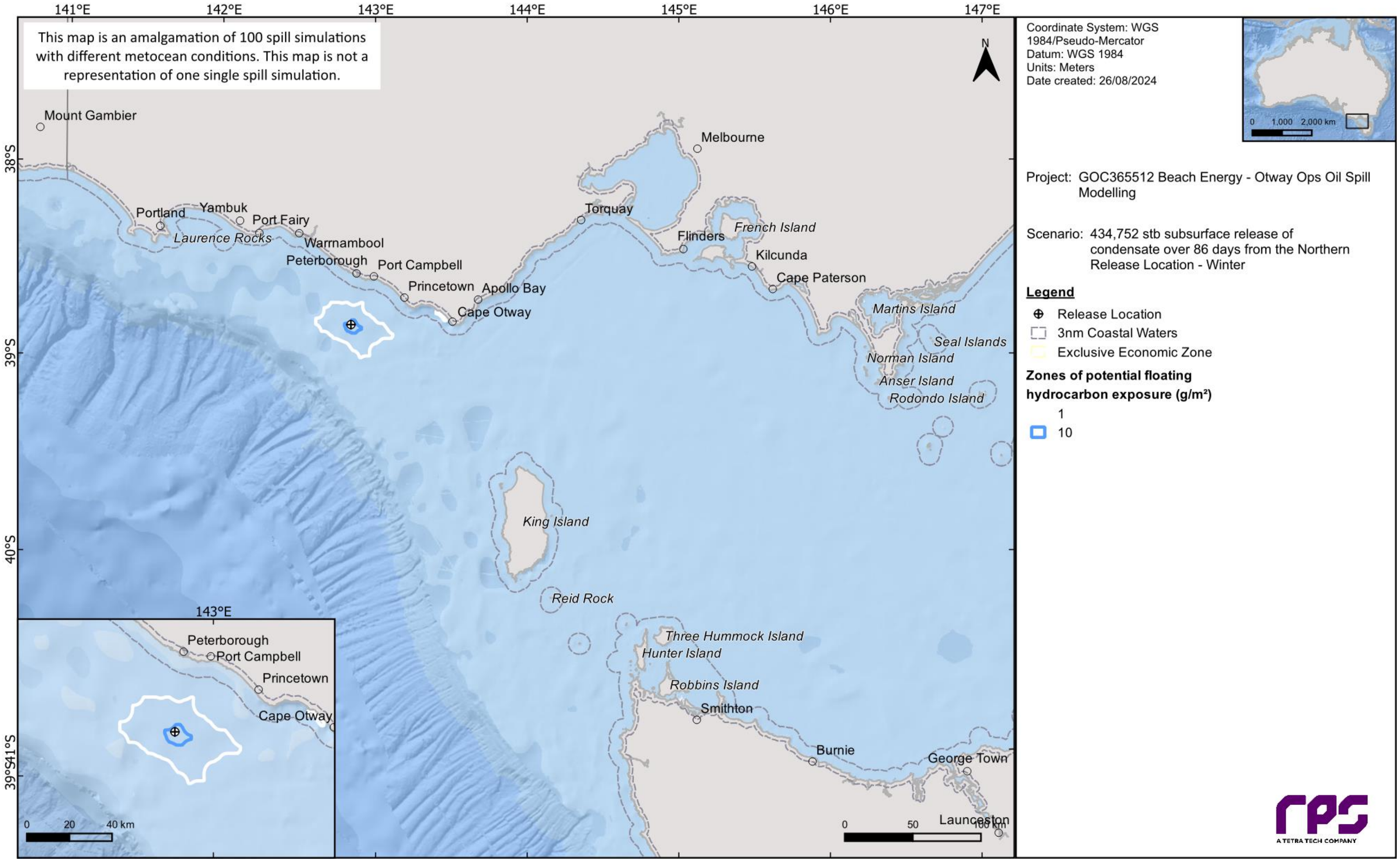


Figure 13-3 Zones of potential floating oil exposure in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

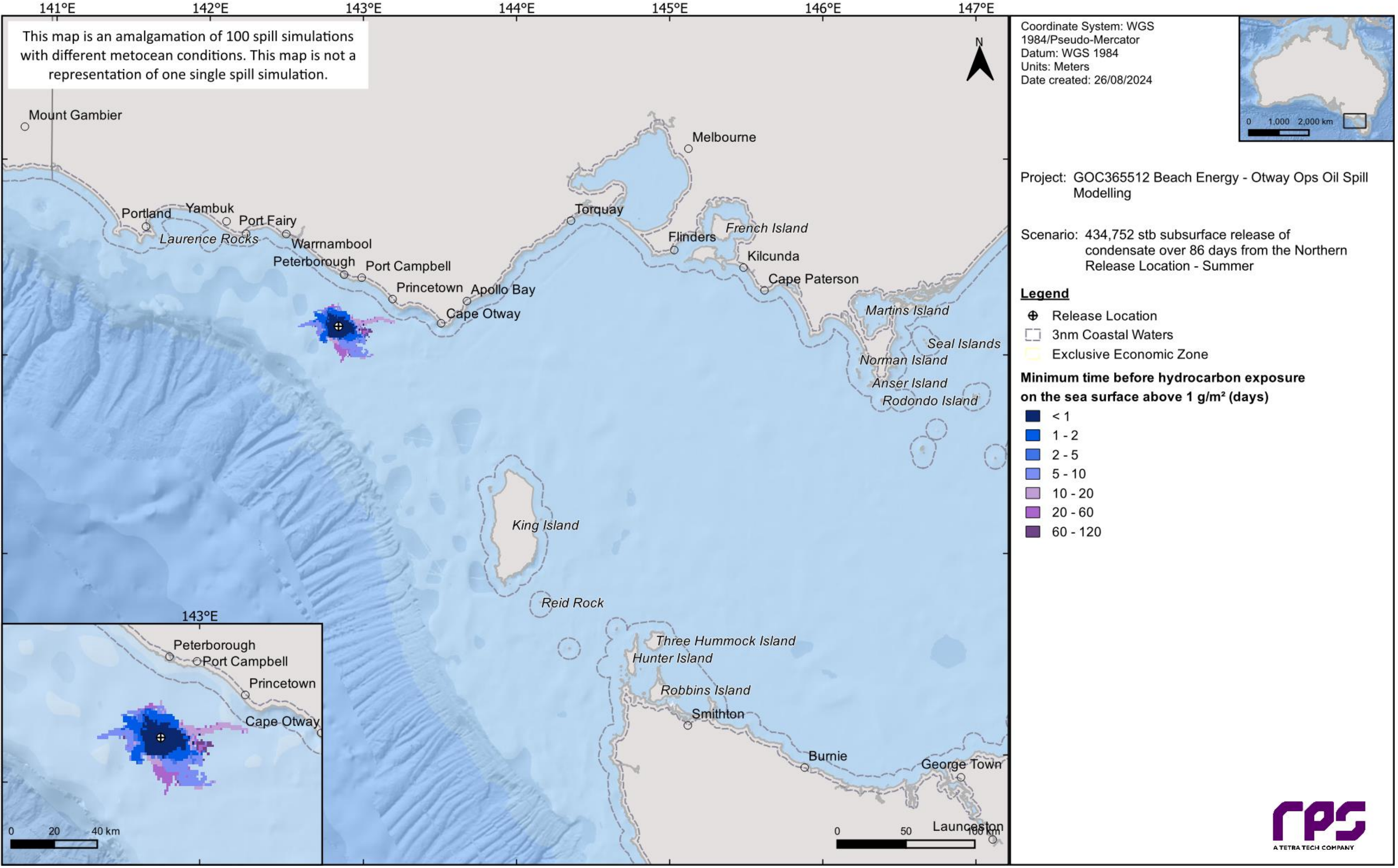


Figure 13-4 Minimum time before floating oil exposure above 1 g/m^2, in the event of 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

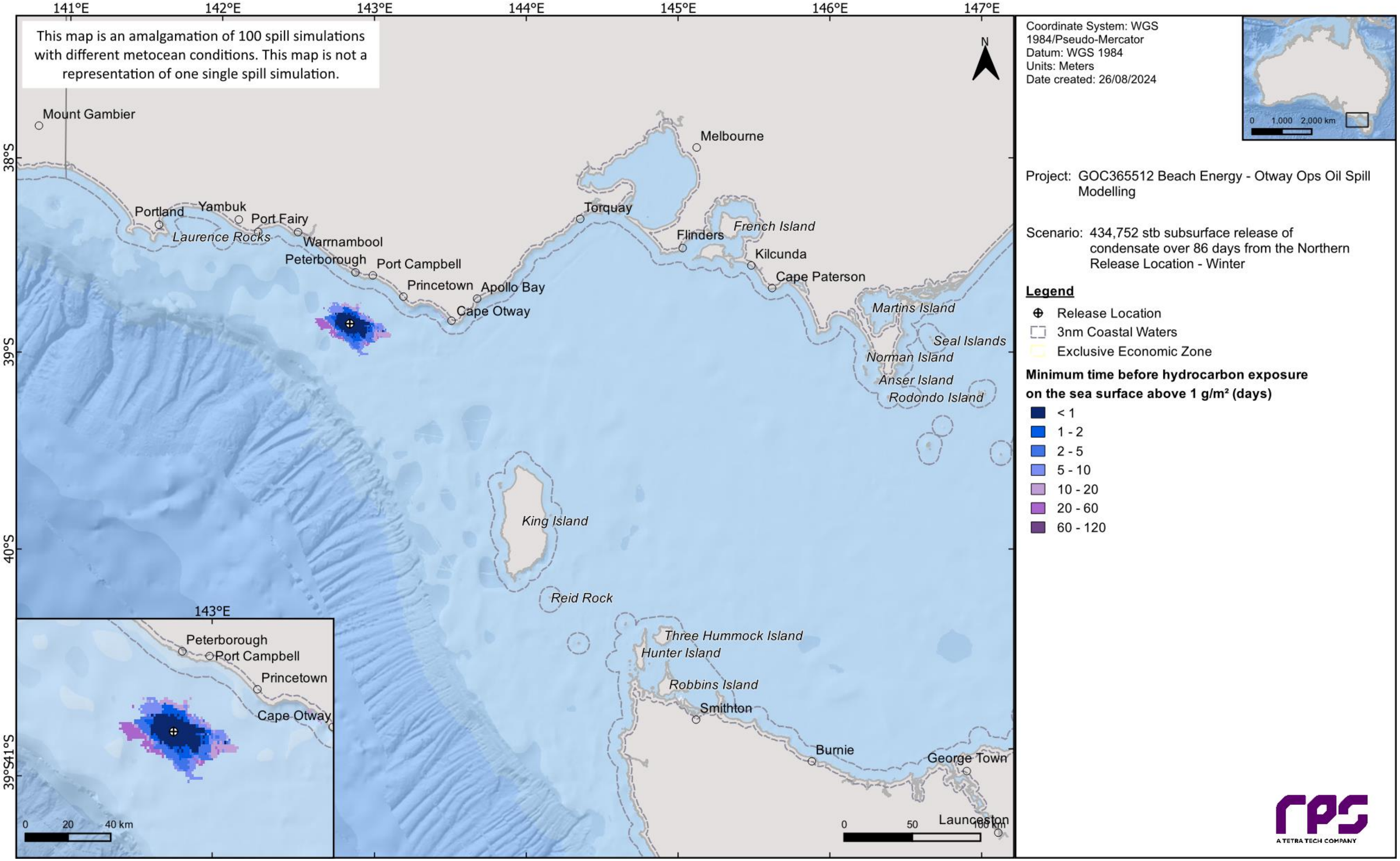


Figure 13-5 Minimum time before floating oil exposure above 1 g/m^2, in the event of 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

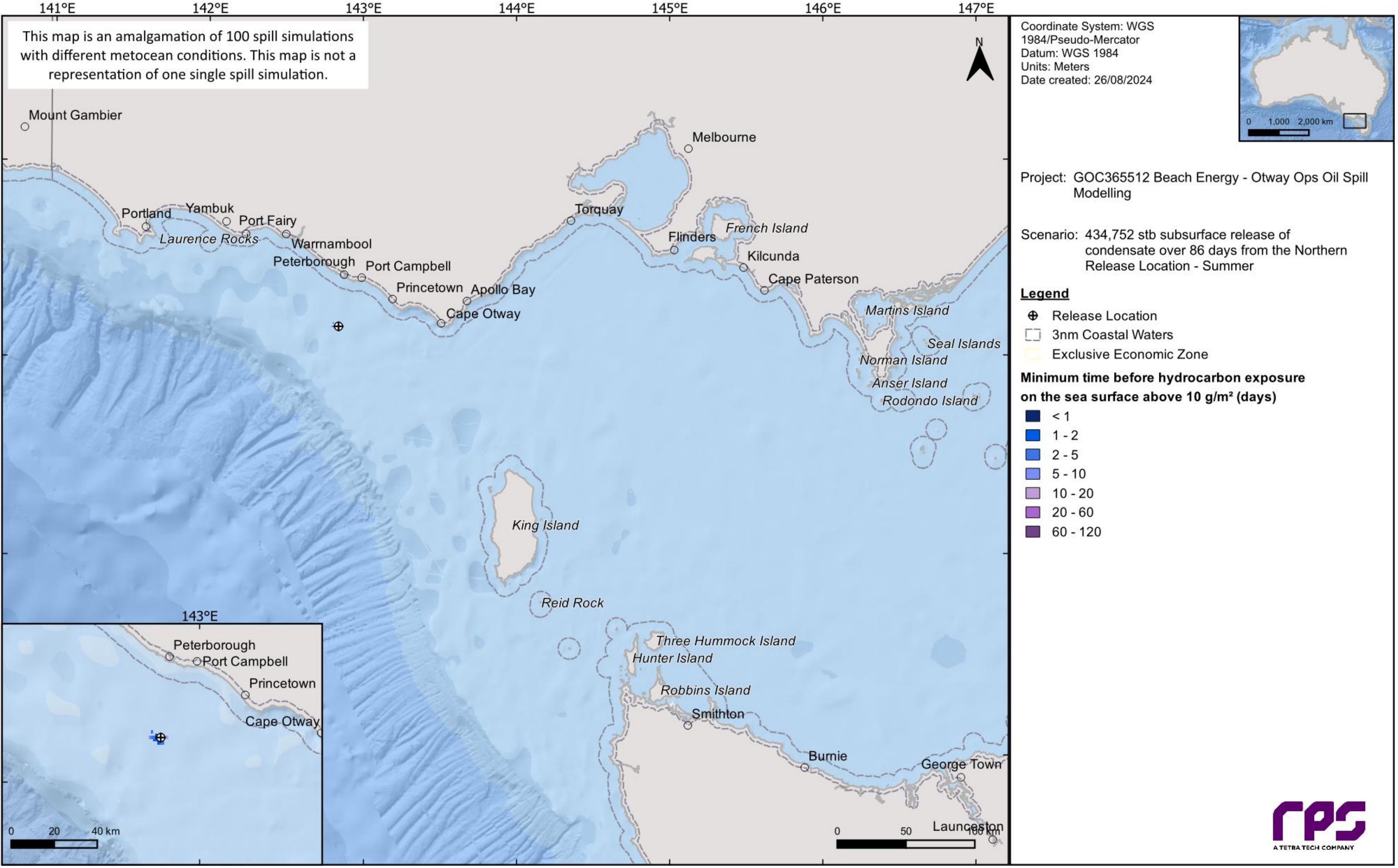


Figure 13-6 Minimum time before floating oil exposure above 10 g/m^2, in the event of 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

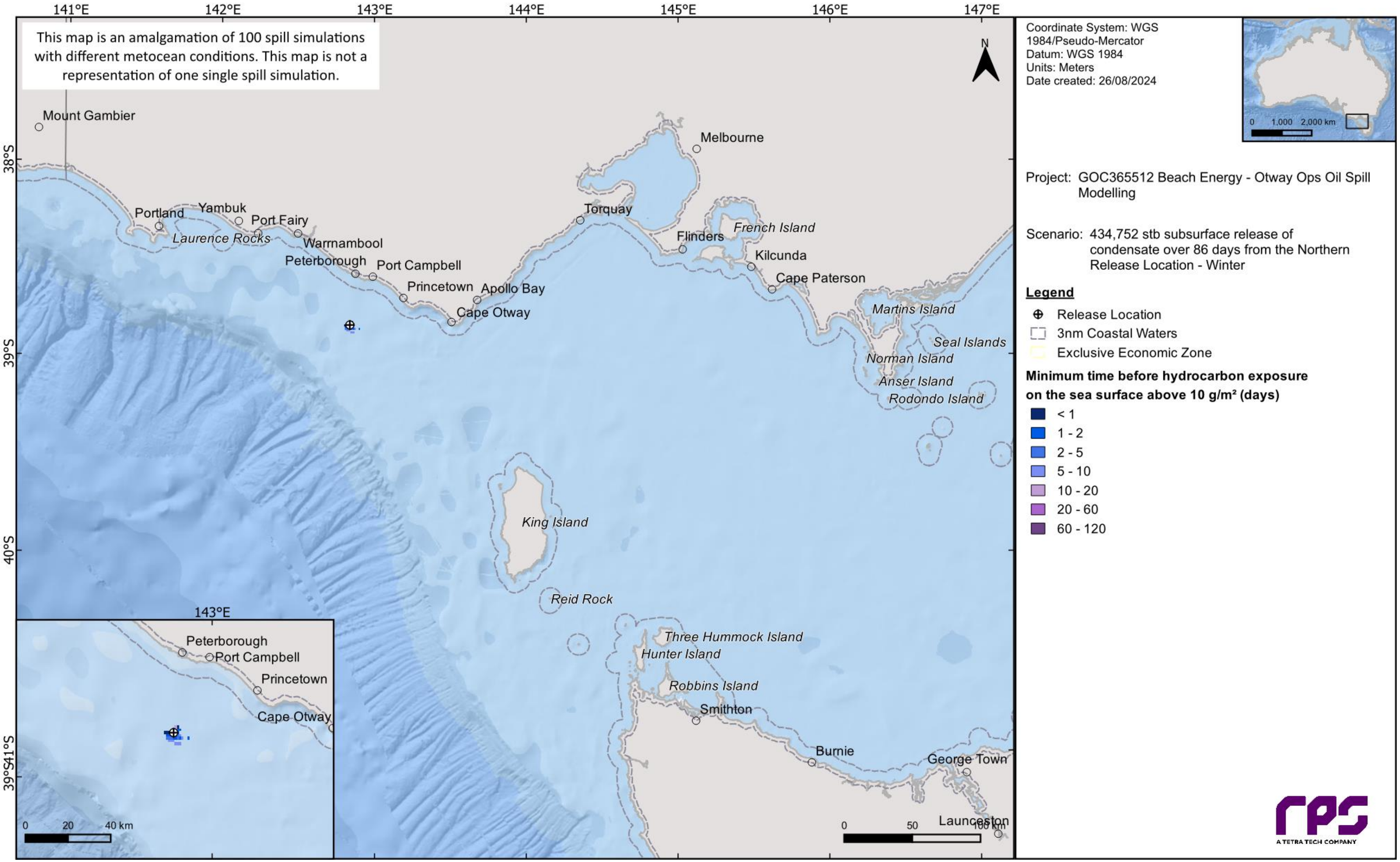


Figure 13-7 Minimum time before floating oil exposure above 10 g/m^2, in the event of 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

13.1.3 Shoreline Accumulation

Table 13-4 presents a summary of the predicted potential shoreline accumulation during the summer and winter conditions. The probability of accumulation to any shoreline at, or above, the low level (10 g/m^2) threshold was 99% during summer conditions and 96% during winter conditions. The minimum time before oil accumulation at, or above, the low threshold was 5.7 days during summer conditions, and 3.7 days during winter conditions. The maximum volume ashore for a single spill trajectory during the summer and winter conditions was 67.91 m^3 and 87.54 m^3, respectively, whilst the maximum length of shoreline accumulation at the low threshold was 104.17 km and 114.39 km, respectively. For the moderate threshold (100 g/m^2), the maximum length of shoreline accumulation predicted was 15.24 km (summer) and 22.86 km (winter). No shoreline accumulation was predicted for the high (1,000 g/m^2) threshold.

Table 13-5 summarises the shoreline accumulation on individual receptors during the summer and winter conditions. Cape Otway West shoreline recorded the highest probability of shoreline accumulation at the low threshold, being 96% and 92% for summer and winter respectively. The minimum time before shoreline accumulation above the low threshold was forecast for the same receptor (5.7 and 3.7 days during summer and winter respectively).

The summer and winter conditions maximum potential shoreline loading above the low and moderate shoreline thresholds are presented in Figure 13-8 and Figure 13-9, respectively.

Table 13-4 Summary of oil accumulation across all shorelines. Results are based on a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations per season.

Shoreline Statistics	Summer	Winter
Probability of accumulation on any shoreline (%)	99	96
Absolute minimum time for visible oil to shore (days)	5.7	3.7
Maximum total volume of hydrocarbons ashore (m^3)	67.91	87.54
Average volume of hydrocarbons ashore (m^3)	21.24	28.61
Maximum length of the shoreline at **10 g/m^2** (km)	104.17	114.39
Average shoreline length (km) at **10 g/m^2** (km)	30.98	37.36
Maximum length of the shoreline at **100 g/m^2** (km)	15.24	22.86
Average shoreline length (km) at **100 g/m^2** (km)	1.82	3.74
Maximum length of the shoreline at **1,000 g/m^2** (km)	-	-
Average shoreline length (km) at **1,000 g/m^2** (km)	-	-

Table 13-5 **Summary of oil accumulation on individual shoreline receptors. Results are based on a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations per season.**

Shoreline Receptor		Summer																Winter															
		Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline accumulation (km)			Maximum length of shoreline accumulation (km)			Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline accumulation (km)			Maximum length of shoreline accumulation (km)		
		Low	Mod	High	Low	Mod	High	Mean	Peak	Mean	Peak	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High	Mean	Peak	Mean	Peak	Low	Mod	High	Low	Mod	High
SHORE-LGA	Flinders Council (TAS)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	39.34	-	-	2.58	12.56	0.04	0.2	0.03	-	-	1.27	-	-
	Gabo Island (Unincorporated) (VIC)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	45.18	-	-	4.47	57.69	0.07	0.92	0.19	-	-	3.83	-	-
	King Island Council (TAS)	4	-	-	49.77	-	-	2.91	42.16	0.05	0.66	0.09	-	-	3.79	-	-	7	-	-	27.68	-	-	2.65	57.76	0.04	0.91	0.19	-	-	3.79	-	-
SHORE-VIC-MPRA	Anglesea	5	-	-	51.63	-	-	2.8	22.71	0.04	0.36	0.29	-	-	10.18	-	-	18	-	-	23.53	-	-	5.85	36.77	0.09	0.58	1.41	-	-	20.36	-	-
	Apollo Bay	47	-	-	14.16	-	-	12.17	49.66	0.19	0.78	2.34	-	-	17.78	-	-	46	-	-	11.25	-	-	12.63	57.7	0.2	0.91	2.11	-	-	20.32	-	-
	Bay of Islands	18	-	-	24.08	-	-	6.39	30.95	0.1	0.49	0.78	-	-	8.9	-	-	8	-	-	11.25	-	-	4.05	78.59	0.06	1.24	0.52	-	-	19.07	-	-
	Cape Conran	3	-	-	84.43	-	-	0.85	17.19	0.01	0.27	0.04	-	-	1.28	-	-	8	-	-	63.93	-	-	3.06	25.65	0.05	0.41	0.1	-	-	1.28	-	-
	Cape Howe / Mallacoota	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	45.18	-	-	4.65	57.69	0.07	0.92	0.28	-	-	6.39	-	-
	Cape Liptrap - Northwest	5	-	-	66.06	-	-	1.57	16.61	0.02	0.26	0.09	-	-	2.54	-	-	34	-	-	19.05	-	-	10.74	69.37	0.17	1.09	0.89	-	-	5.08	-	-
	Cape Nelson	18	-	-	21.48	-	-	5.92	46.95	0.09	0.74	0.75	-	-	11.45	-	-	1	-	-	89.69	-	-	0.41	38.33	0.01	0.61	0.05	-	-	5.09	-	-
	Cape Otway West	96	34	-	5.7	9.91	-	104.54	418.94	1.65	6.61	17.89	1.79	-	34.29	13.97	-	92	34	-	3.7	10.49	-	98.46	375.12	1.55	5.92	17.82	3.06	-	35.56	17.78	-
	Cape Patton	28	-	-	12.64	-	-	9.19	65.77	0.15	1.04	1.99	-	-	24.14	-	-	53	-	-	12.6	-	-	12.28	42.09	0.19	0.66	2.92	-	-	16.52	-	-
	Childers Cove	7	-	-	53.98	-	-	3.05	19.11	0.05	0.3	0.28	-	-	8.91	-	-	2	-	-	8.4	-	-	1	28.19	0.02	0.45	0.11	-	-	8.9	-	-
	Croajingolong - West	1	-	-	93.19	-	-	1.15	12.23	0.02	0.19	0.01	-	-	1.28	-	-	15	-	-	44.36	-	-	5.18	73.35	0.08	1.16	0.22	-	-	2.55	-	-
	Kilcunda							-		-	-	-	-	-	-	-	-	1	-	-	73.03	-	-	1.9	10.21	0.03	0.16	0.01	-	-	1.27	-	-
	Lorne	9	-	-	25.72	-	-	3.78	31.23	0.06	0.49	0.85	-	-	15.26	-	-	22	-	-	24.81	-	-	6.03	37.76	0.1	0.6	1.7	-	-	22.89	-	-
	Marlo	3	-	-	84.43	-	-	0.88	17.19	0.01	0.27	0.04	-	-	1.28	-	-	8	-	-	63.93	-	-	3.04	25.65	0.05	0.41	0.1	-	-	1.28	-	-
	Moonlight Head	79	2	-	8.91	24.45	-	27.14	124.04	0.43	1.96	5.91	0.03	-	20.33	1.27	-	77	11	-	7.42	18.22	-	42.01	278.45	0.66	4.39	6.06	0.42	-	24.14	6.35	-
	Mornington Peninsula - South	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	13.6	-	-	3.44	16.18	0.05	0.26	0.06	-	-	1.27	-	-
	Mornington Peninsula - Southwest	2	-	-	61.59	-	-	1.44	11.14	0.02	0.18	0.03	-	-	1.27	-	-	7	-	-	42.96	-	-	3.84	19.65	0.06	0.31	0.11	-	-	2.55	-	-
	Point Hicks	14	-	-	62.36	-	-	5.55	77.4	0.09	1.23	0.38	-	-	3.83	-	-	50	10	-	40.96	46.24	-	34.37	350.63	0.55	5.56	1.68	0.24	-	6.38	3.83	-
	Port Campbell	20	-	-	16.75	-	-	8.29	71.04	0.13	1.12	0.69	-	-	6.35	-	-	12	1	-	11.13	18.11	-	6.17	111.38	0.1	1.76	0.43	0.01	-	12.71	1.27	-
	Port Phillip - Queenscliff	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	38.77	-	-	3.98	21.43	0.06	0.34	0.17	-	-	3.82	-	-
	Port Phillip - Sorrento Shore	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	51.99	-	-	2.53	10.53	0.04	0.17	0.04	-	-	2.55	-	-
	Port Phillip Heads	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	51.99	-	-	2.52	10.44	0.04	0.17	0.03	-	-	2.55	-	-
	Torquay	1	-	-	73.05	-	-	1.41	10.1	0.02	0.16	0.01	-	-	1.27	-	-	11	-	-	24.86	-	-	3.37	17.9	0.05	0.28	0.31	-	-	6.36	-	-
	Venus Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-	43.85	-	-	5.33	44.04	0.08	0.7	0.32	-	-	2.54	-	-
	Waratah Bay	5	-	-	66.78	-	-	1.51	16.61	0.02	0.26	0.08	-	-	2.54	-	-	34	-	-	27.85	-	-	10.72	69.37	0.17	1.09	0.85	-	-	3.81	-	-
	Westernport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	55.68	-	-	1.93	10.97	0.03	0.17	0.01	-	-	1.27	-	-
	Wilsons Promontory - West	1	-	-	65.96	-	-	0.74	11.12	0.01	0.18	0.01	-	-	1.27	-	-	8	-	-	14.39	-	-	4.56	41.88	0.07	0.66	0.1	-	-	1.27	-	-

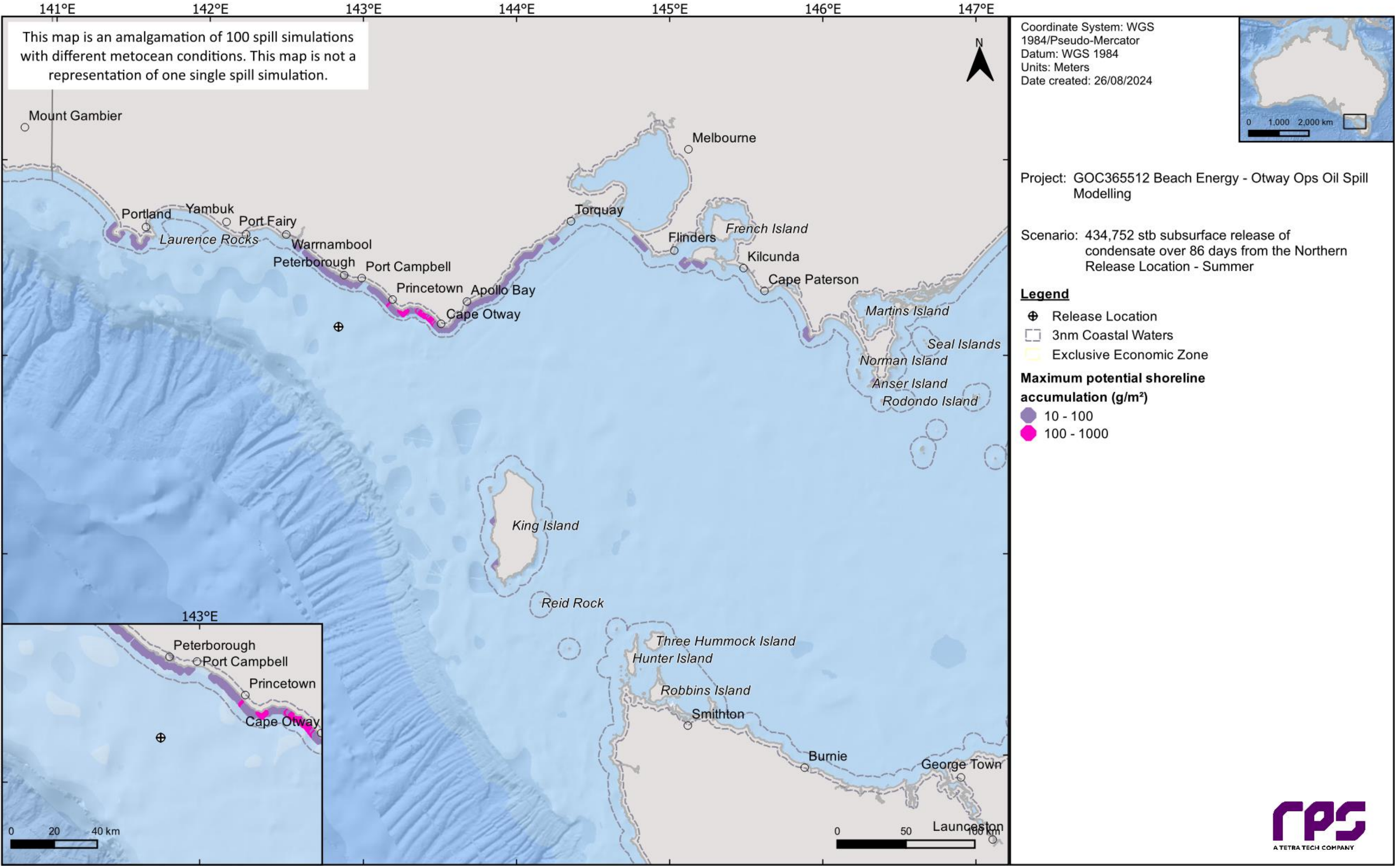


Figure 13-8 Maximum potential shoreline loading in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

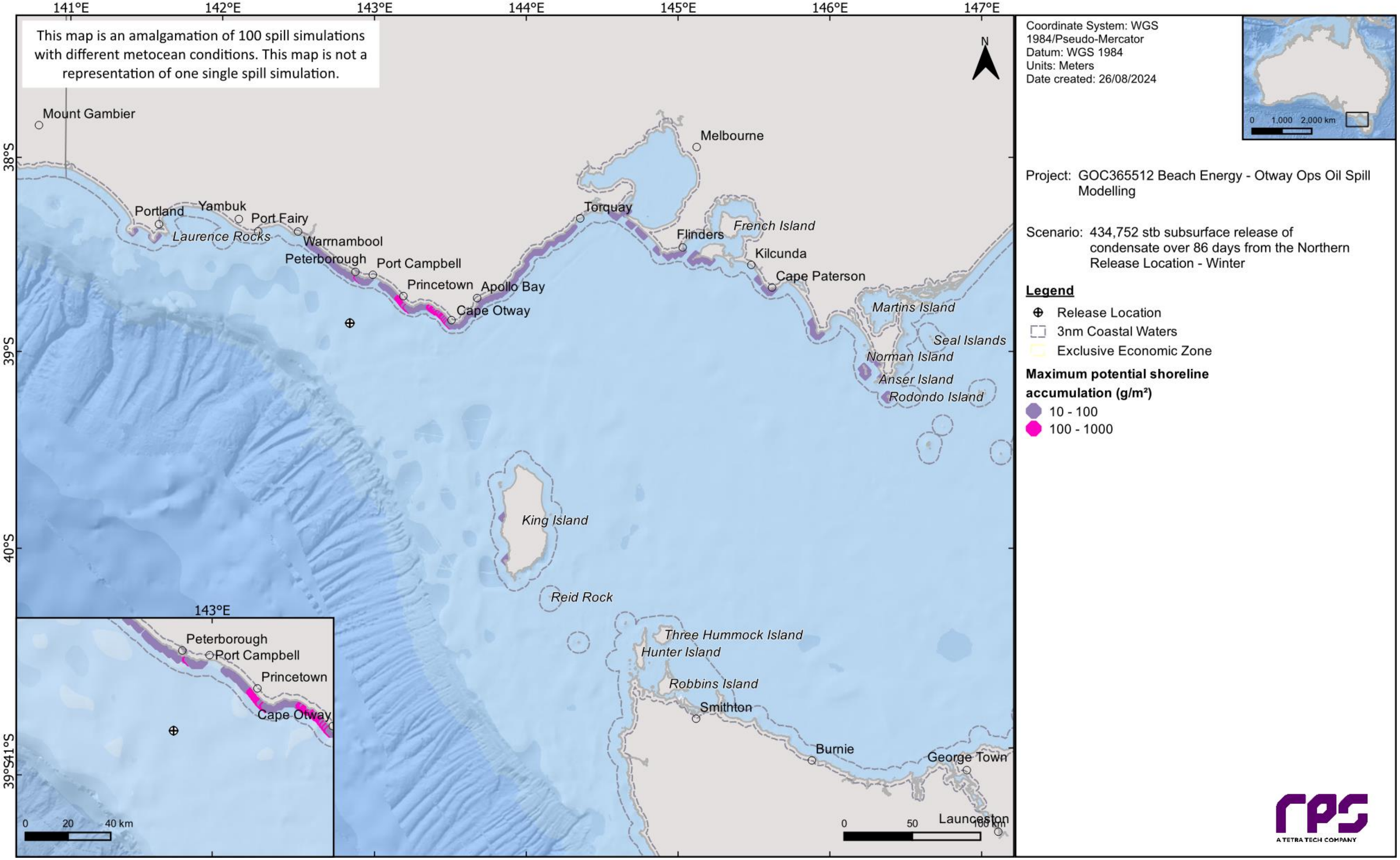


Figure 13-9 Maximum potential shoreline loading in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

13.1.4 In-water exposure

13.1.4.1 Dissolved Hydrocarbons

Table 13-6 summarises the probability of exposure to individual receptors from dissolved hydrocarbons in the 0-10 m layer during the summer and winter conditions.

Outside of the receptors that the Northern Release Location resides within (refer to Table 12-1), the highest concentration of dissolved hydrocarbon was predicted for Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area) BIA and Corangamite (VIC) NRMR (summer – 570.15 ppb, winter – 1,332.51 ppb).

Table 13-7 presents the predicted minimum time to dissolved hydrocarbon exposure and maximum residence time for dissolved hydrocarbon exposure to individual receptors, in the 0-10 m depth layer, for all seasonal conditions and all thresholds assessed. The minimum time before dissolved hydrocarbon exposure at the low threshold predicted for receptors which the release location does not reside within was 0.6 day (summer) and 0.47 day (winter) for the Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait) BIA.

Figure 13-10 and Figure 13-11 present the zones of potential dissolved hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 13-12 to Figure 13-17 present the maximum residence time of dissolved hydrocarbon exposure for the NOPSEMA thresholds in summer and winter.

Table 13-6 **Probability of dissolved hydrocarbons exposure to marine based receptors in the 0–10 m dept. Results are based on a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations per season.**

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure			Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	56.85	25	2	-	182.82	88	26	-
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	742.67	100	100	94	781.48	100	100	98
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	742.67	100	100	94	781.48	100	100	98
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	742.67	100	100	94	781.48	100	100	98
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	742.67	100	100	94	781.48	100	100	98
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	742.67	100	100	94	1,332.51	100	100	98
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	742.67	100	100	94	781.48	100	100	98
	Pygmy Blue Whale - Distribution (None)**	742.67	100	100	94	1,332.51	100	100	98
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	567.15	94	44	3	1,332.51	100	95	23
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	742.67	100	100	94	1,332.51	100	100	98
	Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)	48.37	15	-	-	143.86	77	10	-
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)	630.44	96	57	3	620.89	100	98	16
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	742.67	100	100	94	1,332.51	100	100	98
	Southern Right Whale - Aggregation (Bridgewater Bay, Portland to E of Logan's Beach, Warrnambool)	103.3	26	2	-	58.23	16	1	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	742.67	100	100	94	1,332.51	100	100	98

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure			Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
	Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area)	570.15	53	16	3	1,332.51	87	70	17
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	742.67	100	100	94	781.48	100	100	98
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	742.67	100	100	94	1,332.51	100	100	98
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	33.17	10	-	-	39.12	2	-	-
	White Shark - Distribution (Between the 60-120m depth contour)**	742.67	100	100	94	781.48	100	100	98
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	742.67	100	100	94	781.48	100	100	98
	White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region)	22.4	2	-	-	-	-	-	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	742.67	100	100	94	781.48	100	100	98
	White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)	48.37	12	-	-	137.49	76	6	-
IMCRA-MESO	Central Bass Strait	34.08	7	-	-	131.15	65	5	-
	Central Victoria	48.37	10	-	-	143.86	76	8	-
	Otway**	742.67	100	100	94	1,332.51	100	100	98
IMCRA-PROV	Bass Strait Shelf Province	48.37	10	-	-	143.86	76	9	-
	West Tasmania Transition	-	-	-	-	13.76	1	-	-
	Western Bass Strait Shelf Transition**	742.67	100	100	94	1,332.51	100	100	98
MNP	Twelve Apostles	570.15	39	15	1	566.43	79	61	2
MR	South-east (Marine)**	742.67	100	100	94	781.48	100	100	98
MS	The Arches	16.06	1	-	-	350.39	20	7	-
NHPH	Great Ocean Road and Scenic Environs	27.26	3	-	-	32.15	9	-	-
NRMR	Corangamite (VIC)	570.15	62	25	3	1,332.51	91	79	19
RSB	Bravenes Rock	32.86	3	-	-	149.9	7	1	-
	Apollo Bay	15.76	3	-	-	35.04	10	-	-

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure			Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
SHORE-VIC-MPRA	Cape Otway West	164.4	38	4	-	422.26	57	11	1
	Cape Patton	-	-	-	-	29.1	1	-	-
	Moonlight Head	567.15	29	8	2	1,332.51	71	56	14
	Port Campbell	570.15	21	9	1	937	47	27	4
State Waters	Victoria	570.15	62	25	3	1,332.51	91	79	19

*The release location resides within the receptor boundaries.

Table 13-7 Predicted minimum time to dissolved hydrocarbon exposure and maximum residence time for dissolved hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill trajectories per season.

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)			Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
AMP	Apollo	2.96	22.7	-	10.75	0.25	-	1.9	3.17	-	11.5	4	3
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	3
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	3
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	5.75
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	3
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	5.75
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	5.75
	Pygmy Blue Whale - Distribution (None)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	5.75
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	0.67	2.04	22.53	34.75	9.5	1.25	0.53	1.11	4.11	84	21	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	1.5
	Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)	3.24	-	-	8	-	-	2.14	4.08	-	13.5	3.75	5.75
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)	0.6	1.99	8.47	53.75	9.5	0.25	0.47	0.96	4.07	84	18.5	-
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	5.75
	Southern Right Whale - Aggregation (Bridgewater Bay, Portland to E of Logan's Beach, Warrnambool)	4.15	9.77	-	13.25	3	-	2.27	5.45	-	13.75	0.25	5.75

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)			Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	3
	Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area)	6.61	11.6	37.38	107.25	39	1.25	3.01	9.97	14.58	143.25	33.75	5.75
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	-
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	3
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	3.96	-	-	15.75	-	-	10.3	-	-	11.25	-	3
	White Shark - Distribution (Between the 60-120m depth contour)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	3
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	-
	White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region)	11.03	-	-	4	-	-	-	-	-	-	-	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	5.75
	White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)	7.55	-	-	8	-	-	2.2	5.42	-	13.5	3.75	-
IMCRA-MESO	Central Bass Strait	8.74	-	-	7	-	-	2.73	8.47	-	12.25	3.75	5.75
	Central Victoria	3.24	-	-	8	-	-	2.14	5.36	-	13.5	1.75	-
	Otway**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	-
IMCRA-PROV	Bass Strait Shelf Province	3.24	-	-	8	-	-	2.14	5.36	-	13.5	3.75	5.75
	West Tasmania Transition	-	-	-	-	-	-	11.02	-	-	2.5	-	2.5
	Western Bass Strait Shelf Transition**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	3
MNP	Twelve Apostles	9.14	33.55	40.88	107.25	39	0.25	9.76	9.95	35	101.5	29	-
MR	South-east (Marine)**	0.02	0.02	0.82	230	73.25	4.25	0.02	0.03	0.9	300.5	54.75	-

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)			Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
MS	The Arches	41.29	-	-	1.75	-	-	19.18	25.98	-	143.25	24.25	5.75
NHPH	Great Ocean Road and Scenic Environs	46.29	-	-	14	-	-	10.78	-	-	26.25	-	-
NRMR	Corangamite (VIC)	6.52	11.6	37.38	107.25	39	1.25	2.64	9.86	9.96	143.25	33.75	1.25
RSB	Bravenes Rock	21.11	-	-	6	-	-	10.51	10.53	-	9.25	2	-
SHORE-VIC-MPRA	Apollo Bay	17.02	-	-	2.25	-	-	6.07	-	-	7.25	-	-
	Cape Otway West	6.61	11.6	-	53.75	5.75	-	3.21	10.94	35.09	84	12.25	5.75
	Cape Patton	-	-	-	-	-	-	32.88	-	-	6.5	-	1.25
	Moonlight Head	14.66	37.26	37.38	44.5	22.25	1.25	9.97	9.97	14.58	67.5	21	5.75
	Port Campbell	14.52	32.83	40.88	91.75	39	0.25	11.99	17.65	23.93	143.25	33.75	
State Waters	Victoria	6.52	11.6	37.38	107.25	39	1.25	2.64	9.86	9.96	143.25	33.75	

*The release location resides within the receptor boundaries.

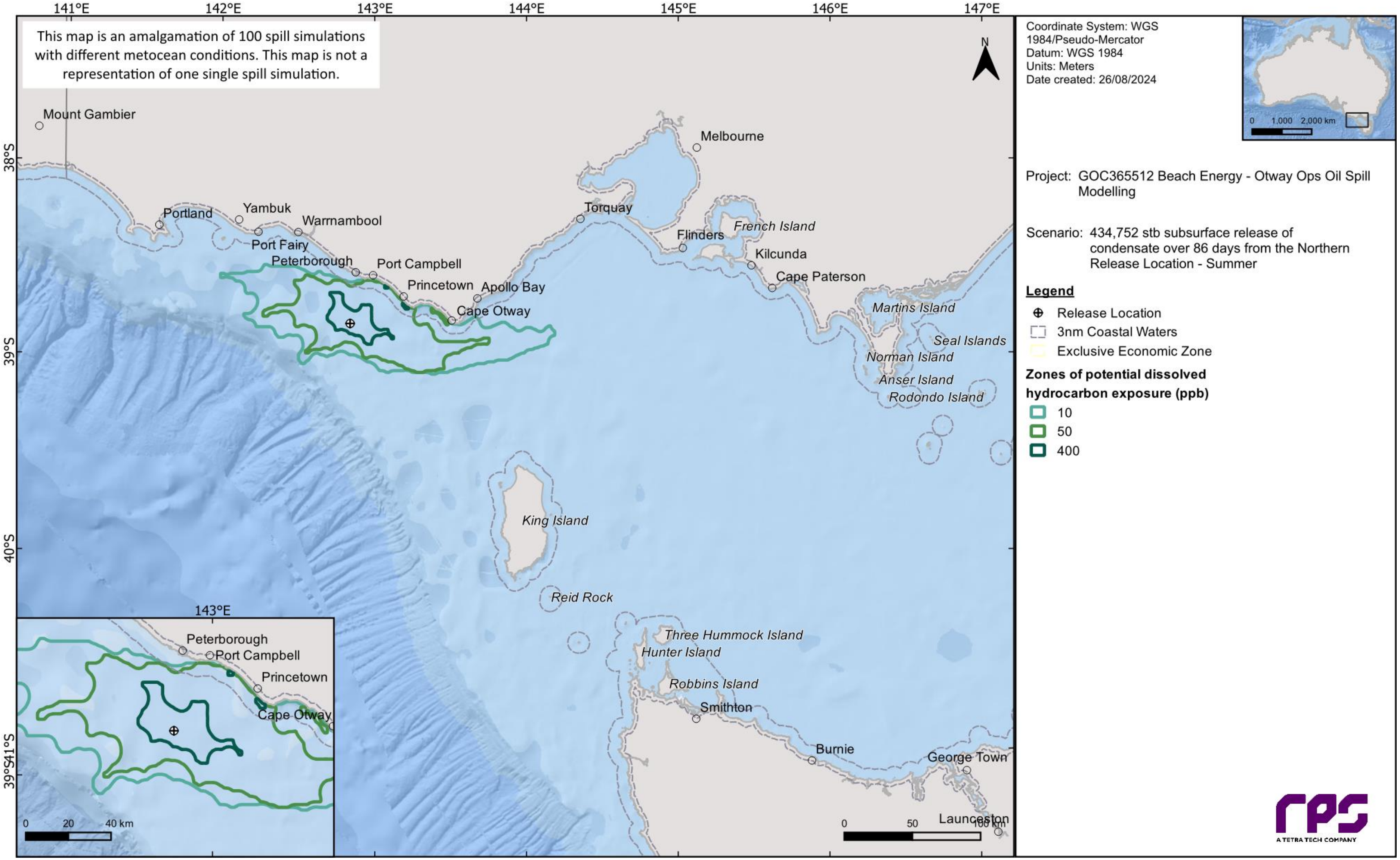


Figure 13-10 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

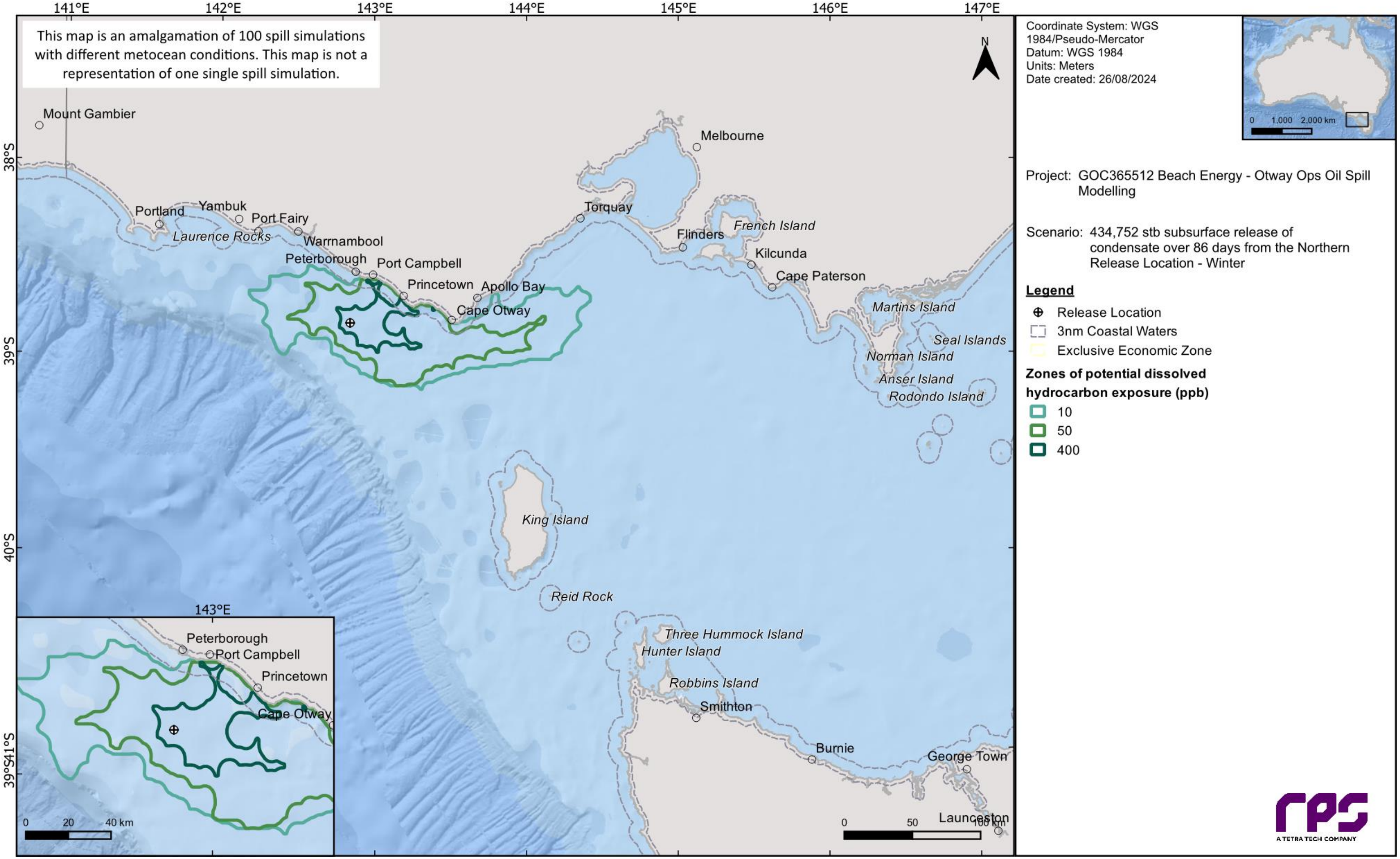


Figure 13-11 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

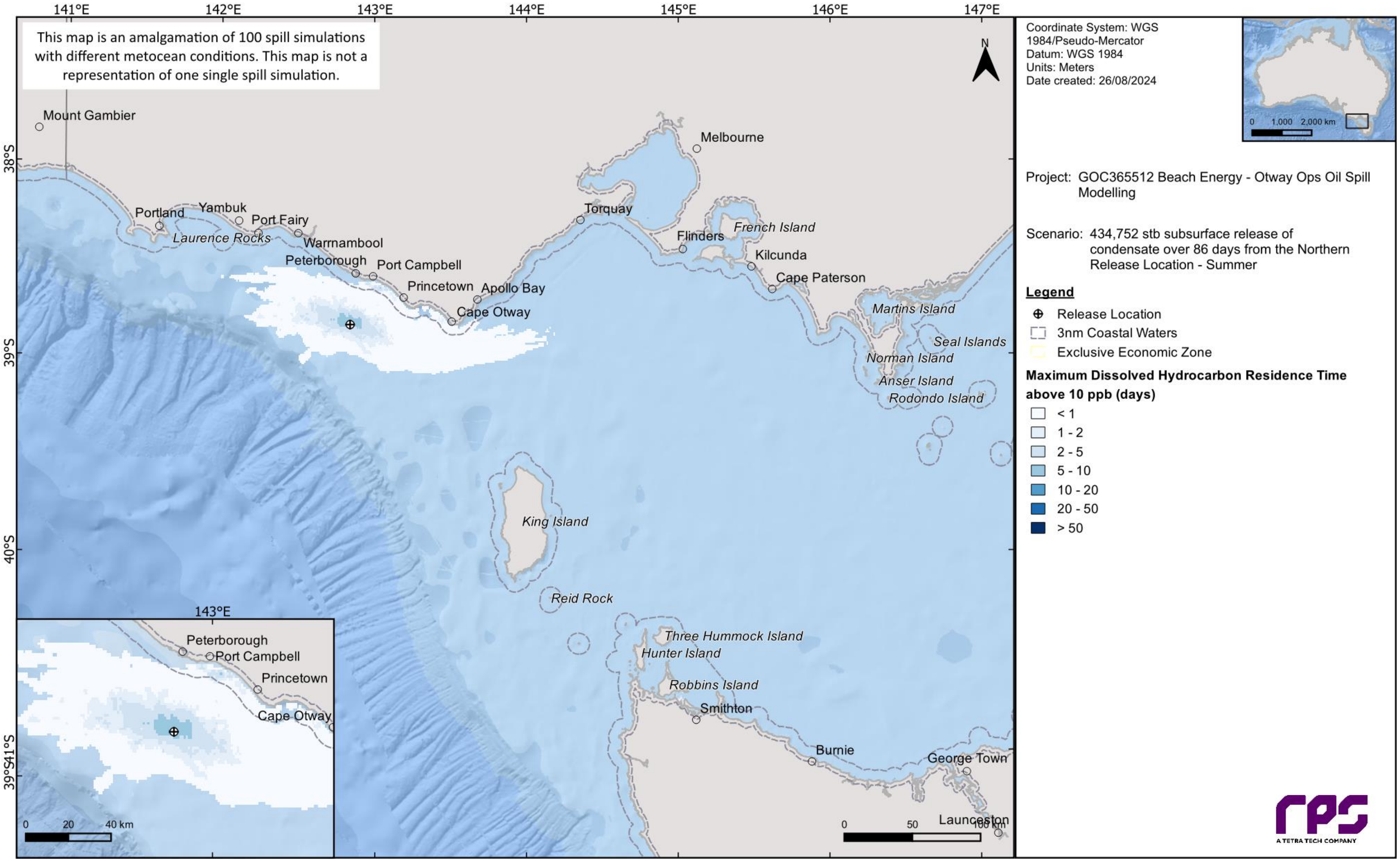


Figure 13-12 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

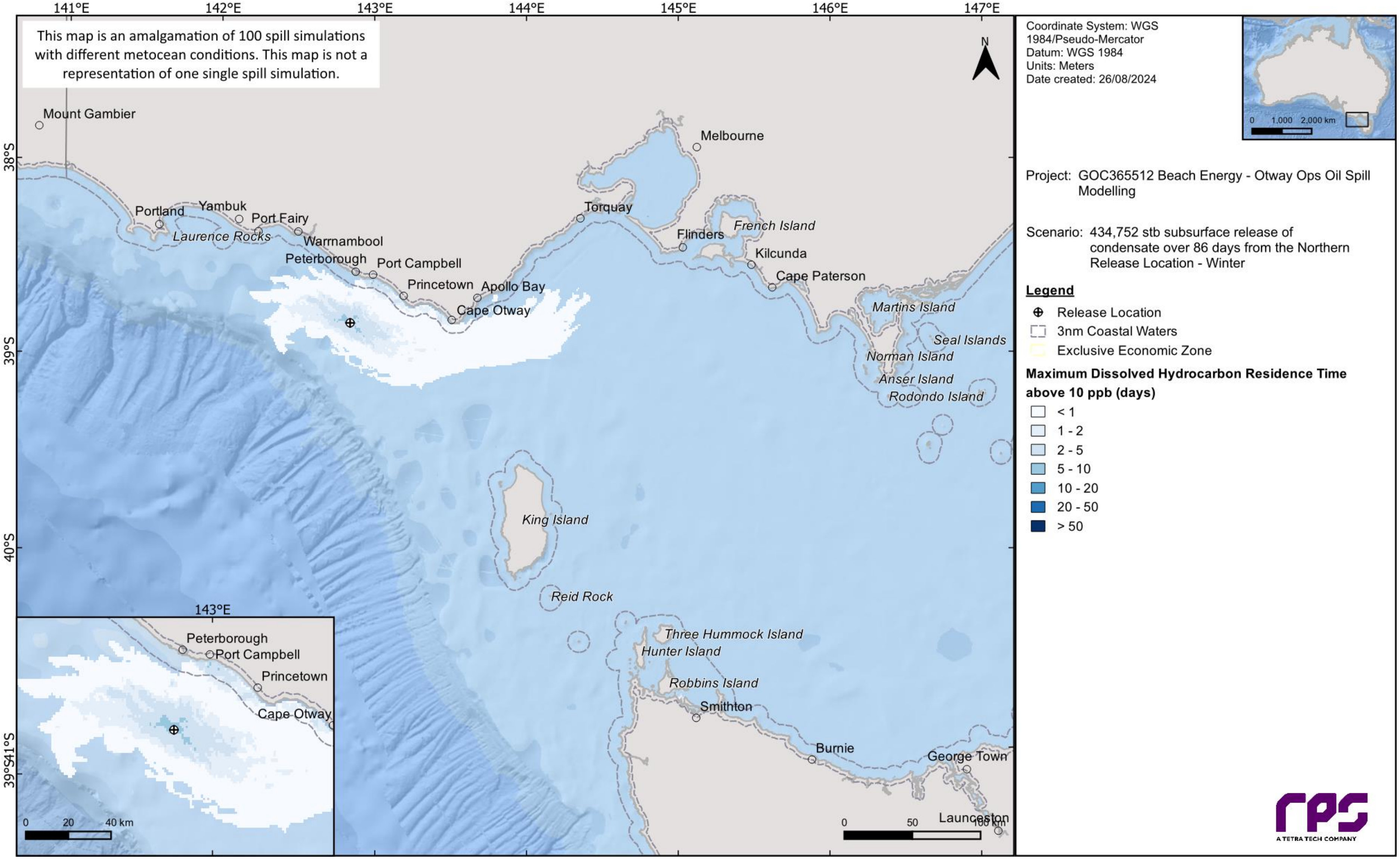


Figure 13-13 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

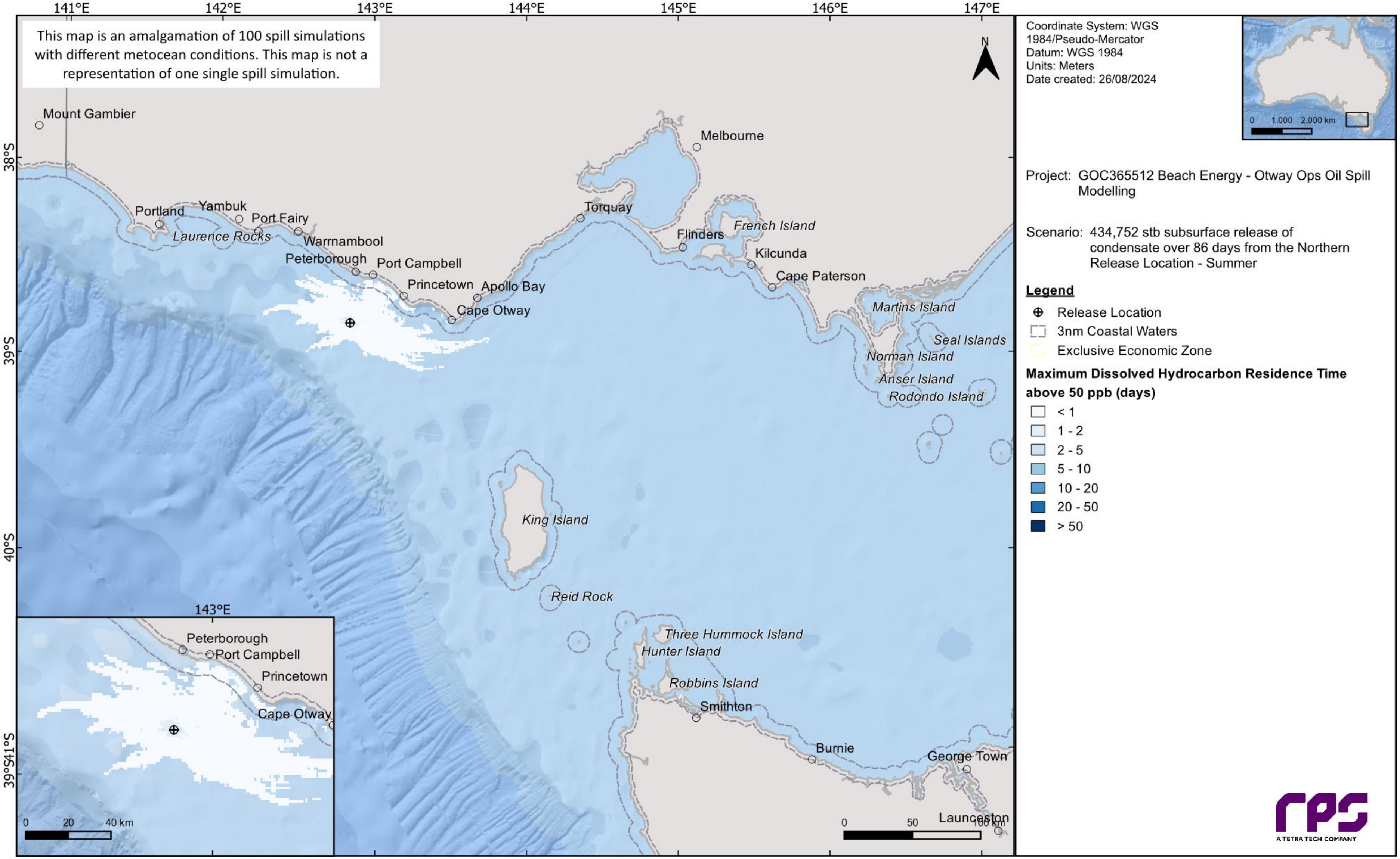


Figure 13-14 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

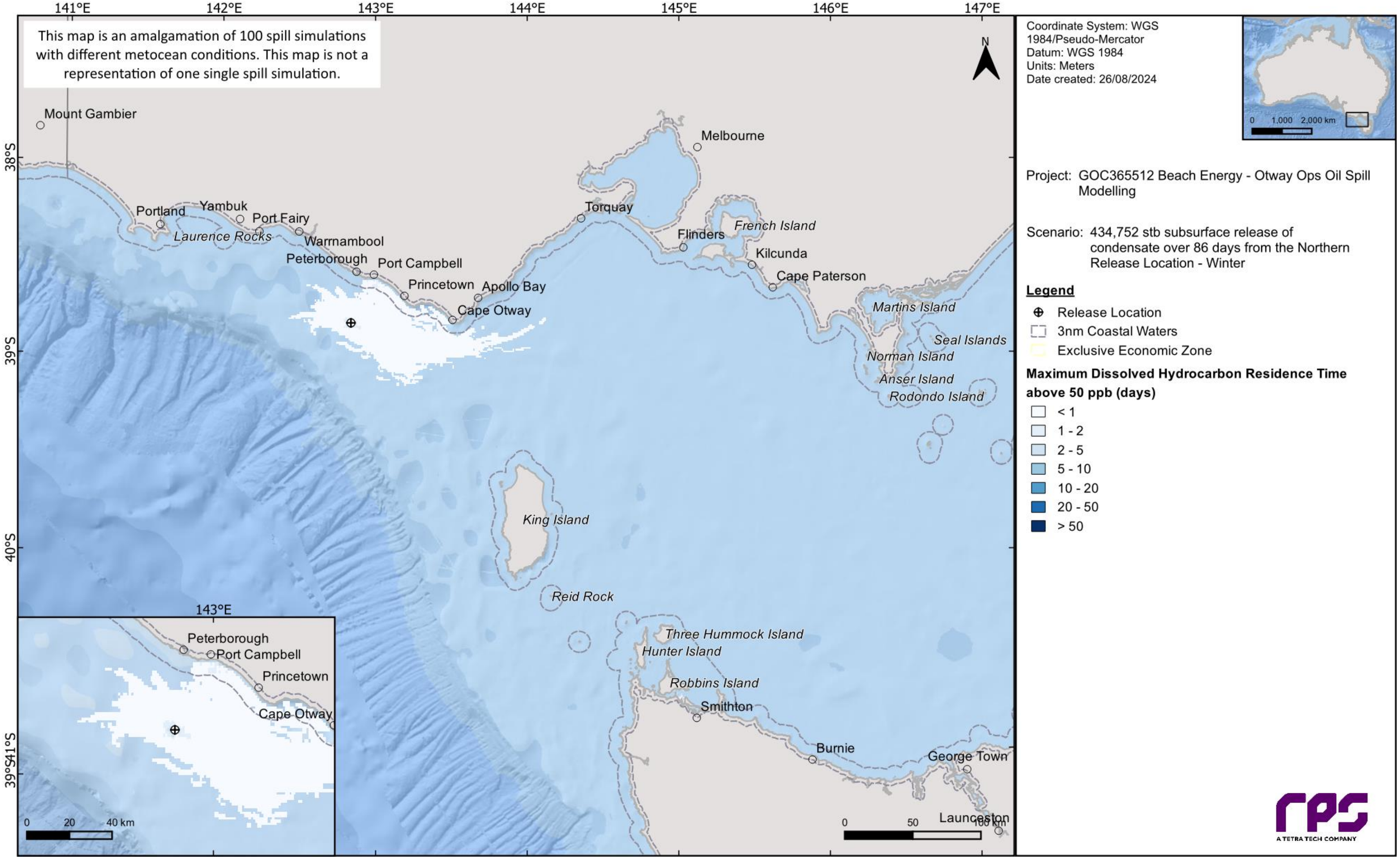


Figure 13-15 **Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.**

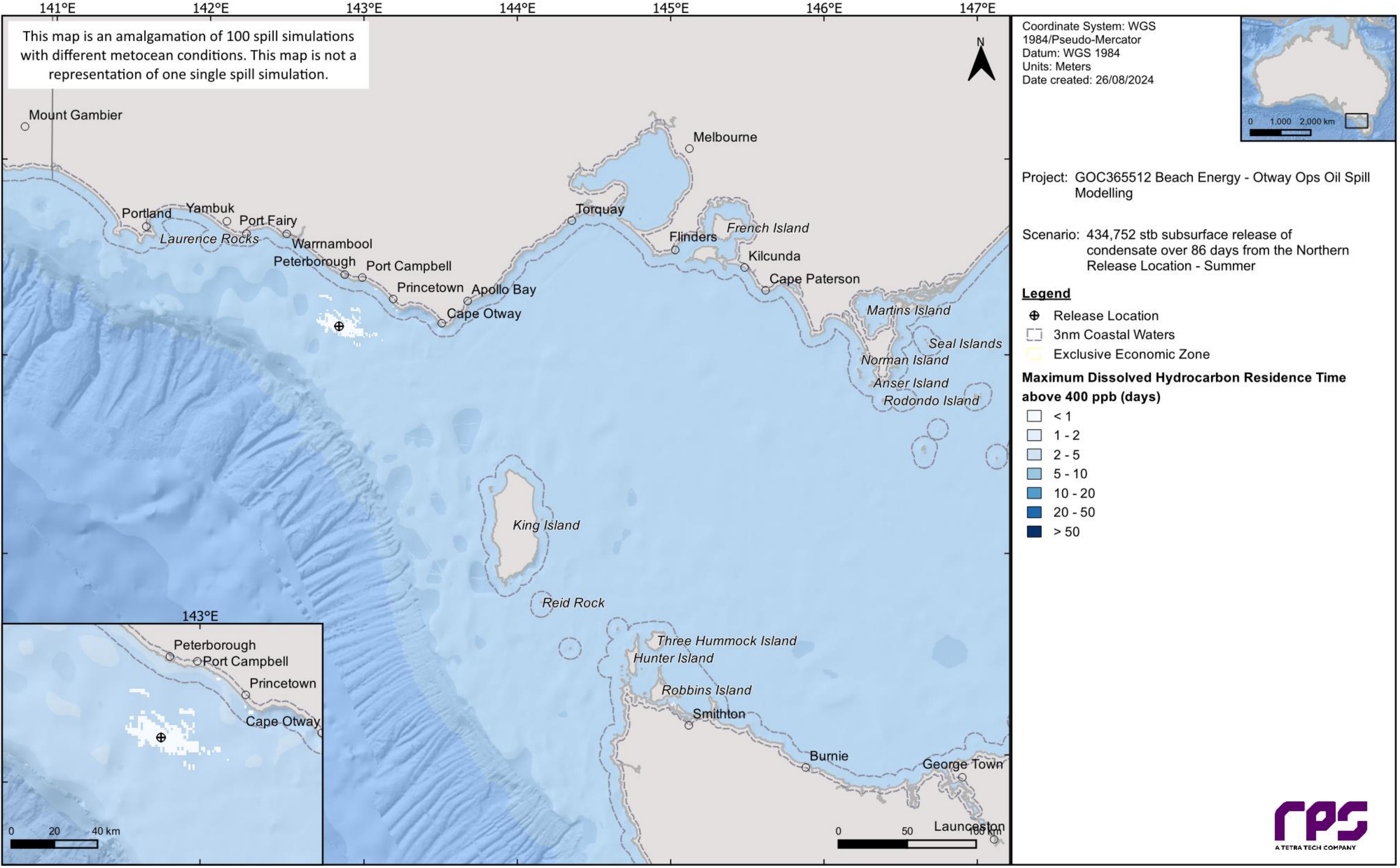


Figure 13-16 Maximum residence time for dissolved hydrocarbon exposure above 400 ppb, at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

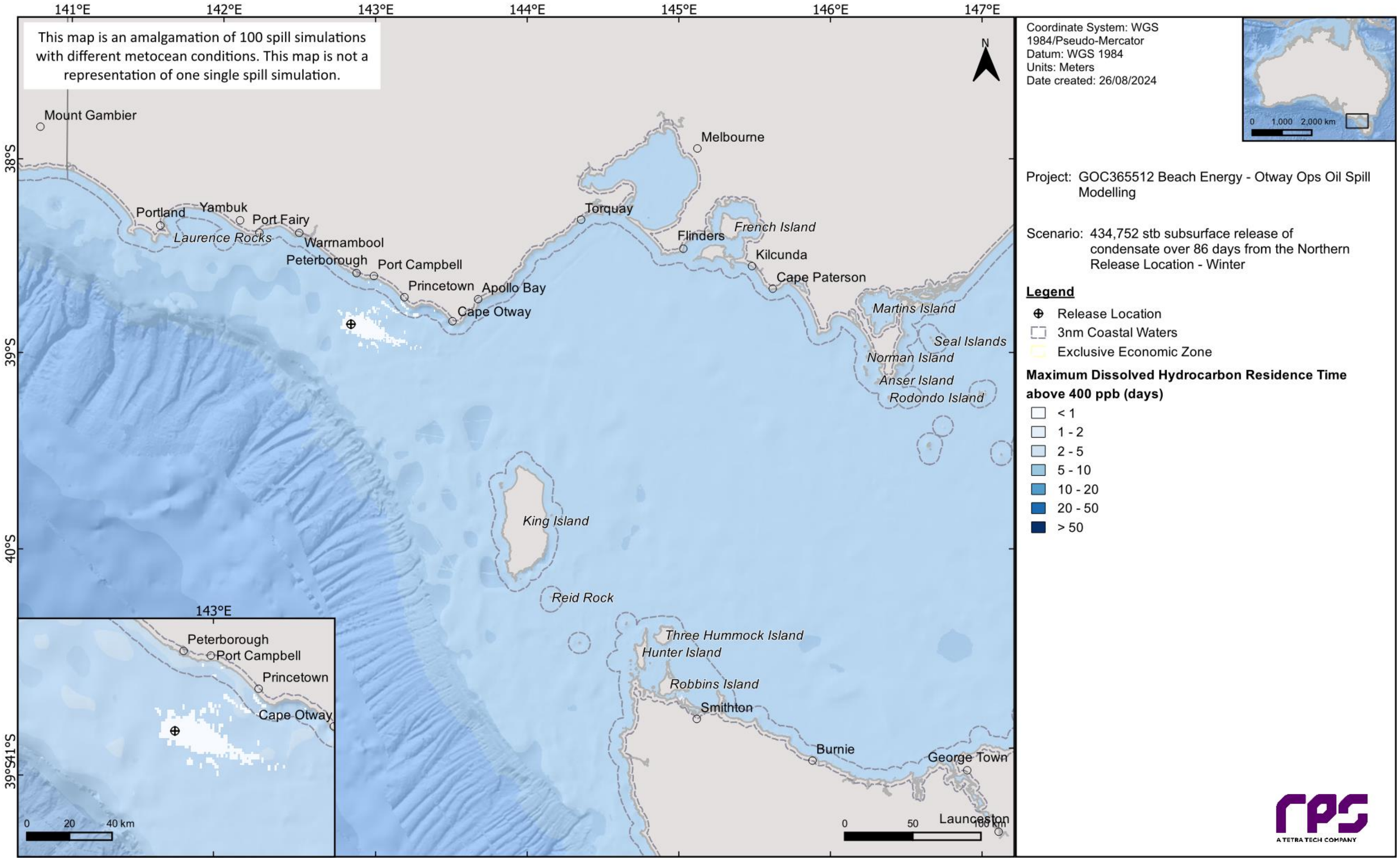


Figure 13-17 Maximum residence time for dissolved hydrocarbon exposure above 400 ppb, at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

13.1.4.2 Entrained Hydrocarbons

Table 13-8 presents the probability of exposure to individual receptors from entrained hydrocarbons in the 0-10 m depth layer for the summer and winter conditions.

Outside of the receptors that the Northern Release Location resides within (refer to Table 12-1), the highest concentration of entrained hydrocarbon was predicted for Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area) and Short-tailed Shearwater - Foraging BIAs (summer – 358.93 ppb, winter – 527.26 ppb).

Table 13-9 presents the predicted minimum time to entrained hydrocarbon exposure and maximum residence time for entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer, for all seasonal conditions and all thresholds assessed.

Figure 13-18 and Figure 13-19 presents the zones of potential entrained hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 13-20 to Figure 13-25 present the maximum residence time of entrained hydrocarbon exposure for the NOPSEMA thresholds in summer and winter.

Table 13-8 Probability of entrained hydrocarbons exposure to marine based receptors in the 0–10 m depth layer. Results are based on a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations per season.

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	71.12	92	-	-	84.87	100	-	-
	Zeehan	-	-	-	-	12.87	1	-	-
BAS	Gippsland Basin - Gippsland	-	-	-	-	12.97	3	-	-
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	-	-	-	-	3,192.69	100	100	100
	Australasian Gannet - Foraging (Buffer around the coast off Portland Vic)	50.61	42	-	-	-	-	-	-
	Australasian Gannet - Foraging (Port Phillip Bay)	23.29	15	-	-	84.36	65	-	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	3,246.16	100	100	100	3,192.69	100	100	100
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	3,246.16	100	100	100	3,192.69	100	100	100
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	3,246.16	100	100	100	3,192.69	100	100	100
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	3,246.16	100	100	100	3,192.69	100	100	100
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	3,246.16	100	100	100	3,192.69	100	100	100
	Little Penguin - Breeding (Phillip Island)	-	-	-	-	15.26	4	-	-
	Little Penguin - Foraging (Buffer around Phillip Island)	-	-	-	-	23.9	27	-	-
	Pygmy Blue Whale - Distribution (None)**	3,246.16	100	100	100	3,192.69	100	100	100
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	358.93	100	54	-	484.26	100	47	-

Receptor	Summer (November through to March)				Winter (April to October)			
	Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
		Low	Moderate	High		Low	Moderate	High
Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	3,246.16	100	100	100	3,192.69	100	100	100
Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)	72.38	93	-	-	88.05	100	-	-
Short-tailed Shearwater - Breeding (Phillip Island)	-	-	-	-	15.26	4	-	-
Short-tailed Shearwater - Foraging (Buffer around Montague Island)	358.93	100	58	-	12.87	6	-	-
Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)	-	-	-	-	527.26	100	68	-
Shy Albatross - Foraging likely (The whole South-east Marine Region)**	3,246.16	100	100	100	3,192.69	100	100	100
Southern Right Whale - Aggregation (Bridgewater Bay, Portland to E of Logan's Beach, Warrnambool)	50.61	90	-	-	43.15	60	-	-
Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	3,246.16	100	100	100	3,192.69	100	100	100
Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area)	358.93	100	55	-	527.26	100	43	-
Southern Right Whale - Migration and resting on migration (Philip Island area to Wilsons Promotory)	-	-	-	-	74.12	63	-	-
Southern Right Whale - Migration and resting on migration (Philip Island area)	-	-	-	-	26.56	47	-	-
Southern Right Whale - Migration and resting on migration (Victor Harbour area to Portland)	12.52	3	-	-	-	-	-	-

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	3,246.16	100	100	100	3,192.69	100	100	100
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer-Muttonbird Island (VIC))**	3,246.16	100	100	100	3,192.69	100	100	100
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	37.35	86	-	-	35.83	32	-	-
	White Shark - Distribution (Between the 60-120m depth contour)**	3,246.16	100	100	100	3,192.69	100	100	100
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	3,246.16	100	100	100	3,192.69	100	100	100
	White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region)	69.45	60	-	-	74.53	77	-	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	3,246.16	100	100	100	3,192.69	100	100	100
	White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)	70.33	93	-	-	87.44	100	-	-
	White-faced Storm-petrel - Foraging (Gabo Island)	-	-	-	-	74.53	40	-	-
CP	Discovery Bay Coastal Park	14.66	10	-	-	-	-	-	-
IBRA	Naracoorte Coastal Plain	17.27	13	-	-	84.87	100	-	-
	South East Coastal Plain	-	-	-	-	12.87	1	-	-
	South Eastern Highlands	44.34	29	-	-	12.97	3	-	-
IMCRA-MESO	Central Bass Strait	46.07	84	-	-	3,192.69	100	100	100
	Central Victoria	65.41	92	-	-	-	-	-	-
	Otway**	3,246.16	100	100	100	84.36	65	-	-
	Twofold Shelf	-	-	-	-	3,192.69	100	100	100
	Victorian Embayments	-	-	-	-	3,192.69	100	100	100
	Bass Strait Shelf Province	65.41	93	-	-	3,192.69	100	100	100

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
IMCRA-PROV	West Tasmania Transition	28.3	61	-	-	3,192.69	100	100	100
	Western Bass Strait Shelf Transition**	3,246.16	100	100	100	3,192.69	100	100	100
KEF	Bonney Coast Upwelling	50.61	23	-	-	15.26	4	-	-
	West Tasmania Canyons	13.15	10	-	-	23.9	27	-	-
MNP	Bunurong	-	-	-	-	3,192.69	100	100	100
	Discovery Bay	12.52	3	-	-	484.26	100	47	-
	Point Addis	-	-	-	-	3,192.69	100	100	100
	Port Phillip Heads	-	-	-	-	88.05	100	-	-
	Twelve Apostles	48.13	69	-	-	15.26	4	-	-
MR	South-east (Marine)**	3,246.16	100	100	100	12.87	6	-	-
MS	Mushroom Reef	-	-	-	-	527.26	100	68	-
	The Arches	19.88	10	-	-	3,192.69	100	100	100
NHPH	Great Ocean Road and Scenic Environs	203.86	86	16	-	43.15	60	-	-
NHPN	Summerland Peninsula	-	-	-	-	3,192.69	100	100	100
NIW	Western Port	-	-	-	-	527.26	100	43	-
NP	Great Otway	30.36	23	-	-	74.12	63	-	-
NPS4	Bunurong Marine Park	-	-	-	-	26.56	47	-	-
NRMR	Corangamite (VIC)	358.93	100	55	-	-	-	-	-
	Glenelg Hopkins (VIC)	50.61	25	-	-	3,192.69	100	100	100
	Port Phillip and Western Port (VIC)	-	-	-	-	3,192.69	100	100	100
	West Gippsland (VIC)	-	-	-	-	35.83	32	-	-
OP	Phillip Island Nature Park	-	-	-	-	3,192.69	100	100	100
RAMSAR	Western Port	-	-	-	-	3,192.69	100	100	100
RSB	Bravenes Rock	45.38	81	-	-	74.53	77	-	-
SHORE-VIC-MPRA	Anglesea	23.06	6	-	-	87.44	100	-	-
	Apollo Bay	71.73	84	-	-	74.53	40	-	-
	Bay of Islands	44.32	32	-	-	-	-	-	-

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
	Cape Nelson	50.61	19	-	-	3,192.69	100	100	100
	Cape Otway West	358.93	100	55	-	84.87	100	-	-
	Cape Patton	54.52	49	-	-	12.87	1	-	-
	Childers Cove	13.43	5	-	-	12.97	3	-	-
	Cape Nelson	12.33	1	-	-	3,192.69	100	100	100
	Kilcunda	-	-	-	-	-	-	-	-
	Lorne	38.59	11	-	-	84.36	65	-	-
	Moonlight Head	203.86	92	21	-	3,192.69	100	100	100
	Mornington Peninsula - South	-	-	-	-	3,192.69	100	100	100
	Mornington Peninsula - Southwest	-	-	-	-	3,192.69	100	100	100
	Port Campbell	82.86	47	-	-	3,192.69	100	100	100
	Port Phillip - Queenscliff	-	-	-	-	3,192.69	100	100	100
	Port Phillip - Sorrento Shore	-	-	-	-	15.26	4	-	-
	Port Phillip Heads	-	-	-	-	23.9	27	-	-
	Torquay	-	-	-	-	3,192.69	100	100	100
	Venus Bay	-	-	-	-	484.26	100	47	-
	Westernport	-	-	-	-	3,192.69	100	100	100
State Waters	Victoria	358.93	100	55	-	88.05	100	-	-

*The release location resides within the receptor boundaries.

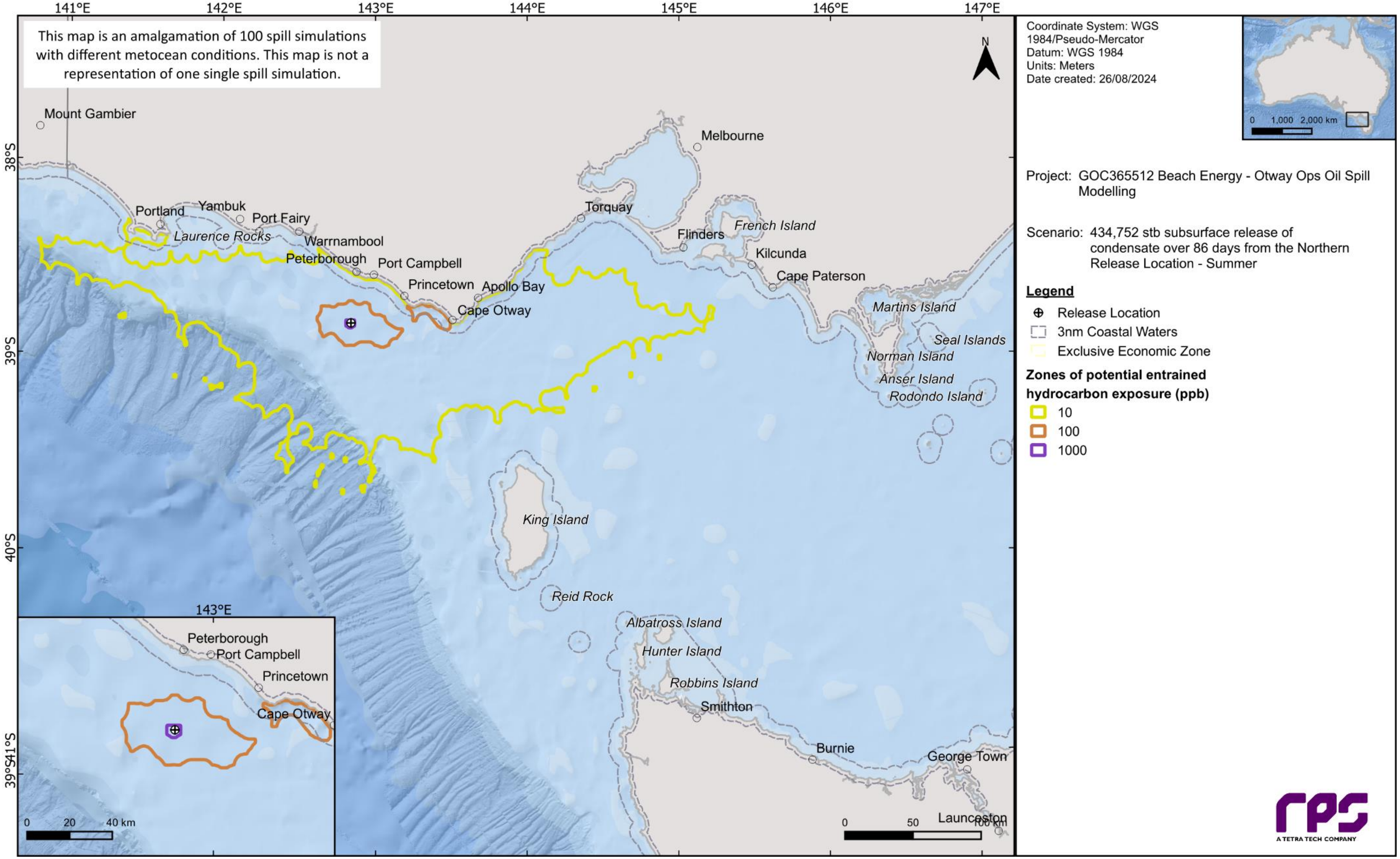
Table 13-9 Predicted minimum time to entrained hydrocarbon exposure and maximum residence time for entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill trajectories per season.

Receptor		Summer (November through March)						Winter (April to October)					
		Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)			Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
AMP	Apollo	2.59	-	-	157.5	-	-	1.18	-	-	126.25	-	-
	Zeehan	-	-	-	-	-	-	15.91	-	-	1	-	-
BAS	Gippsland Basin - Gippsland	-	-	-	-	-	-	58.55	-	-	1.5	-	-
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Australasian Gannet - Foraging (Buffer around the coast off Portland Vic)	5.38	-	-	110.75	-	-	-	-	-	-	-	-
	Australasian Gannet - Foraging (Port Phillip Bay)	42.54	-	-	64.25	-	-	5.52	-	-	138.25	-	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	Little Penguin - Breeding (Phillip Island)	-	-	-	-	-	-	15.81	-	-	6.5	-	-
	Little Penguin - Foraging (Buffer around Phillip Island)	-	-	-	-	-	-	11.05	-	-	44.5	-	-
	Pygmy Blue Whale - Distribution (None)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	0.42	2.31	-	1,145.25	85.75	-	0.43	0.59	-	940.5	70.25	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)	2.79	-	-	739.25	-	-	1.38	-	-	359.25	-	-
	Short-tailed Shearwater - Breeding (Phillip Island)	-	-	-	-	-	-	15.81	-	-	6.5	-	-
	Short-tailed Shearwater - Foraging (Buffer around Montague Island)	0.31	2.27	-	1,145.25	85.75	-	52.77	-	-	44	-	-
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)	-	-	-	-	-	-	0.39	0.45	-	940.5	70.25	-
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	Southern Right Whale - Aggregation (Bridgewater Bay, Portland to E of Logan's Beach, Warrnambool)	1.53	-	-	205.25	-	-	1.15	-	-	195.25	-	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area)	3.47	7.23	-	787.75	61.25	-	1.45	5.51	-	787.25	70.25	-
	Southern Right Whale - Migration and resting on migration (Philip Island area to Wilsons Promotory)	-	-	-	-	-	-	11.7	-	-	525.5	-	-
	Southern Right Whale - Migration and resting on migration (Philip Island area)	-	-	-	-	-	-	7.63	-	-	50	-	-
	Southern Right Whale - Migration and resting on migration (Victor Harbour area to Portland)	30.95	-	-	4.5	-	-	-	-	-	-	-	-
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer-Muttonbird Island (VIC))**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	2.07	-	-	108.5	-	-	5.47	-	-	77.5	-	-
	White Shark - Distribution (Between the 60-120m depth contour)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region)	3.79	-	-	270.25	-	-	7.26	-	-	363.75	-	-

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)			Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
	White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)	2.88	-	-	739.25	-	-	1.45	-	-	525.5	-	-
	White-faced Storm-petrel - Foraging (Gabo Island)	-	-	-	-	-	-	40.46	-	-	363.75	-	-
CP	Discovery Bay Coastal Park	32.98	-	-	43.5	-	-	-	-	-	-	-	-
IBRA	Naracoorte Coastal Plain	19.6	-	-	67	-	-	1.18	-	-	126.25	-	-
	South East Coastal Plain	-	-	-	-	-	-	15.91	-	-	1	-	-
	South Eastern Highlands	6.9	-	-	162	-	-	58.55	-	-	1.5	-	-
IMCRA-MESO	Central Bass Strait	3.05	-	-	156.25	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Central Victoria	2.79	-	-	739.25	-	-	-	-	-	-	-	-
	Otway**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	5.52	-	-	138.25	-	-
	Twofold Shelf	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Victorian Embayments	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
IMCRA-PROV	Bass Strait Shelf Province	2.79	-	-	739.25	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	West Tasmania Transition	3.06	-	-	108.5	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Western Bass Strait Shelf Transition**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	0.01	0.01	0.01	2,082.75	2,064	1,115
KEF	Bonney Coast Upwelling	15.49	-	-	110.75	-	-	15.81	-	-	6.5	-	-
	West Tasmania Canyons	8.43	-	-	2.75	-	-	11.05	-	-	44.5	-	-
MNP	Bunurong	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Discovery Bay	30.95	-	-	4.5	-	-	0.43	0.59	-	940.5	70.25	-
	Point Addis	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Port Phillip Heads	-	-	-	-	-	-	1.38	-	-	359.25	-	-
	Twelve Apostles	7.2	-	-	395.75	-	-	15.81	-	-	6.5	-	-
MR	South-east (Marine)**	0.01	0.01	0.01	2,090	2,064.25	1,110.25	52.77	-	-	44	-	-
MS	Mushroom Reef	-	-	-	-	-	-	0.39	0.45	-	940.5	70.25	-
	The Arches	20.3	-	-	20.5	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
NHPH	Great Ocean Road and Scenic Environs	6.9	14.17	-	284.5	46.25	-	1.15	-	-	195.25	-	-
NHPN	Summerland Peninsula	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
NIW	Western Port	-	-	-	-	-	-	1.45	5.51	-	787.25	70.25	-
NP	Great Otway	6.9	-	-	51.5	-	-	11.7	-	-	525.5	-	-
NPS4	Bunurong Marine Park	-	-	-	-	-	-	7.63	-	-	50	-	-
NRMR	Corangamite (VIC)	2.93	7.23	-	1,145.25	85.75	-	-	-	-	-	-	-
	Glenelg Hopkins (VIC)	18.71	-	-	112.5	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Port Phillip and Western Port (VIC)	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	West Gippsland (VIC)	-	-	-	-	-	-	5.47	-	-	77.5	-	-
OP	Phillip Island Nature Park	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
RAMSAR	Western Port	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
RSB	Bravenes Rock	3.92	-	-	328.25	-	-	7.26	-	-	363.75	-	-
SHORE-VIC-MPRA	Anglesea	39.92	-	-	133.5	-	-	1.45	-	-	525.5	-	-
	Apollo Bay	3.96	-	-	394.75	-	-	40.46	-	-	363.75	-	-
	Bay of Islands	14.78	-	-	112	-	-	-	-	-	-	-	-
	Cape Nelson	18.71	-	-	110.75	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Cape Otway West	3.47	7.23	-	787.75	61.25	-	1.18	-	-	126.25	-	-
	Cape Patton	10.22	-	-	517.5	-	-	15.91	-	-	1	-	-
	Childers Cove	42.39	-	-	4	-	-	58.55	-	-	1.5	-	-
	Cape Nelson	36.25	-	-	2.75	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)			Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	Kilcunda	-	-	-	-	-	-	-	-	-	-	-	-
	Lorne	24.43	-	-	230.5	-	-	5.52	-	-	138.25	-	-
	Moonlight Head	7.58	11.34	-	335	46.25	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Mornington Peninsula - South	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Mornington Peninsula - Southwest	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Port Campbell	13	-	-	311	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Port Phillip - Queenscliff	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Port Phillip - Sorrento Shore	-	-	-	-	-	-	15.81	-	-	6.5	-	-
	Port Phillip Heads	-	-	-	-	-	-	11.05	-	-	44.5	-	-
	Torquay	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
	Venus Bay	-	-	-	-	-	-	0.43	0.59	-	940.5	70.25	-
	Westernport	-	-	-	-	-	-	0.01	0.01	0.01	2,082.75	2,064	1,115
State Waters	Victoria	2.93	7.23	-	1,145.25	85.75	-	1.38	-	-	359.25	-	-

*The release location resides within the receptor boundaries.



Coordinate System: WGS 1984/Pseudo-Mercator
Datum: WGS 1984
Units: Meters
Date created: 26/08/2024

Project: GOC365512 Beach Energy - Otway Ops Oil Spill Modelling

Scenario: 434,752 stb subsurface release of condensate over 86 days from the Northern Release Location - Summer

Legend

- ⊕ Release Location
- ☐ 3nm Coastal Waters
- ☐ Exclusive Economic Zone

Zones of potential entrained hydrocarbon exposure (ppb)

- 🟨 10
- 🟧 100
- 🟪 1000

Figure 13-18 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

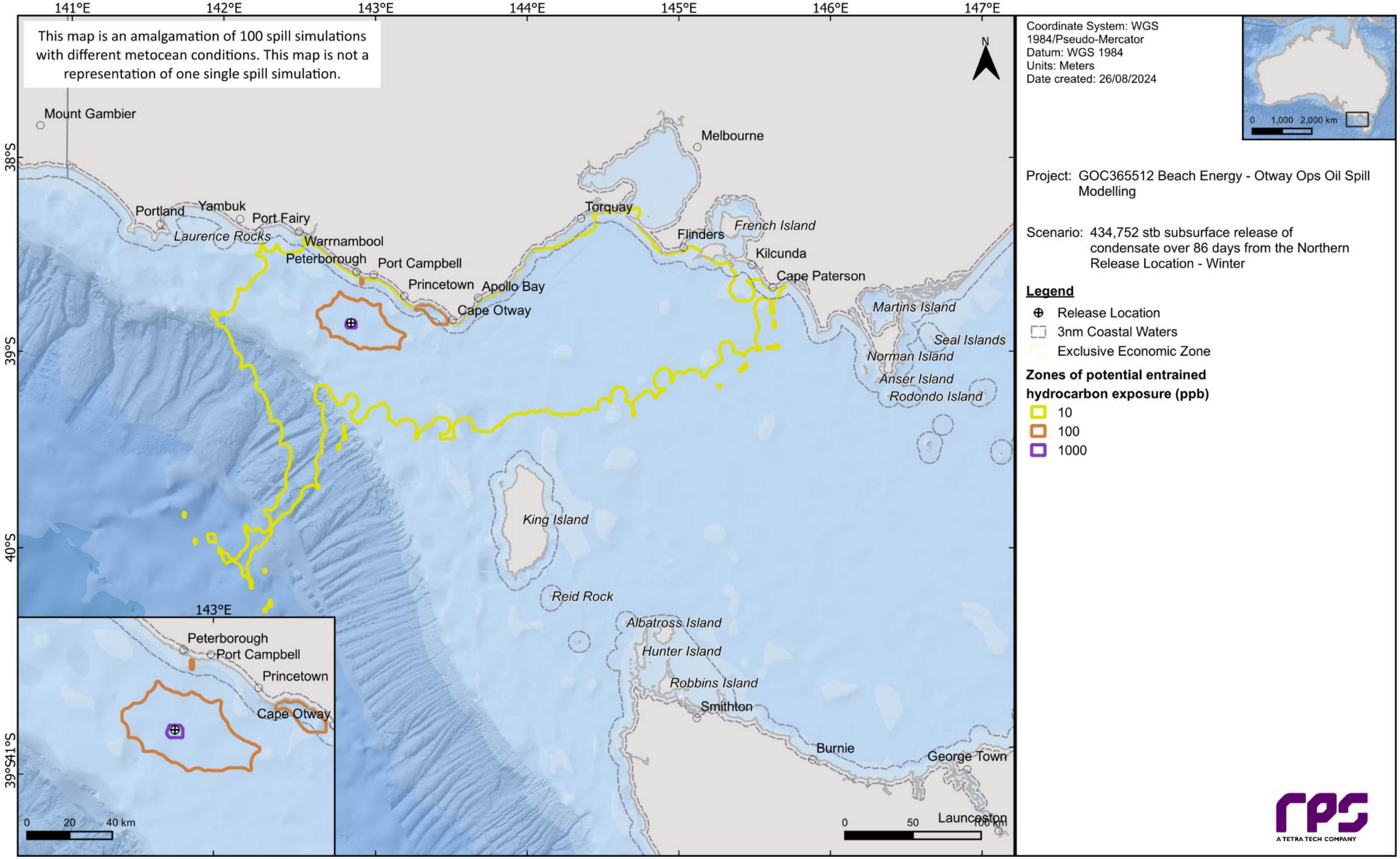


Figure 13-19 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

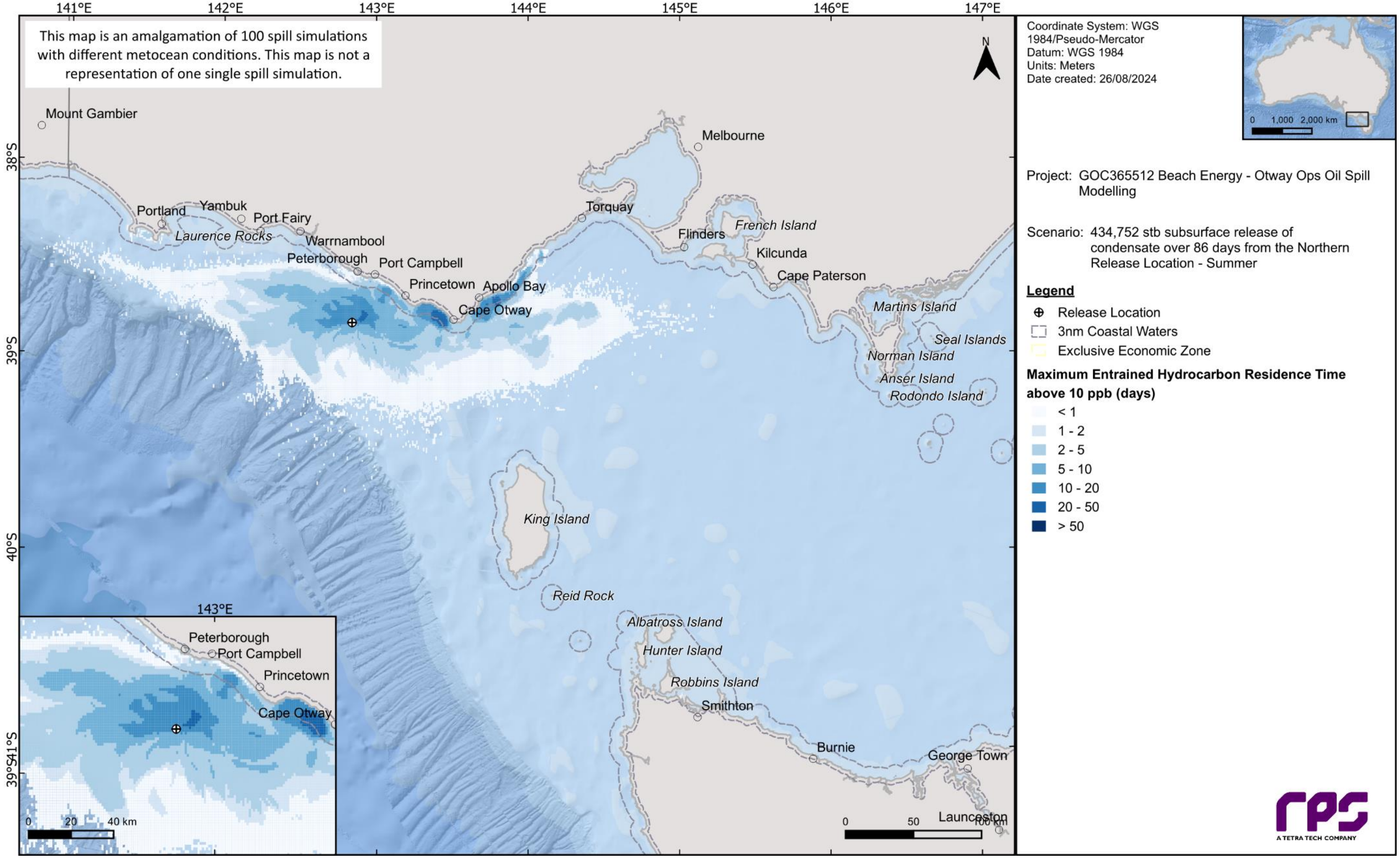


Figure 13-20 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

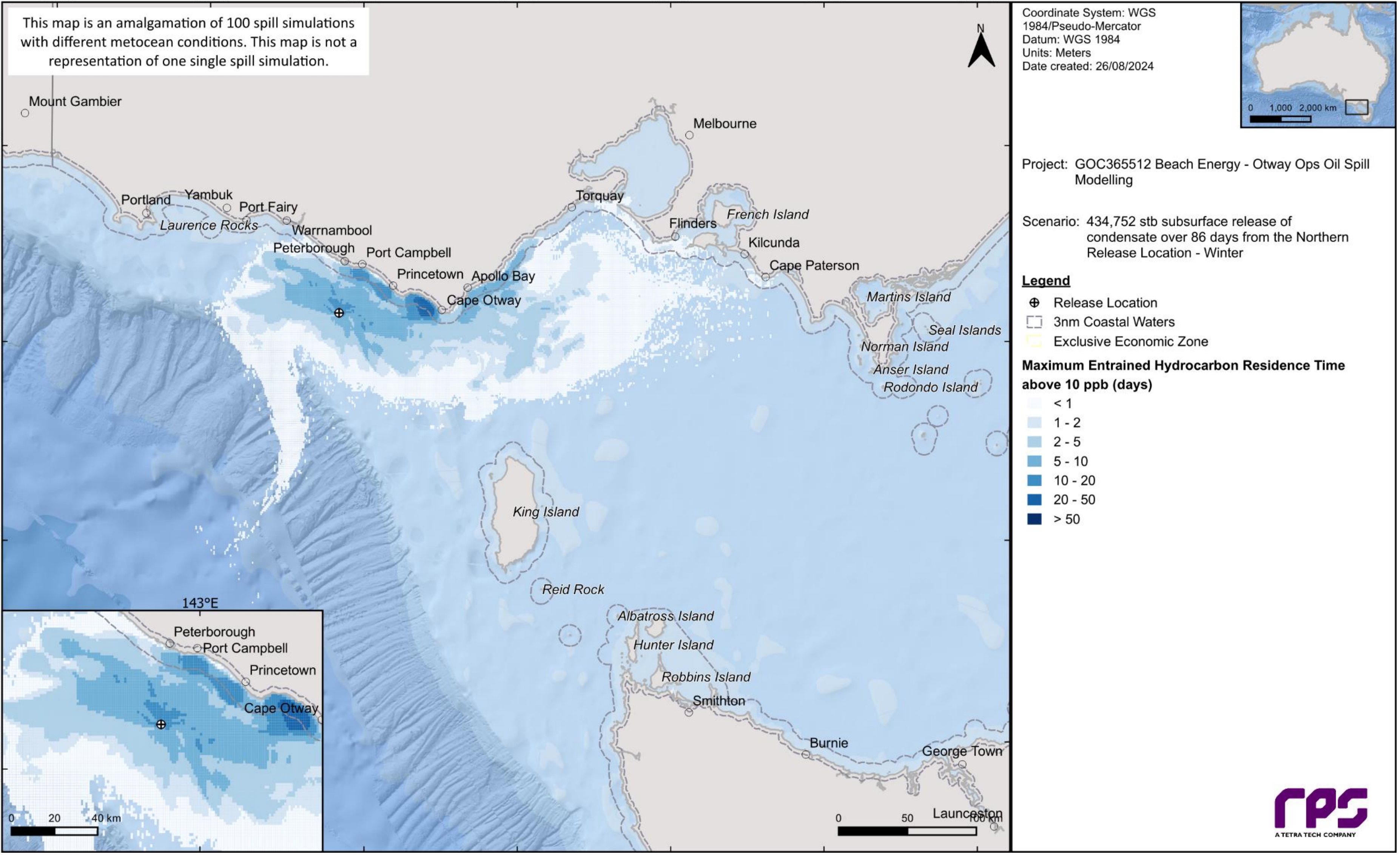


Figure 13-21 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

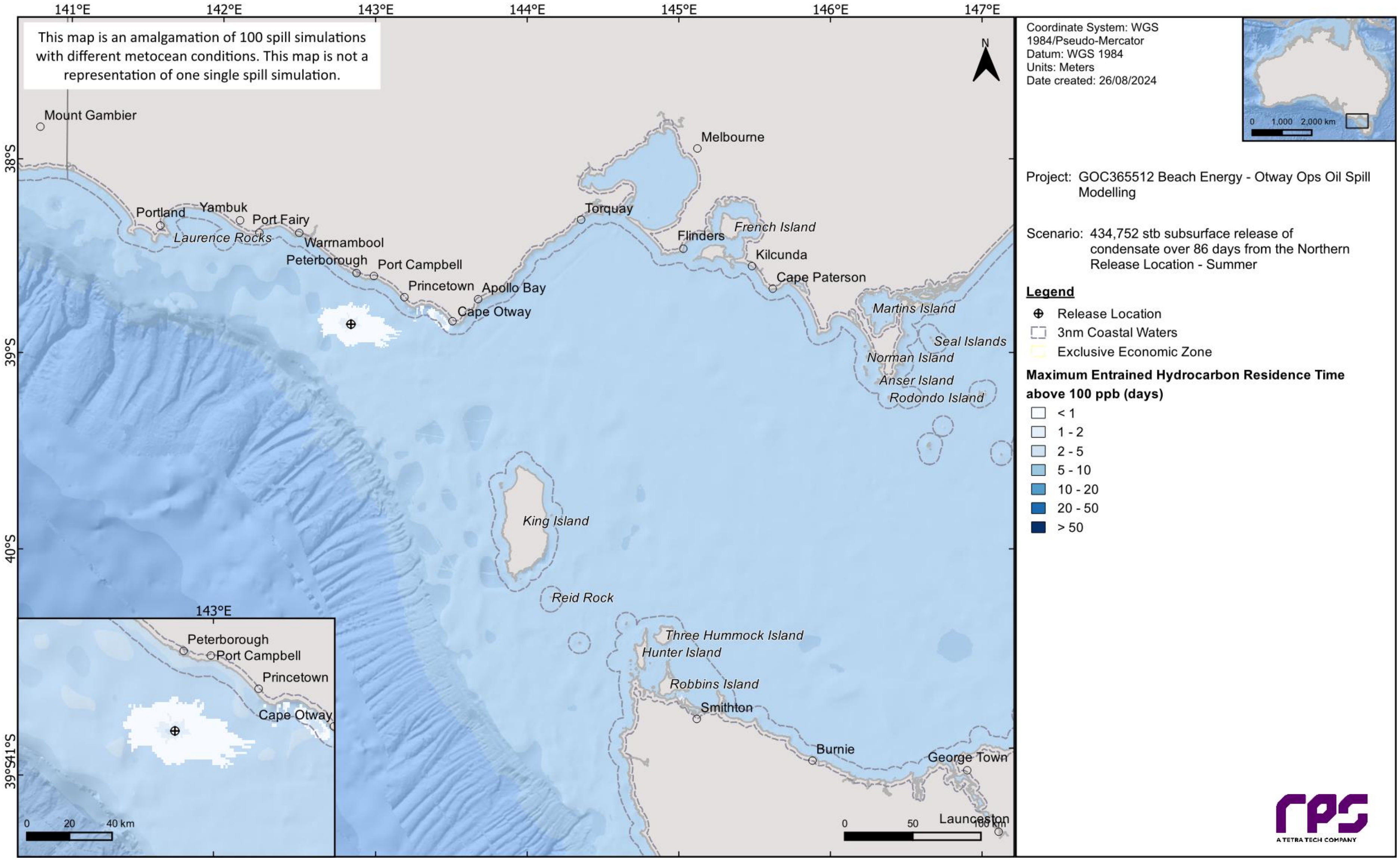


Figure 13-22 **Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.**

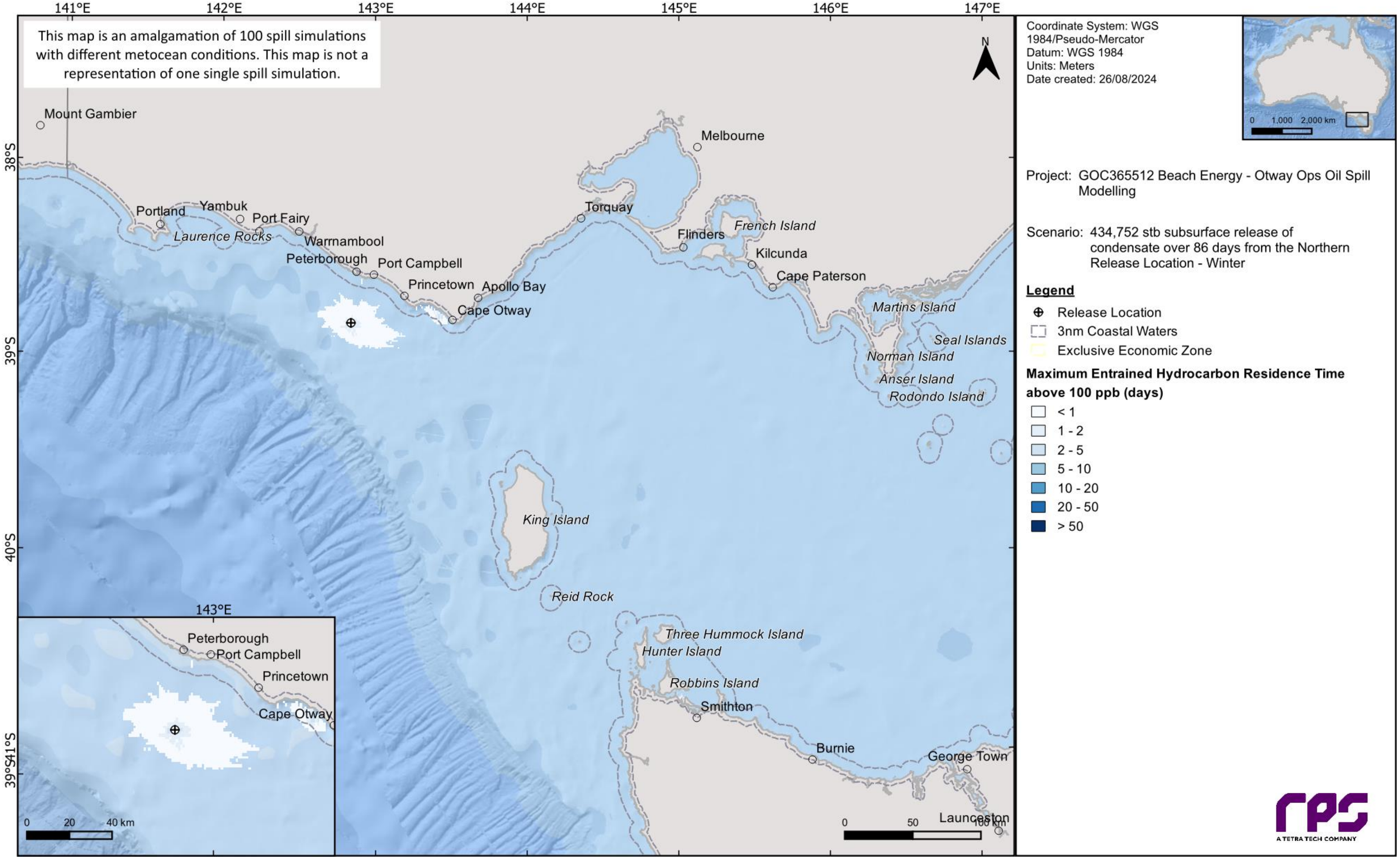


Figure 13-23 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

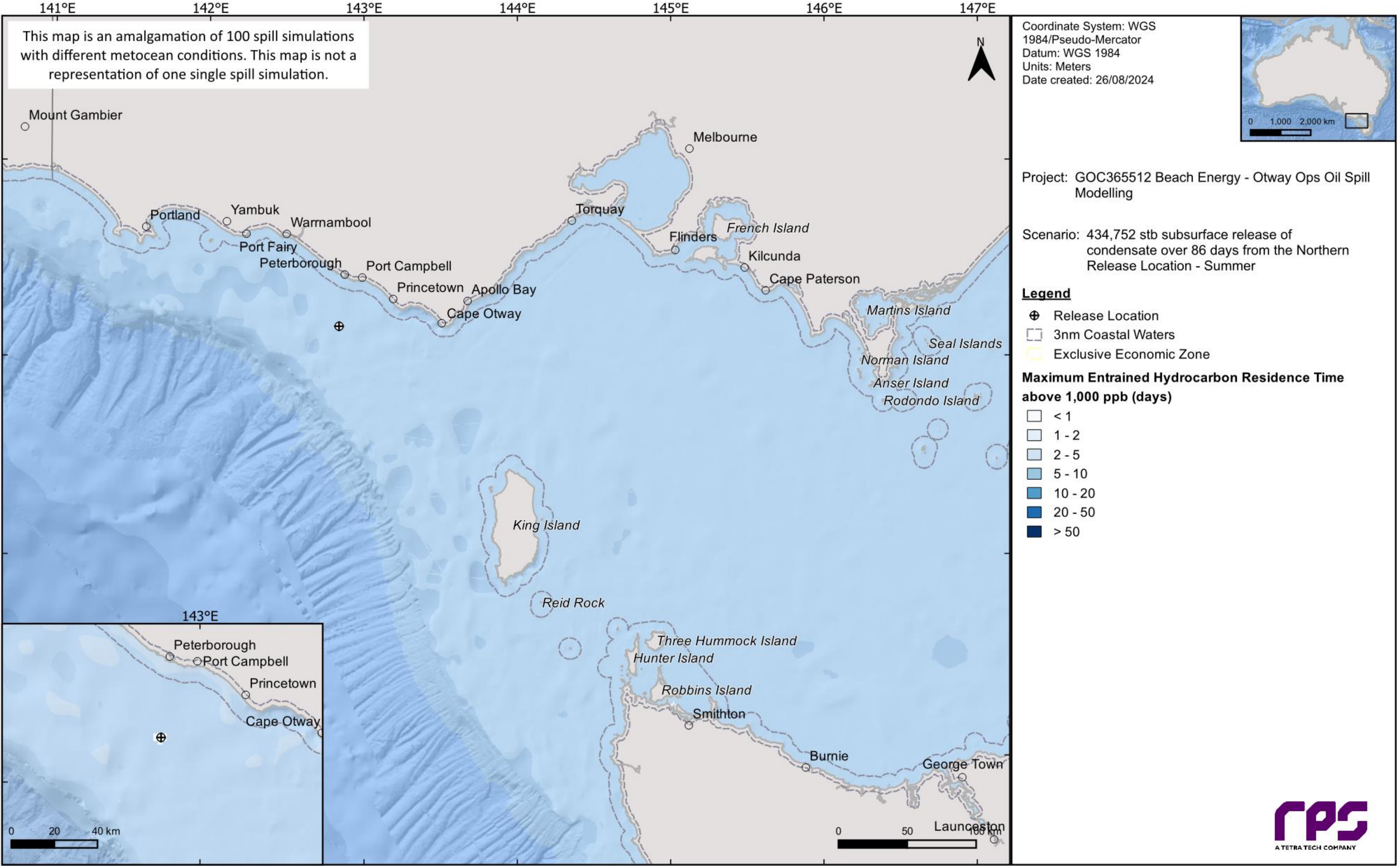


Figure 13-24 Maximum residence time for entrained hydrocarbon exposure above 1,000 ppb, at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

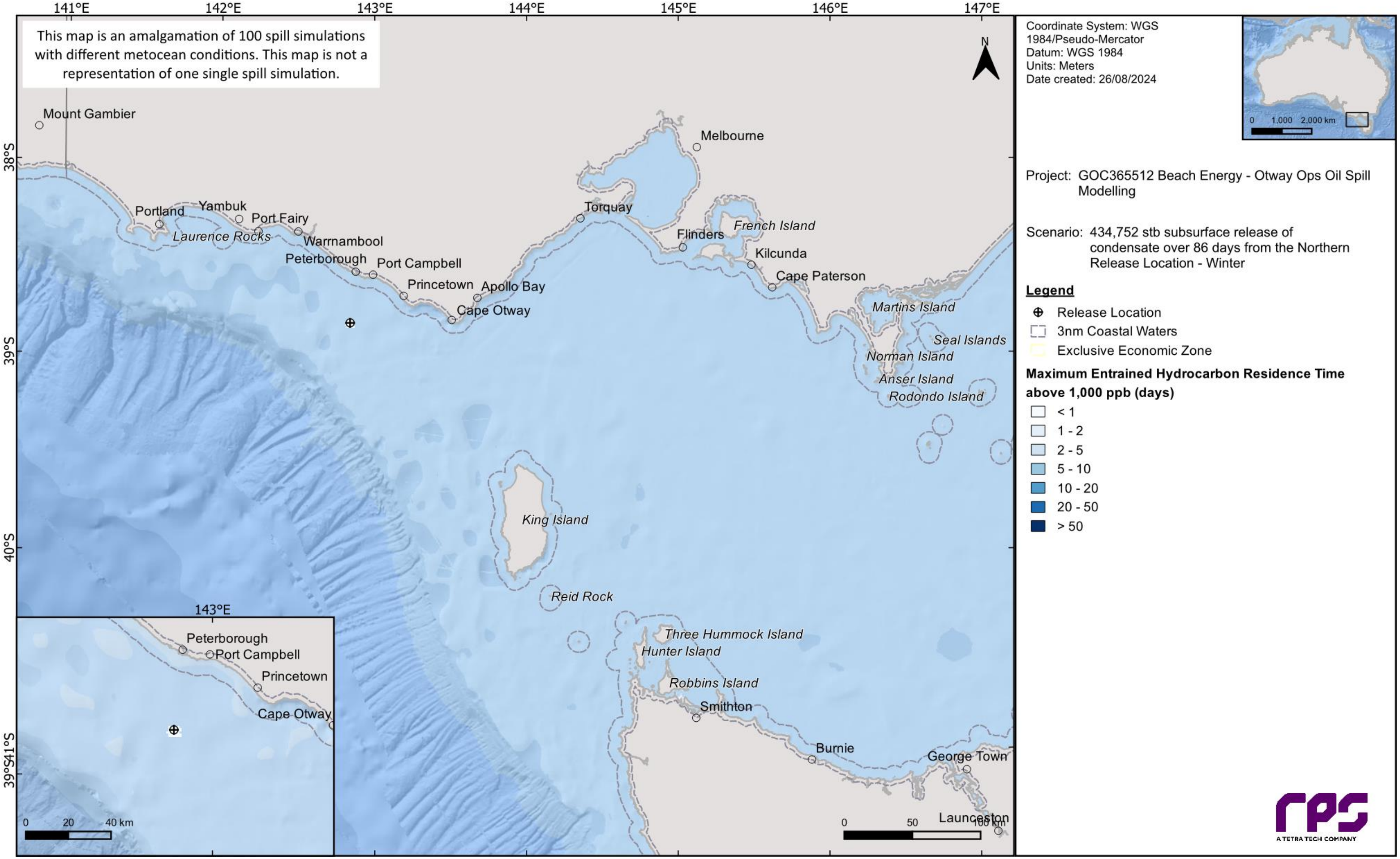


Figure 13-25 Maximum residence time for entrained hydrocarbon exposure above 1,000 ppb, at 0-10 m below the sea surface in the event of a 434,752 stb subsea release of condensate over 86 days from a loss of well control at the Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

14 RESULTS – LOSS OF CONTAINMENT FROM VESSEL COLLISION AT THE NORTHERN RELEASE LOCATION

This scenario examined a 603.7 m^3 surface release of marine diesel for a loss of containment from a vessel collision at the Northern Release Location. A total of 200 spill simulations were run (i.e., 100 spills per season) and tracked for 30 days. The results for all 100 simulations per season were combined and are presented on a seasonal basis (i.e., summer and winter).

14.1 Stochastic Analysis

14.1.1 Area of Exposure

Figure 14-1 presents the combined area of potential exposure for surface, shoreline, entrained and dissolved, by overlaying the results from all 200 simulations (i.e., 100 per season) during summer and winter conditions.

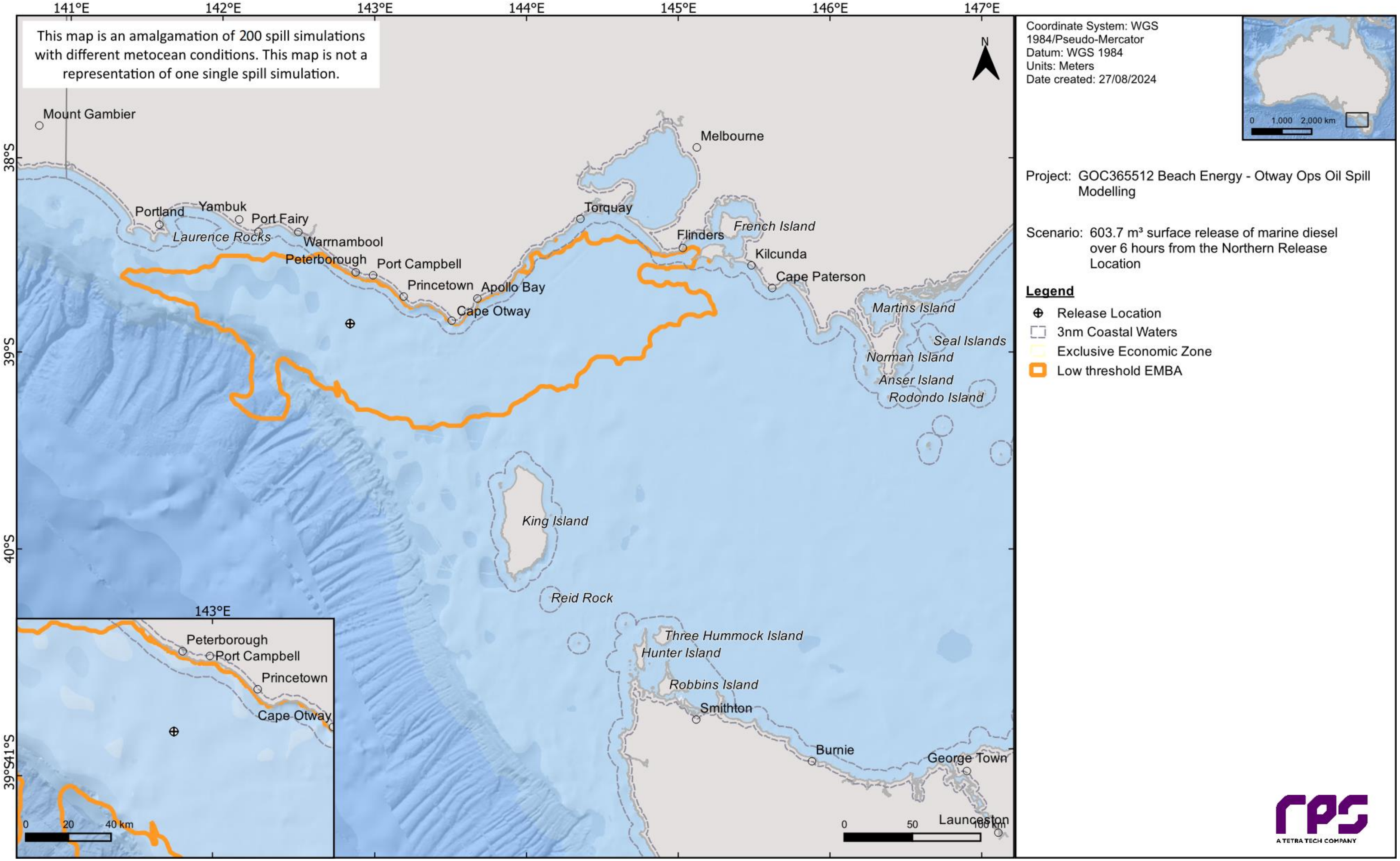


Figure 14-1 Predicted area of exposure for low thresholds produced by overlaying the results from all 200 simulations, resulting from a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location during summer and winter conditions.

14.1.2 Floating Oil Exposure

Table 14-1 summarises the maximum distance travelled by floating oil on the sea surface at each threshold. The maximum distance from the release location to the low (1–10 g/m^2), moderate (10–50 g/m^2) and high (> 50 g/m^2) exposure zones was 32.65 km (east-southeast), 19.85 km (southeast) and 10.53 km (southeast) all during winter conditions.

Table 14-2 summarises the potential floating oil exposure to individual receptors during the summer and winter conditions. Outside of the receptors that the Northern Release Location resides within (refer to Table 12-1), floating oil exposure above the low threshold was predicted at the Pygmy Blue Whale – Foraging (2% winter) and Short-tailed Shearwater - Foraging (2% summer, 3% winter) BIAs.

Table 14-3 presents the maximum residence time of floating oil exposure for each individual grid cell within each individual receptor during summer and winter.

Figure 14-2 and Figure 14-3 present the zones of potential floating oil exposure for all thresholds under summer and winter conditions, respectively.

Figure 14-4 to Figure 14-9 present the minimum time before floating oil exposure for the NOPSEMA thresholds during summer and winter, respectively.

Table 14-1 Maximum distance and direction from the release location to the edge of floating oil exposure. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at the Northern Release Location. The results were calculated from 100 spill simulations per season.

Season	Distance and direction travelled	Zones of potential floating oil exposure		
		Low	Moderate	High
Summer	Maximum distance (km) from release location	25.26	16.96	9.76
	Direction	West-Northwest	Northwest	North-Northwest
Winter	Maximum distance (km) from release location	32.65	19.85	10.53
	Direction	East-Southeast	Southeast	Southeast

Table 14-2 Summary of the potential floating oil exposure to individual receptors. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at the Northern Release Location. The results were calculated from 100 spill simulations per season.

Receptor		Summer (November through to March)						Winter (April to October)					
		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)			Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	Pygmy Blue Whale - Distribution (None)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	-	-	-	-	-	-	2	-	-	1.85	-	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)	2	-	-	0.72	-	-	3	-	-	1.75	-	-
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer-Muttonbird Island (VIC))**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	White Shark - Distribution (Between the 60-120m depth contour)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
IMCRA-MESO	Otway**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
IMCRA-PROV	Western Bass Strait Shelf Transition**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02
MR	South-east (Marine)**	100	100	78	0.01	0.01	0.02	100	100	70	0.01	0.01	0.02

*The release location resides within the receptor boundaries.

Table 14-3 Summary of the maximum residence time of floating oil exposure for each individual grid cell within each individual receptor. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations per season.

Receptor		Summer (November through to March)			Winter (April to October)		
		Maximum residence time of floating oil exposure (days)			Maximum residence time of floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	21.75	16.25	9.5	29.75	19	9.75
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	21.75	16.25	9.5	29.75	19	9.75
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	21.75	16.25	9.5	29.75	19	9.75
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	21.75	16.25	9.5	29.75	19	9.75
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	21.75	16.25	9.5	29.75	19	9.75
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	21.75	16.25	9.5	29.75	19	9.75
	Pygmy Blue Whale - Distribution (None)**	21.75	16.25	9.5	29.75	19	9.75
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	-	-	-	6.75	-	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	21.75	16.25	9.5	29.75	19	9.75
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)	3.5	-	-	13.5	-	-
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	21.75	16.25	9.5	29.75	19	9.75
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	21.75	16.25	9.5	29.75	19	9.75
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	21.75	16.25	9.5	29.75	19	9.75
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	21.75	16.25	9.5	29.75	19	9.75
	White Shark - Distribution (Between the 60-120m depth contour)**	21.75	16.25	9.5	29.75	19	9.75
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	21.75	16.25	9.5	29.75	19	9.75
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	21.75	16.25	9.5	29.75	19	9.75
IMCRA-MESO	Otway**	21.75	16.25	9.5	29.75	19	9.75
IMCRA-PROV	Western Bass Strait Shelf Transition**	21.75	16.25	9.5	29.75	19	9.75
MR	South-east (Marine)**	21.75	16.25	9.5	29.75	19	9.75

*The release location resides within the receptor boundaries.

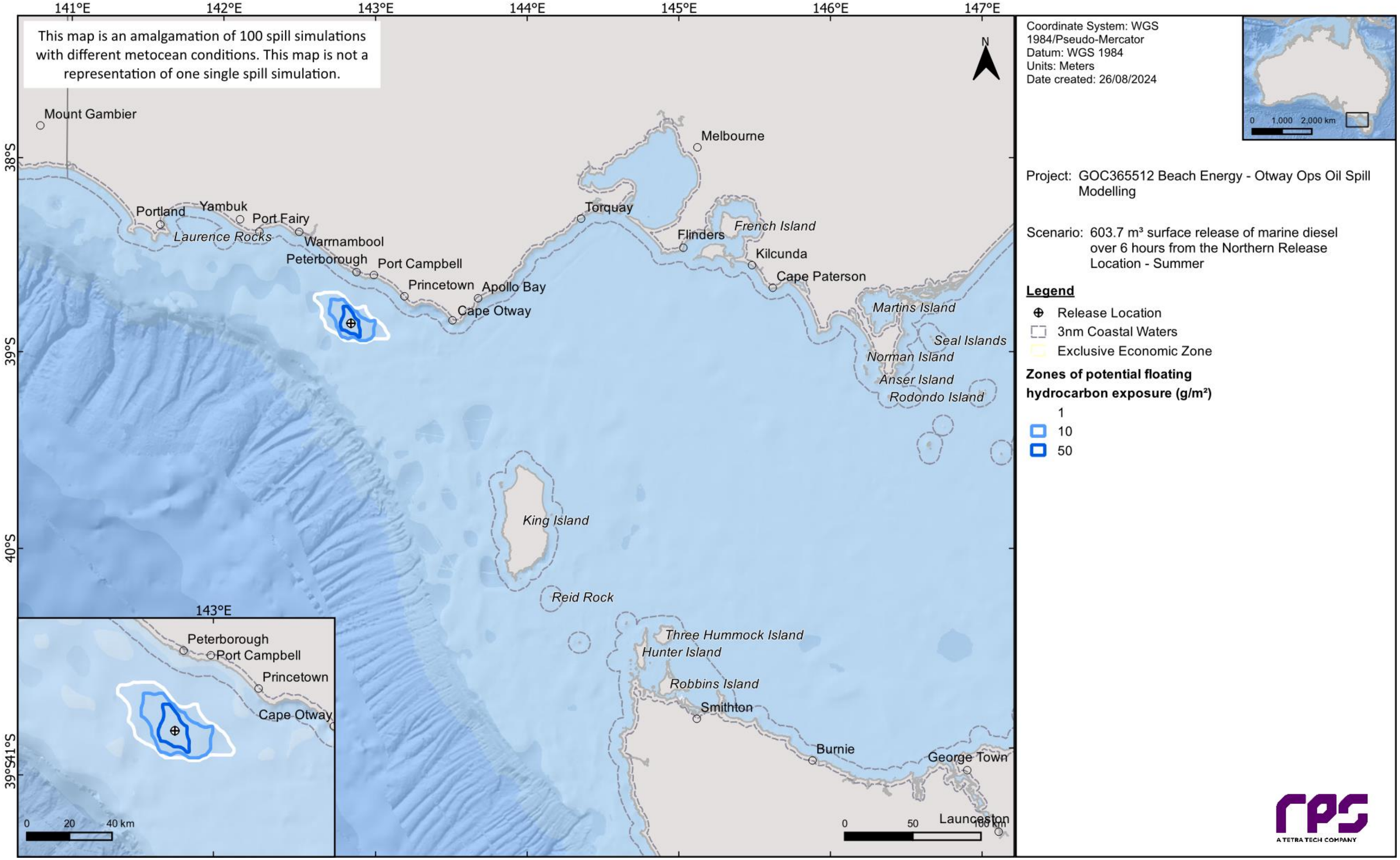


Figure 14-2 Zones of potential floating oil exposure in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

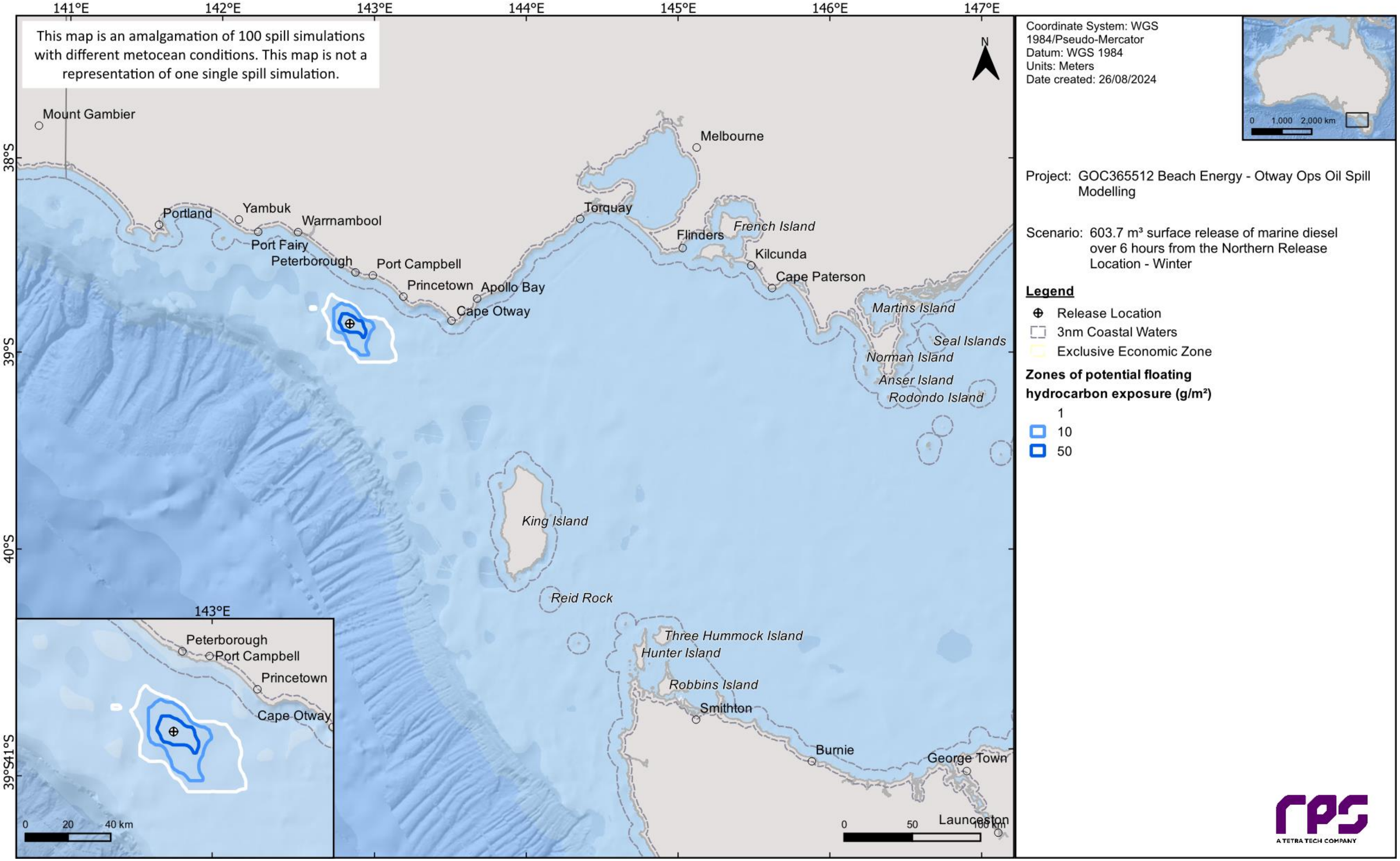


Figure 14-3 Zones of potential floating oil exposure in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

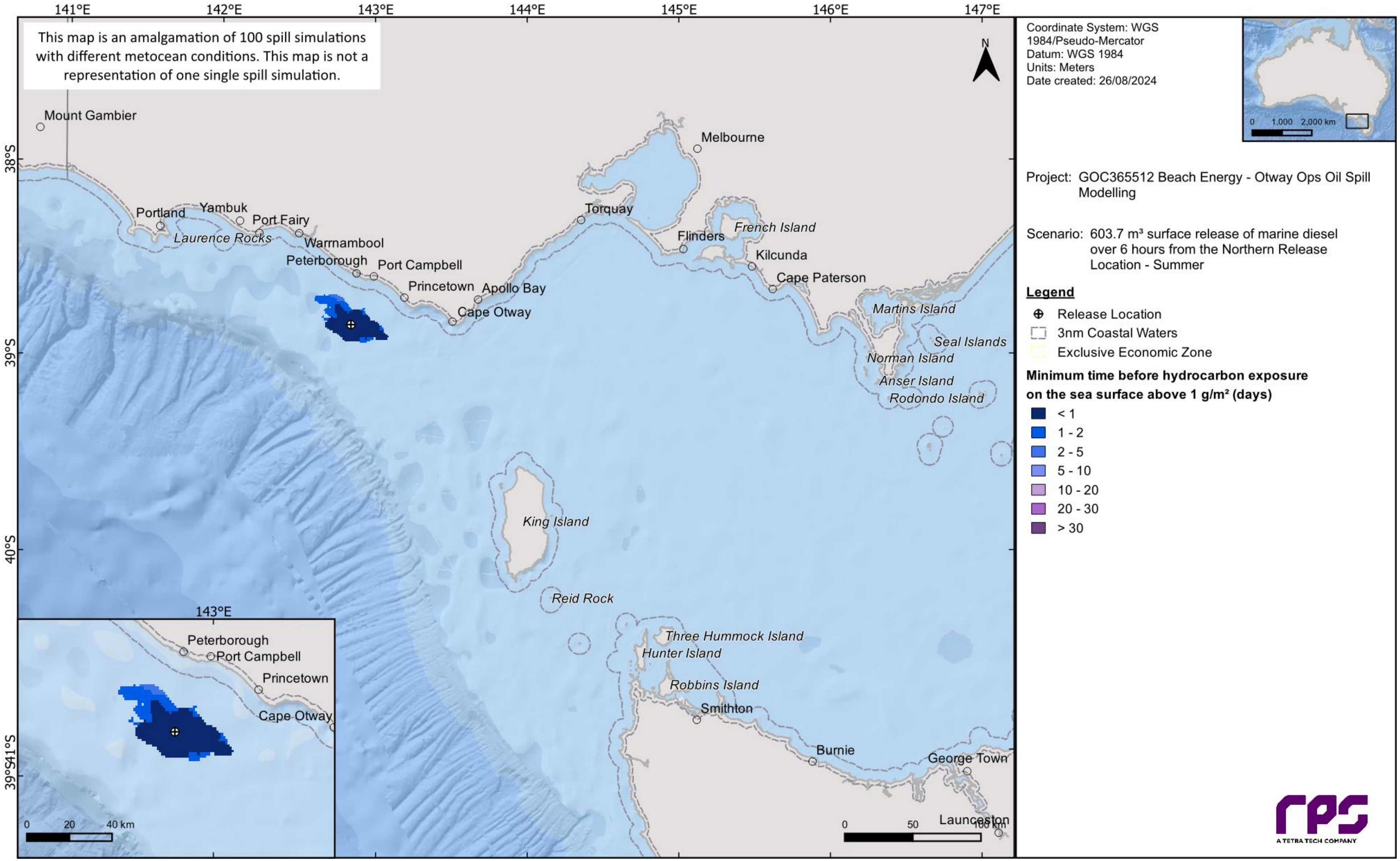


Figure 14-4 Minimum time before floating oil exposure above 1 g/m^2, in the event of 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

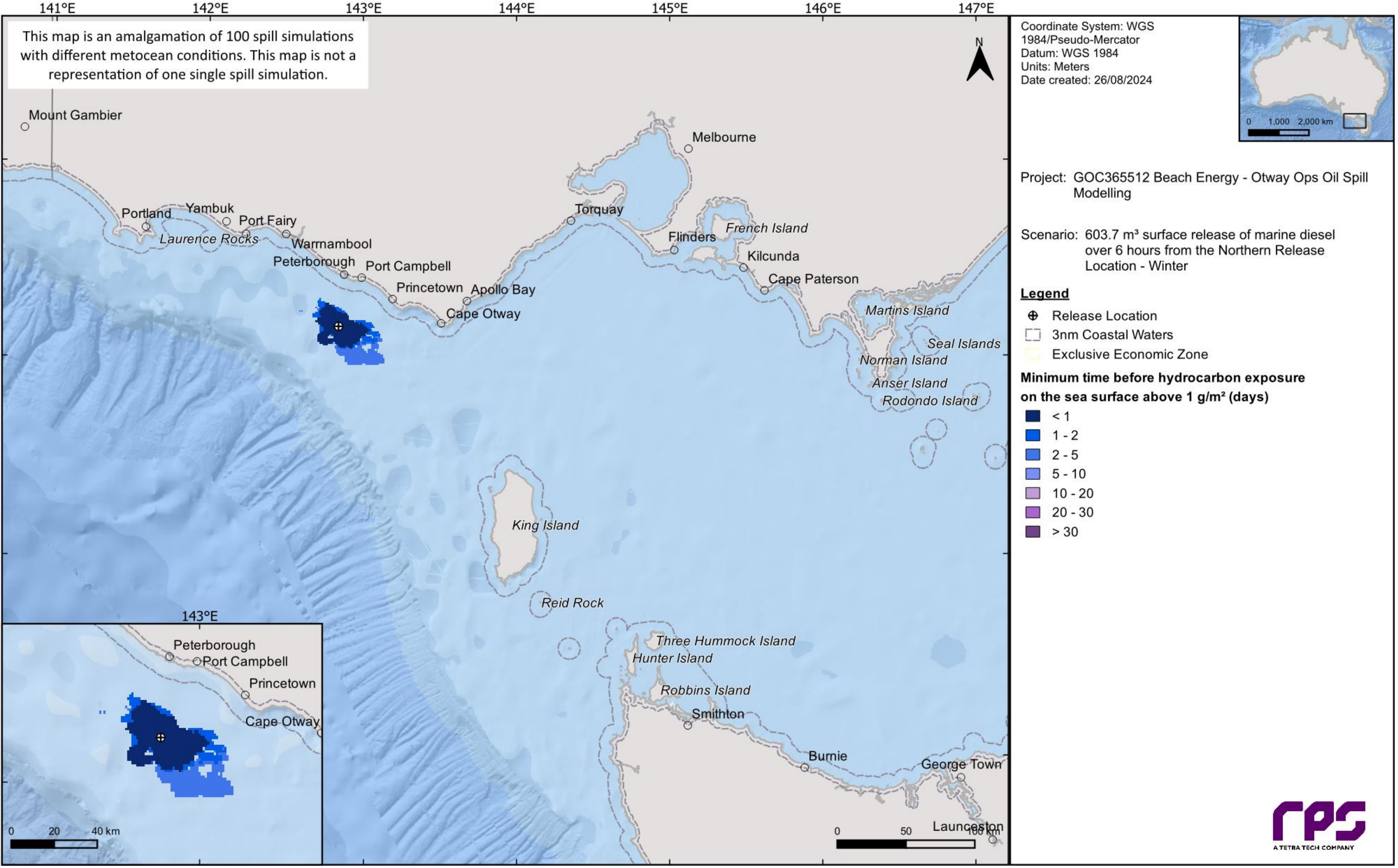


Figure 14-5 Minimum time before floating oil exposure above 1 g/m^2, in the event of 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

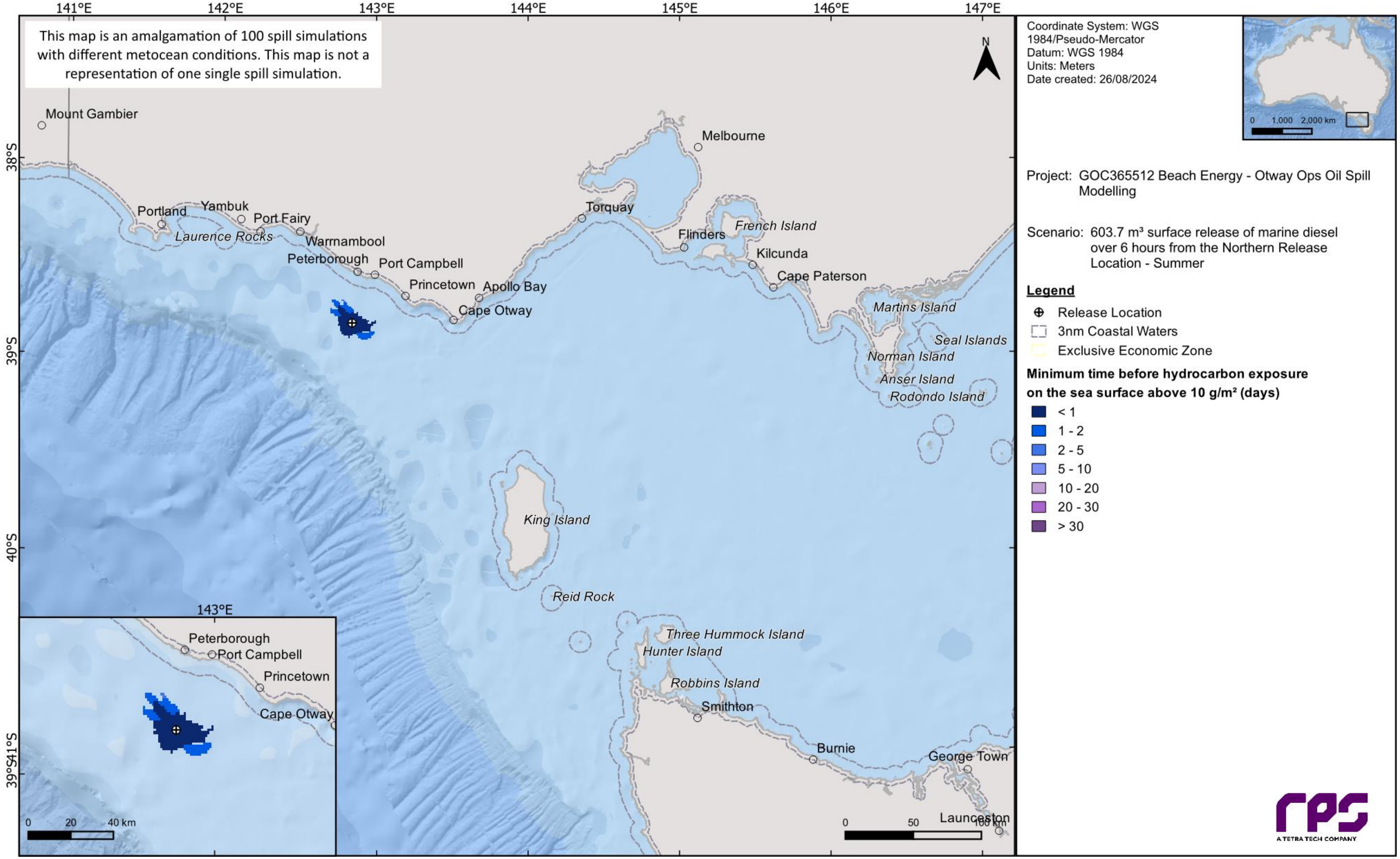


Figure 14-6 **Minimum time before floating oil exposure above 10 g/m^2, in the event of 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.**

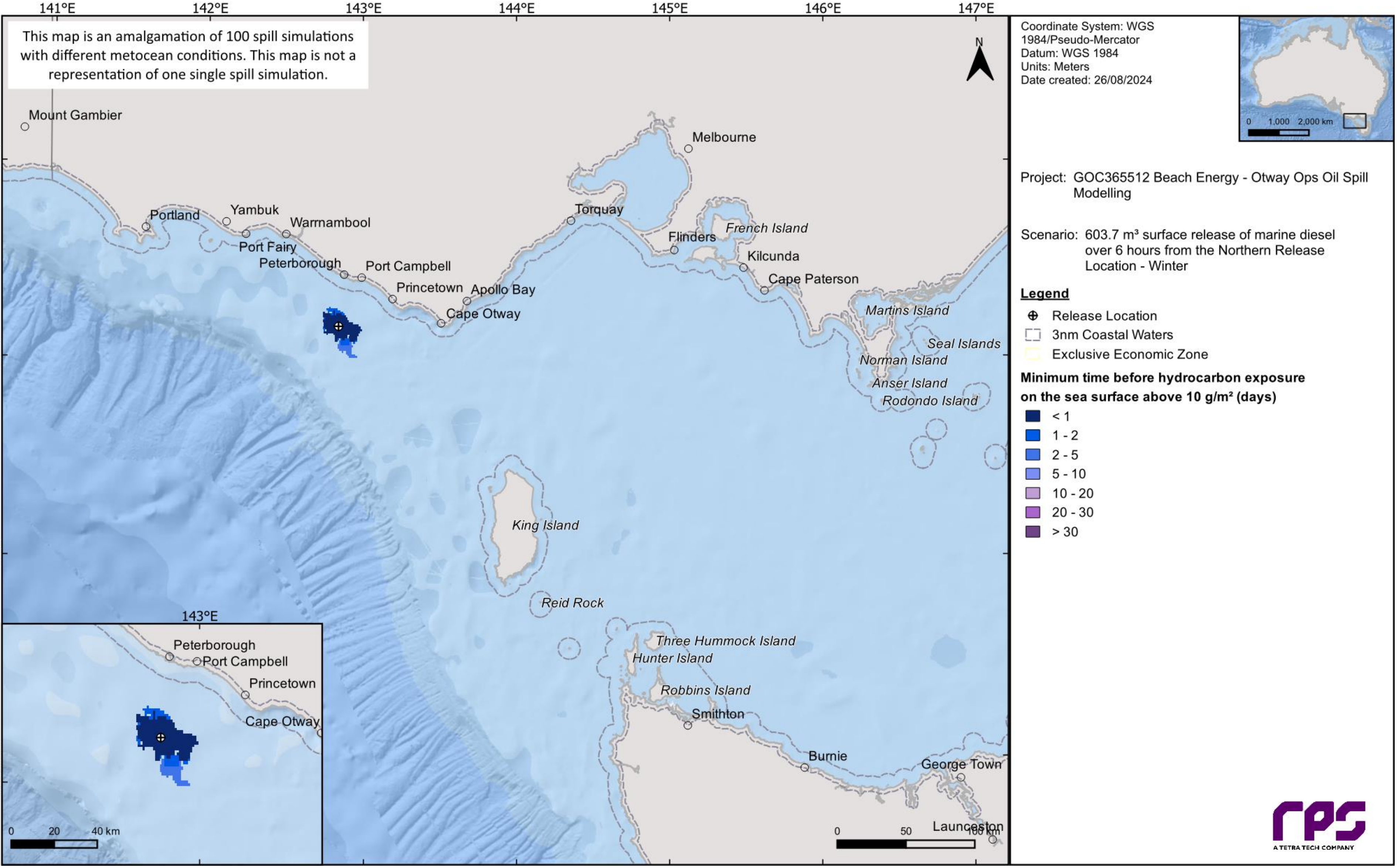


Figure 14-7 Minimum time before floating oil exposure above 10 g/m^2, in the event of 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

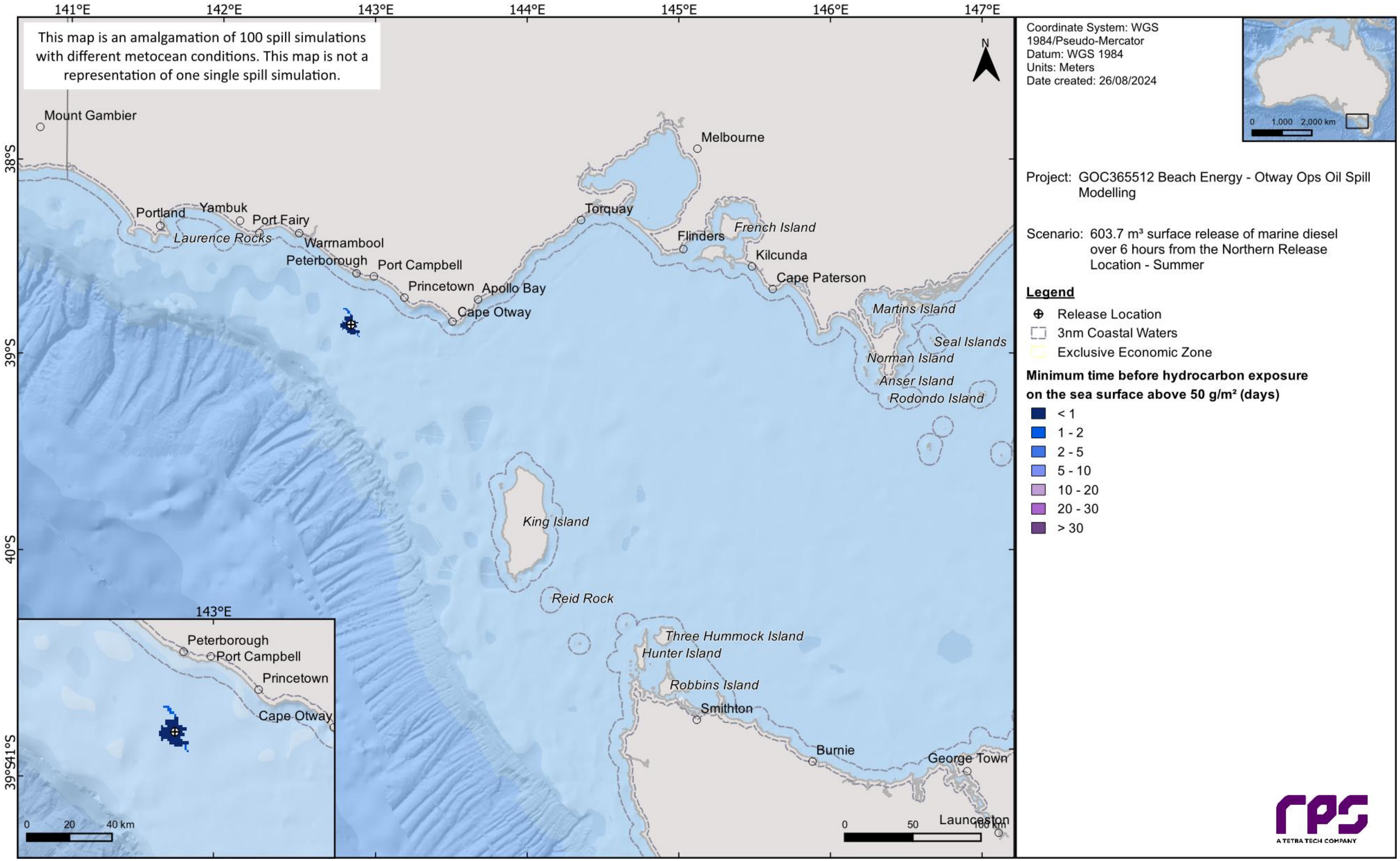


Figure 14-8 Minimum time before floating oil exposure above 50 g/m^2, in the event of 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

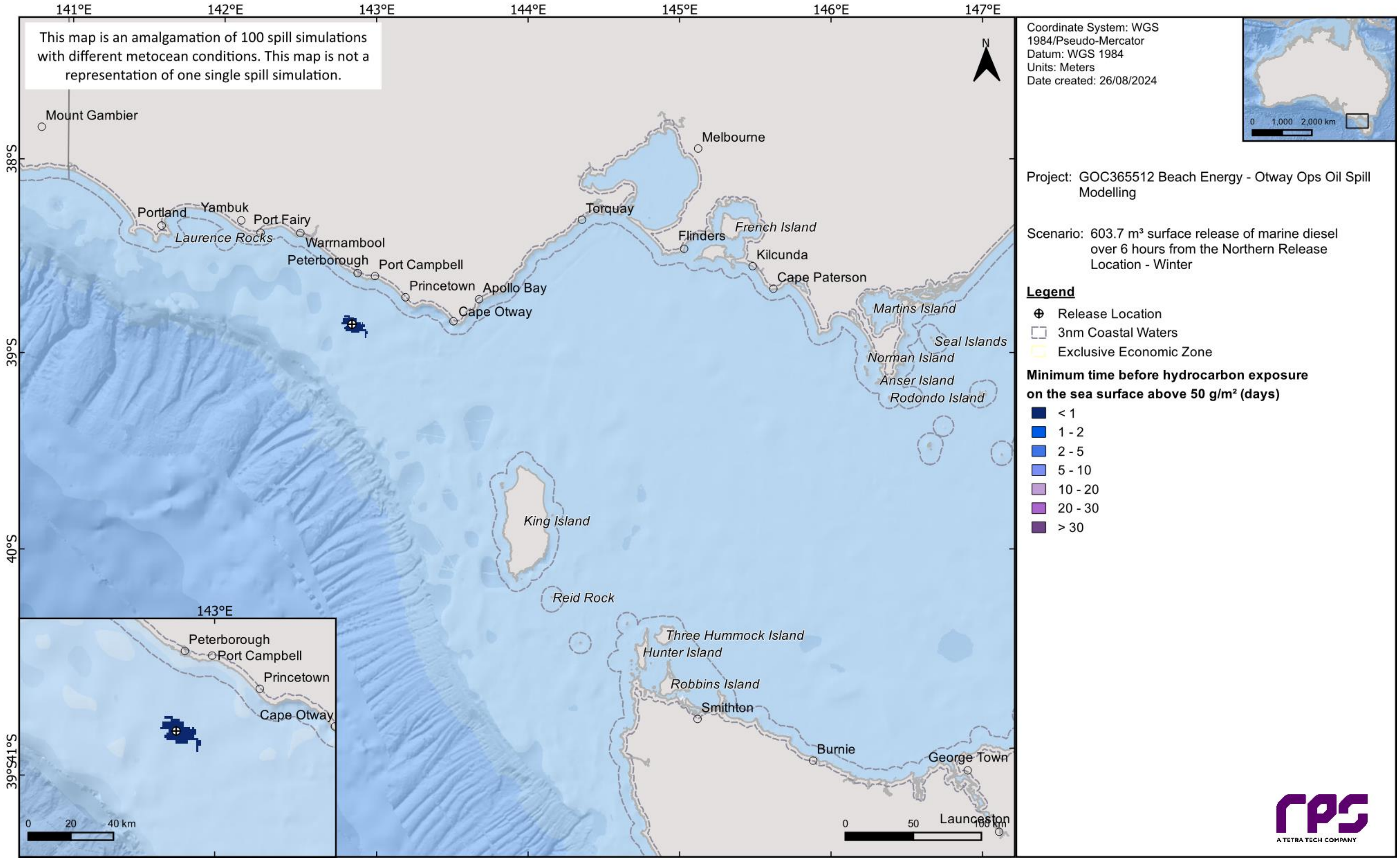


Figure 14-9 Minimum time before floating oil exposure above 50 g/m^2, in the event of 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

14.1.3 Shoreline Accumulation

Table 14-4 presents a summary of the predicted potential shoreline accumulation during the summer and winter conditions. The probability of accumulation to any shoreline at, or above, the low level (10 g/m^2) threshold was 31% during summer conditions and 27% during winter conditions. The minimum time before oil accumulation at, or above, the low threshold was 4.5 days during summer conditions, and 2.0 days during winter conditions. The maximum volume ashore for a single spill trajectory during the summer and winter conditions was 30.86 m^3 and 58.33 m^3, respectively, whilst the maximum length of shoreline accumulation at the low threshold was 29.23 km and 43.19 km, respectively. For the moderate threshold (100 g/m^2), the maximum length of shoreline accumulation predicted was 10.16 km and 12.70 km during summer and winter respectively. No shoreline accumulation was predicted for the high (1,000 g/m^2) threshold.

Table 14-5 summarises the shoreline accumulation on individual receptors during the summer and winter conditions. Cape Otway West recorded the highest probability of shoreline accumulation at the low threshold with 24% (summer) and 20% (winter) and the largest shoreline accumulation with 4.46 m^3 and 9.28 m^3, respectively. The minimum time before shoreline accumulation above the low threshold was predicted for the same receptor as 4.5 and 2.03 days during summer and winter respectively.

The summer and winter conditions maximum potential shoreline loading above the low, moderate and high shoreline thresholds are presented in Figure 14-10 and Figure 14-11, respectively.

Table 14-4 Summary of oil accumulation across all shorelines. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations per season.

Shoreline Statistics	Summer	Winter
Probability of accumulation on any shoreline (%)	31	27
Absolute minimum time for visible oil to shore (days)	4.5	2.0
Maximum total volume of hydrocarbons ashore (m^3)	30.86	58.33
Average volume of hydrocarbons ashore (m^3)	2.13	2.92
Maximum length of the shoreline at **10 g/m^2** (km)	29.23	43.19
Average shoreline length (km) at **10 g/m^2** (km)	3.2	3.38
Maximum length of the shoreline at **100 g/m^2** (km)	10.16	12.70
Average shoreline length (km) at **100 g/m^2** (km)	0.27	0.5
Maximum length of the shoreline at **1,000 g/m^2** (km)	-	-
Average shoreline length (km) at **1,000 g/m^2** (km)	-	-

Table 14-5 Summary of oil accumulation on individual shoreline receptors. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations per season.

Shoreline Receptor		Summer																Winter															
		Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline accumulation (km)			Maximum length of shoreline accumulation (km)			Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline accumulation (km)			Maximum length of shoreline accumulation (km)		
		Low	Mod	High	Low	Mod	High	Mean	Peak	Mean	Peak	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High	Mean	Peak	Mean	Peak	Low	Mod	High	Low	Mod	High
SHORE-LGA	King Island Council (TAS)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	27.75	-	-	0.44	36.12	0.01	0.54	0.01	-	-	1.26	-	-
SHORE-VIC-MPRA	Anglesea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	26.11	-	-	0.51	10.65	0.01	0.16	0.01	-	-	1.27	-	-
	Apollo Bay	8	-	-	6.95	-	-	2.22	34.43	0.03	0.52	0.24	-	-	7.62	-	-	7	-	-	3.59	-	-	2.55	42.31	0.04	0.64	0.27	-	-	6.35	-	-
	Bay of Islands	1	-	-	14.58	-	-	1.02	48.95	0.02	0.74	0.11	-	-	11.44	-	-	1	-	-	7.06	-	-	0.21	12.64	-	0.19	0.01	-	-	1.27	-	-
	Cape Otway West	24	6	-	4.5	6.8	-	14.21	294.11	0.22	4.46	1.73	0.25	-	19.05	10.16	-	20	7	-	2.03	3.65	-	21.73	611.8	0.33	9.28	2.15	0.42	-	27.94	12.7	-
	Cape Patton	10	-	-	8.02	-	-	3.25	74.08	0.05	1.12	0.72	-	-	20.33	-	-	1	-	-	11.53	-	-	1.62	42.31	0.02	0.64	0.06	-	-	6.35	-	-
	Childers Cove	1	-	-	15.43	-	-	0.18	10.58	-	0.16	0.01	-	-	1.27	-	-	-	-	-	-	-	-	0.12	8.54	-	0.13	-	-	-	-	-	-
	Lorne	3	-	-	14.85	-	-	1.12	31.48	0.02	0.48	0.1	-	-	6.36	-	-	-	-	-	-	-	-	0.46	8.5	0.01	0.13	-	-	-	-	-	-
	Moonlight Head	9	1	-	5.53	20.06	-	4.74	101.07	0.07	1.53	0.34	0.01	-	10.16	1.27	-	9	2	-	3.18	7.7	-	6.42	161.0	0.1	2.45	0.85	0.08	-	24.14	3.81	-
	Point Hicks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	29.31	-	-	0.12	12.44	-	0.19	0.03	-	-	2.55	-	-
	Port Campbell	1	-	-	14.71	-	-	0.97	30.22	0.01	0.46	0.06	-	-	6.35	-	-	2	-	-	7	-	-	0.52	19.97	0.01	0.3	0.05	-	-	2.54	-	-

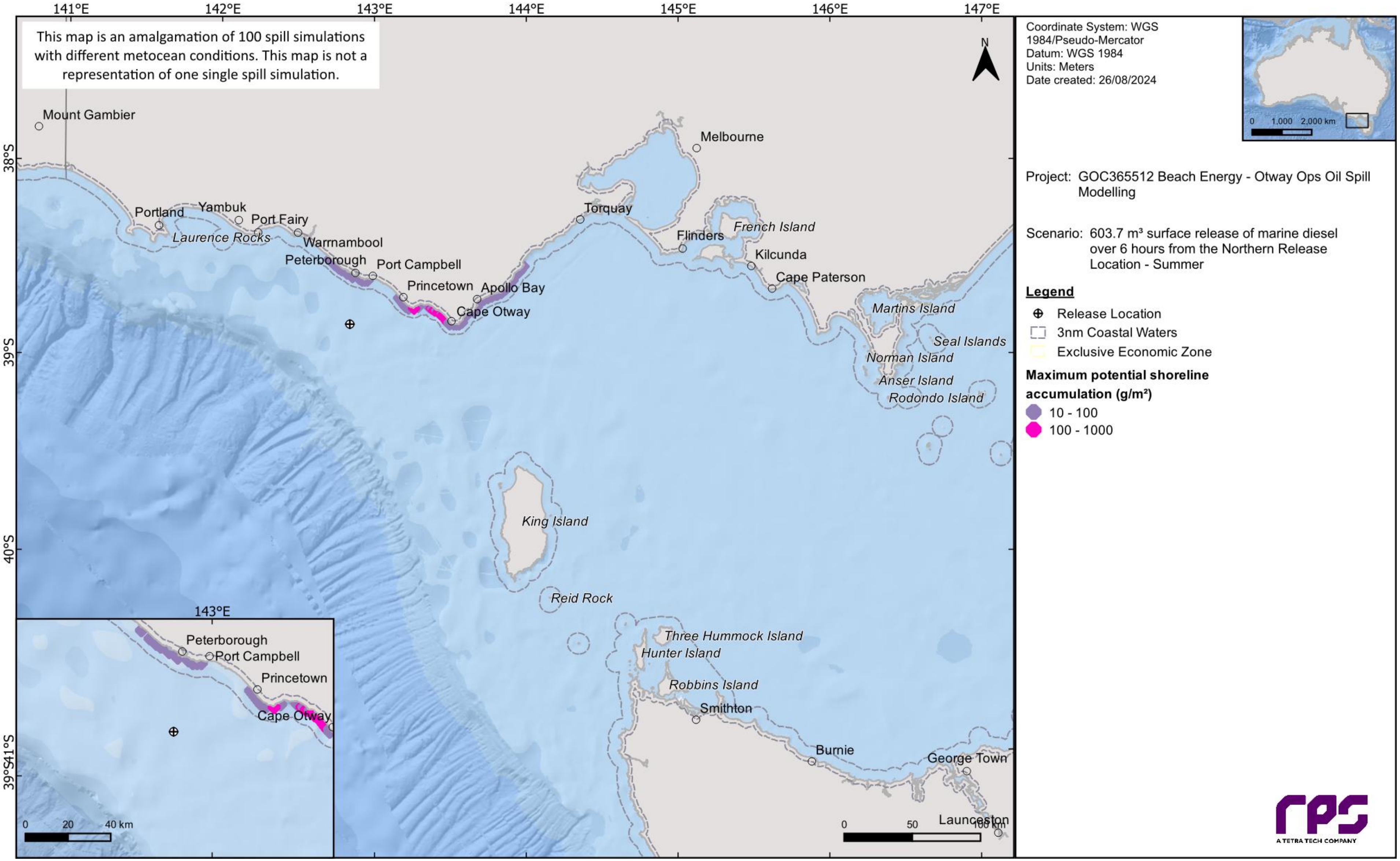


Figure 14-10 **Maximum potential shoreline loading in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.**

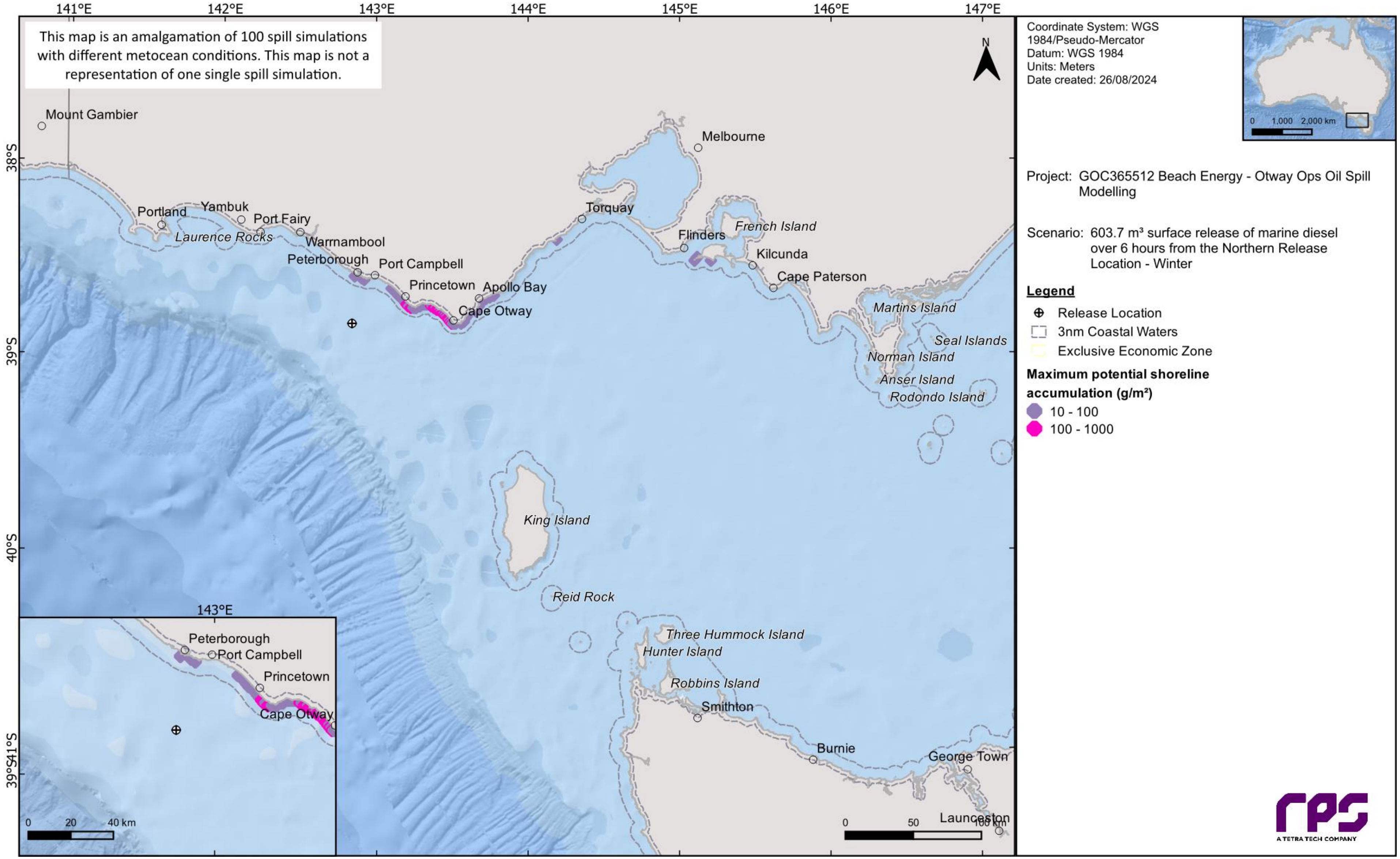


Figure 14-11 Maximum potential shoreline loading in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

14.1.4 In-water exposure

14.1.4.1 Dissolved Hydrocarbons

Table 14-6 summarises the probability of exposure to individual receptors from dissolved hydrocarbons in the 0-10 m layer during the summer and winter conditions. No dissolved hydrocarbon exposure at the high (400 ppb) threshold was predicted,

Only the receptors that the Northern Release Location resides within (refer to Table 12-1) were contacted by dissolved hydrocarbon at the low threshold. The maximum dissolved hydrocarbon concentration was 101.35 ppb and 65.67 ppb during summer and winter respectively.

Table 14-7 presents the predicted minimum time to dissolved hydrocarbon exposure and maximum residence time for dissolved hydrocarbon exposure to individual receptors, in the 0-10 m depth layer, for all seasonal conditions and all thresholds assessed.

Figure 14-12 and Figure 14-13 present the zones of potential dissolved hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 14-14 to Figure 14-17 present the maximum residence time of dissolved hydrocarbon exposure for the NOPSEMA thresholds in summer and winter.

Table 14-6 **Probability of dissolved hydrocarbons exposure to marine based receptors in the 0–10 m dept. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations per season.**

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure			Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	101.35	79	9	-	65.67	78	10	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	101.35	79	9	-	65.67	78	10	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	101.35	79	9	-	65.67	78	10	-
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	101.35	79	9	-	65.67	78	10	-
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	101.35	79	9	-	65.67	78	10	-
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	101.35	79	9	-	65.67	78	10	-
	Pygmy Blue Whale - Distribution (None)**	101.35	79	9	-	65.67	78	10	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	101.35	79	9	-	65.67	78	10	-
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	101.35	79	9	-	65.67	78	10	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	101.35	79	9	-	65.67	78	10	-
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	101.35	79	9	-	65.67	78	10	-
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	101.35	79	9	-	65.67	78	10	-
	White Shark - Distribution (Between the 60-120m depth contour)**	101.35	79	9	-	65.67	78	10	-
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	101.35	79	9	-	65.67	78	10	-

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure			Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	101.35	79	9	-	65.67	78	10	-
IMCRA-MESO	Otway**	101.35	79	9	-	65.67	78	10	-
IMCRA-PROV	Western Bass Strait Shelf Transition**	101.35	79	9	-	65.67	78	10	-
MR	South-east (Marine)**	101.35	79	9	-	65.67	78	10	-

*The release location resides within the receptor boundaries.

Table 14-7 **Predicted minimum time to dissolved hydrocarbon exposure and maximum residence time for dissolved hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill trajectories per season.**

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)			Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	Pygmy Blue Whale - Distribution (None)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	White Shark - Distribution (Between the 60-120m depth contour)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
	White Shark - Distribution (low density) (Australian waters from Barrow	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)			Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**												
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
IMCRA-MESO	Otway**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
IMCRA-PROV	Western Bass Strait Shelf Transition**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-
MR	South-east (Marine)**	0.03	0.19	-	12	1.25	-	0.03	0.14	-	11.5	2.75	-

*The release location resides within the receptor boundaries.

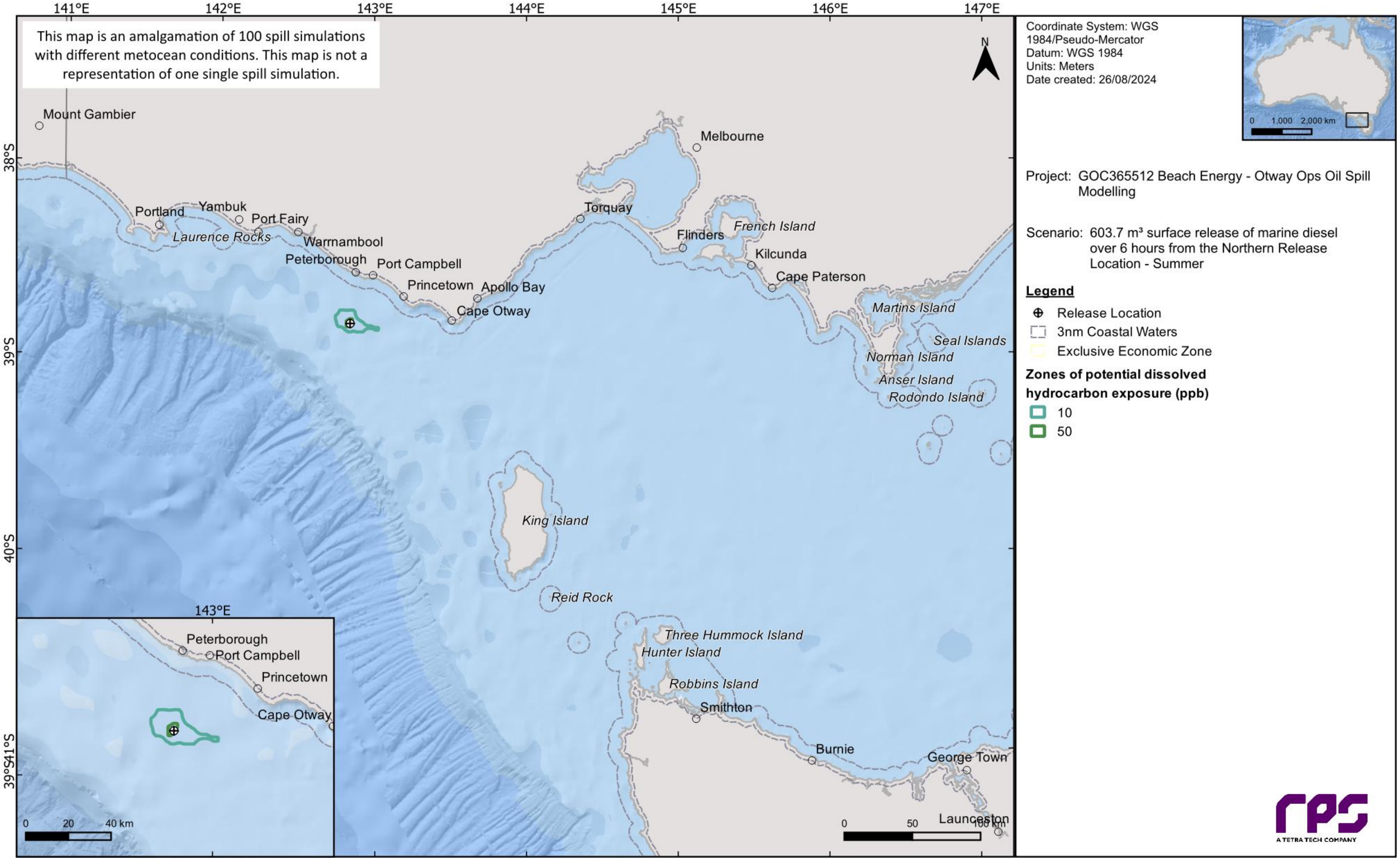


Figure 14-12 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

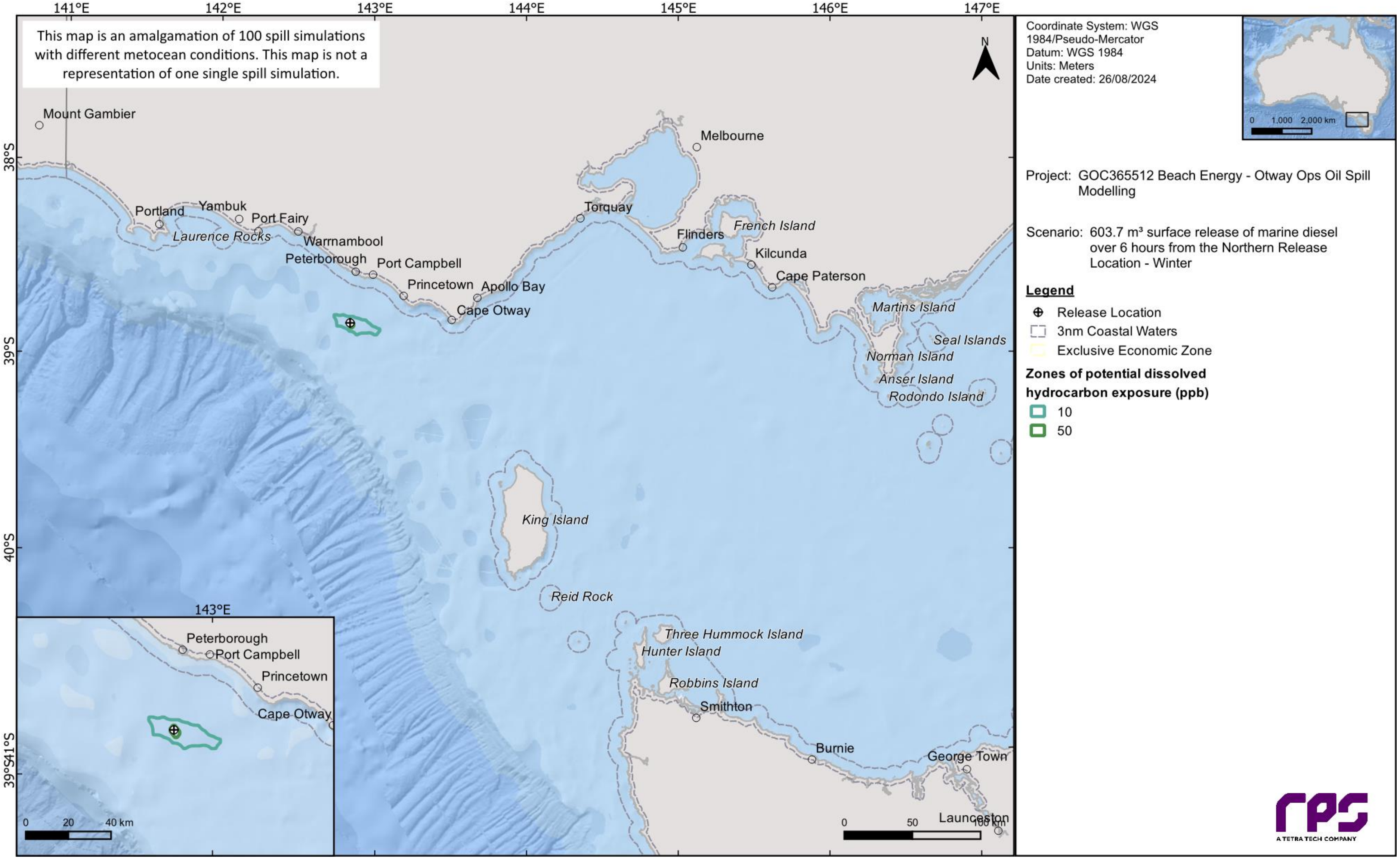


Figure 14-13 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

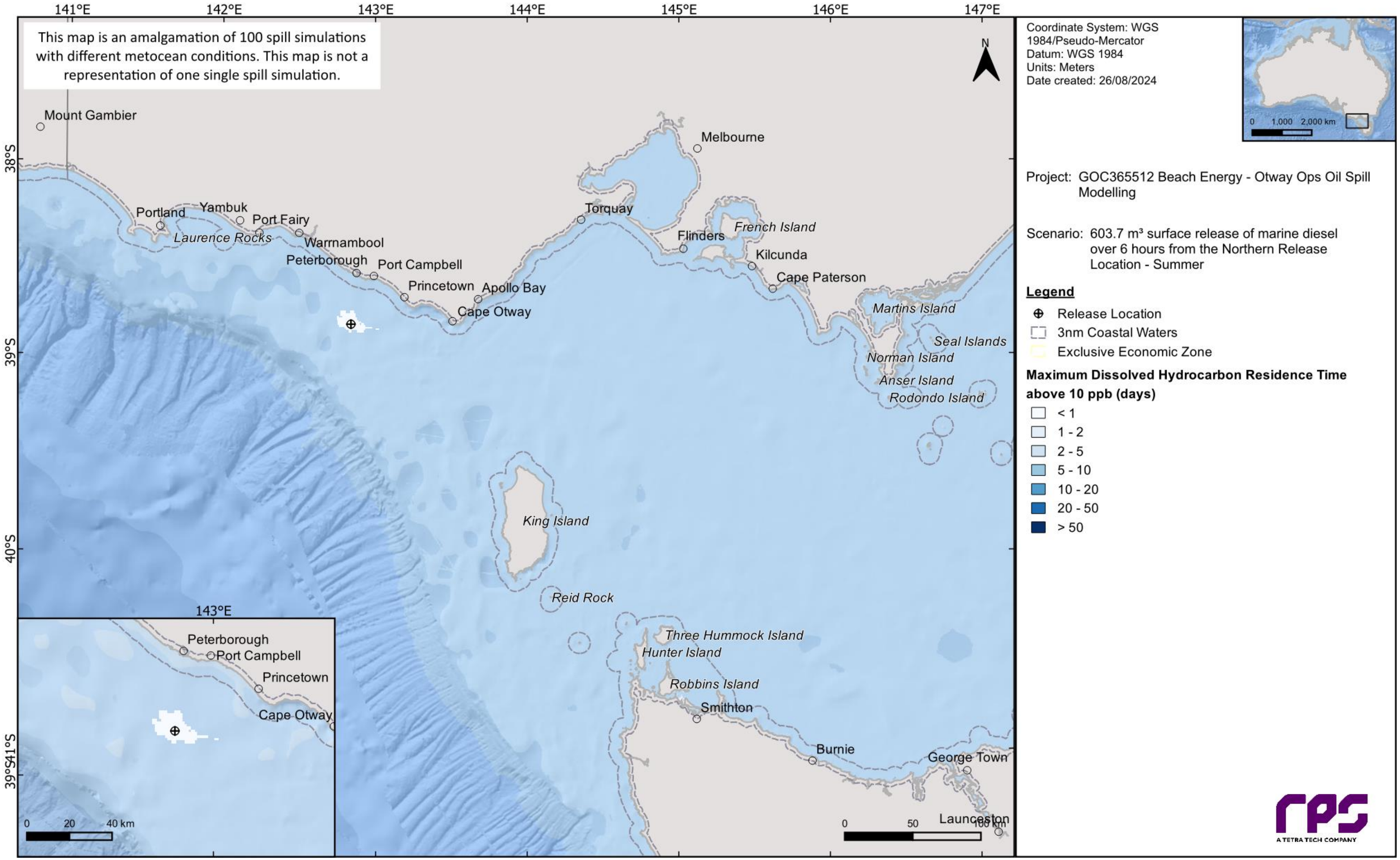


Figure 14-14 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

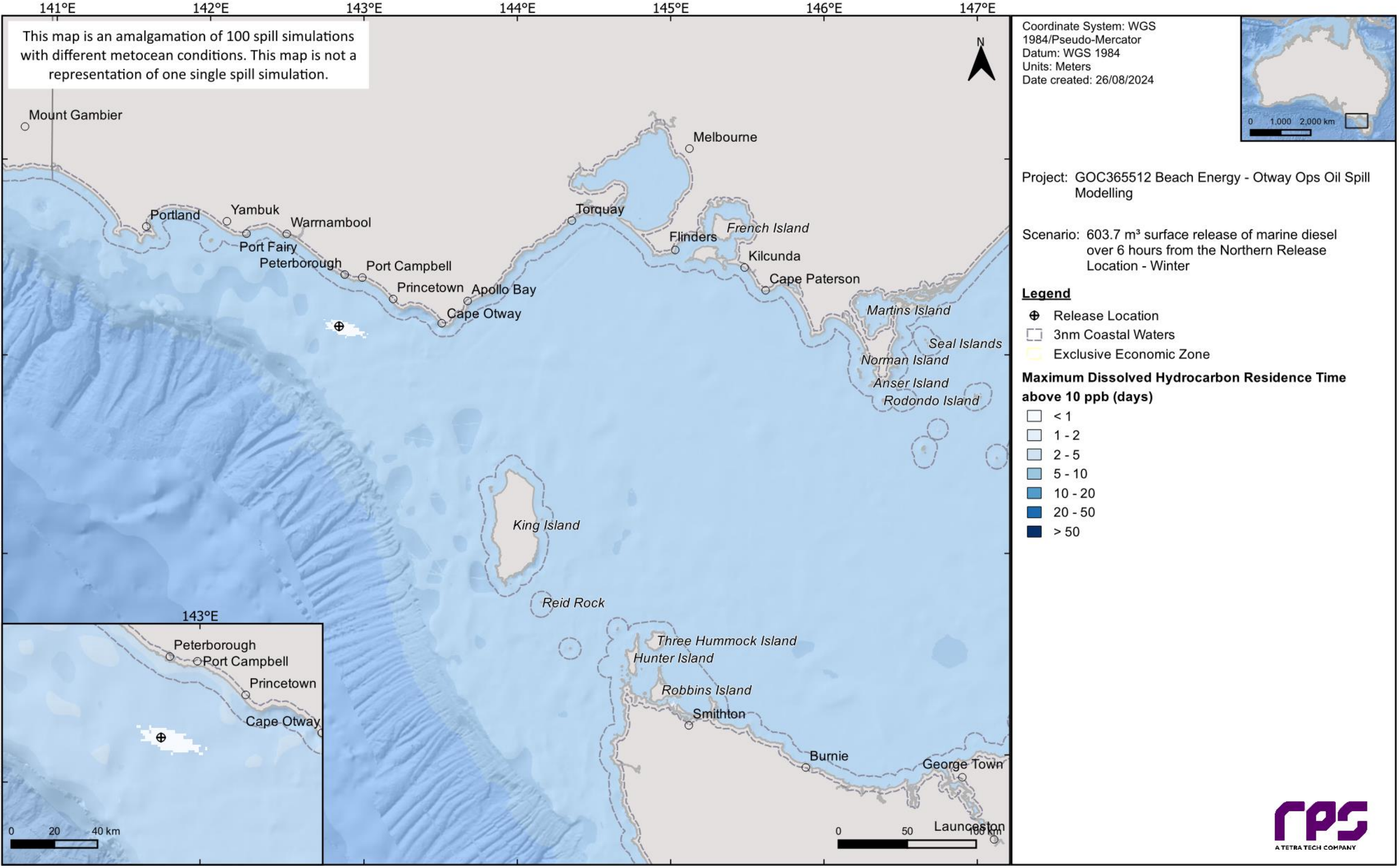
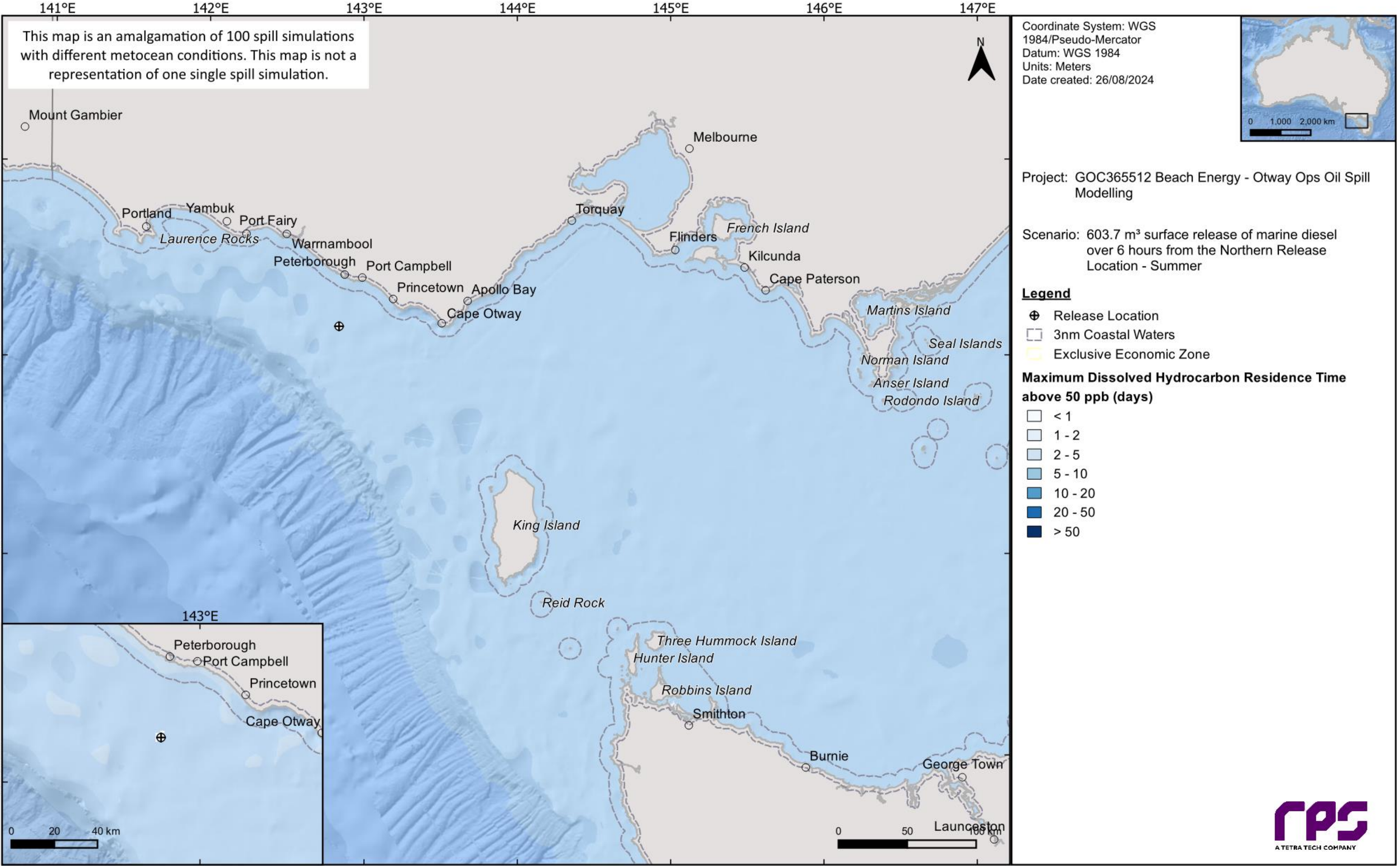


Figure 14-15 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.



Coordinate System: WGS 1984/Pseudo-Mercator
Datum: WGS 1984
Units: Meters
Date created: 26/08/2024

Project: GOC365512 Beach Energy - Otway Ops Oil Spill Modelling

Scenario: 603.7 m³ surface release of marine diesel over 6 hours from the Northern Release Location - Summer

Legend

⊕ Release Location
☐ 3nm Coastal Waters
☐ Exclusive Economic Zone

Maximum Dissolved Hydrocarbon Residence Time above 50 ppb (days)

☐ < 1
☐ 1 - 2
☐ 2 - 5
☐ 5 - 10
☐ 10 - 20
☐ 20 - 50
■ > 50

Figure 14-16 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

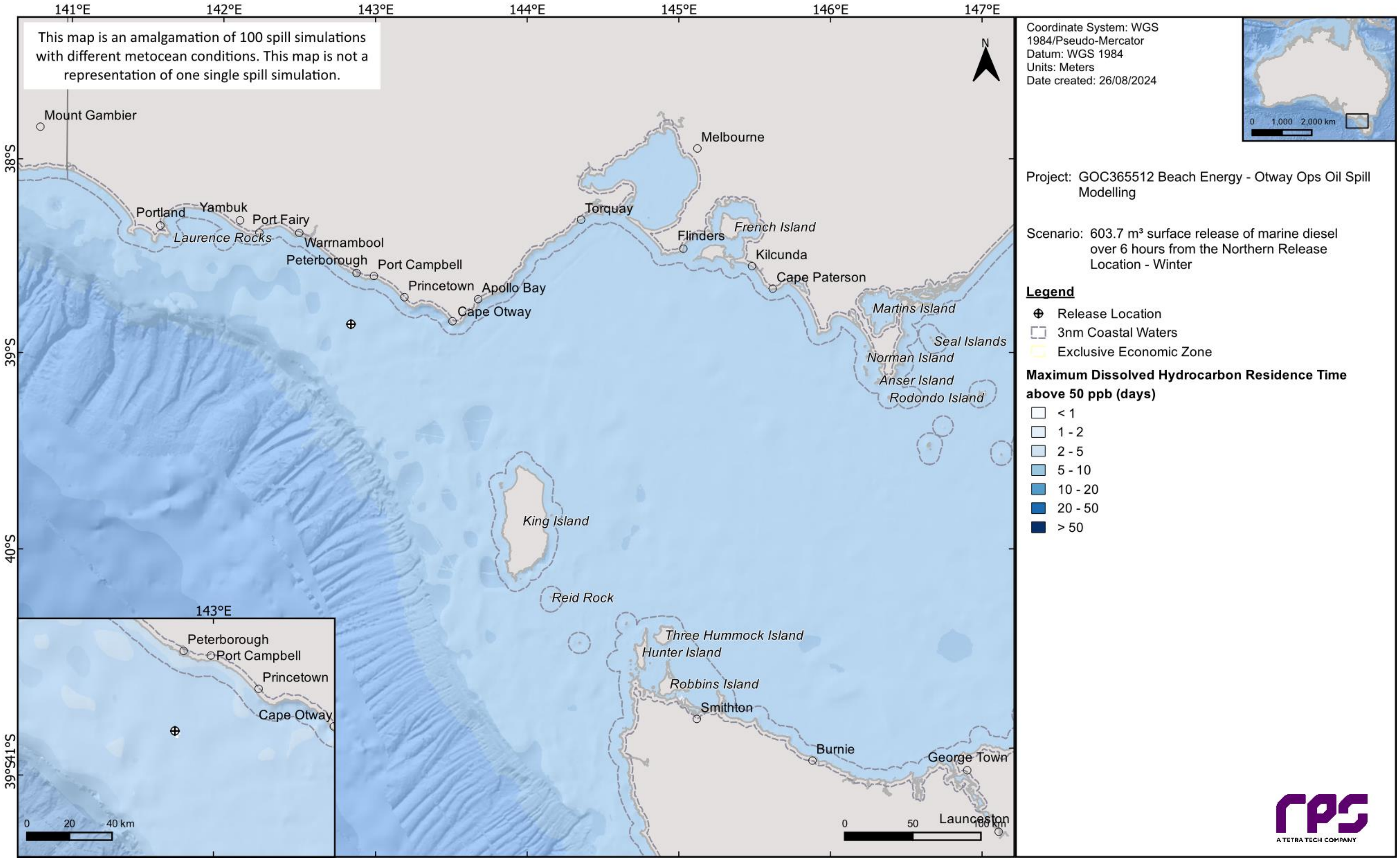


Figure 14-17 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

14.1.4.2 Entrained Hydrocarbons

Table 14-8 presents the probability of exposure to individual receptors from entrained hydrocarbons in the 0-10 m depth layer for the summer and winter conditions.

Outside of the receptors that the Northern Release Location resides within (refer to Table 12-1), the highest concentration of entrained hydrocarbon was predicted for Short-tailed Shearwater - Foraging BIA (summer – 745.77 ppb, winter – 1,391.43 ppb), which also presented the highest probability of low entrained hydrocarbon exposure (summer – 60%, winter – 97%).

Table 14-9 presents the predicted minimum time to entrained hydrocarbon exposure and maximum residence time for entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer, for all seasonal conditions and all thresholds assessed.

Figure 14-18 and Figure 14-19 present the zones of potential entrained hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 14-20 to Figure 14-25 present the maximum residence time of entrained hydrocarbon exposure for the NOPSEMA thresholds in summer and winter.

Table 14-8 **Probability of entrained hydrocarbons exposure to marine based receptors in the 0–10 m depth layer. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations per season.**

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	77.59	33	-	-	260.36	84	11	-
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	11,343.38	100	100	99	11,396.24	100	100	98
	Australasian Gannet - Foraging (Buffer around the coast off Portland Vic)	33.92	8	-	-	-	-	-	-
	Australasian Gannet - Foraging (Port Phillip Bay)	-	-	-	-	42.95	7	-	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	11,343.38	100	100	99	11,396.24	100	100	98
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	11,343.38	100	100	99	11,396.24	100	100	98
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	11,343.38	100	100	99	11,396.24	100	100	98
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	11,343.38	100	100	99	11,396.24	100	100	98
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	11,343.38	100	100	99	11,396.24	100	100	98
	Little Penguin - Breeding (Phillip Island)	-	-	-	-	11.75	1	-	-
	Little Penguin - Foraging (Buffer around Phillip Island)	-	-	-	-	18.47	1	-	-
	Pygmy Blue Whale - Distribution (None)**	11,343.38	100	100	99	11,396.24	100	100	98
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	489.36	59	24	-	1,044.25	97	52	1
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a	11,343.38	100	100	99	11,396.24	100	100	98

Receptor	Summer (November through to March)				Winter (April to October)			
	Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
		Low	Moderate	High		Low	Moderate	High
well described pygmy blue whale feeding area)**								
Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)	75.22	30	-	-	276.68	82	7	-
Short-tailed Shearwater - Breeding (Phillip Island)	-	-	-	-	11.75	1	-	-
Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)	745.77	60	29	-	1,391.43	97	65	3
Shy Albatross - Foraging likely (The whole South-east Marine Region)**	11,343.38	100	100	99	11,396.24	100	100	98
Southern Right Whale - Aggregation (Bridgewater Bay, Portland to E of Logan's Beach, Warrnambool)	321.66	32	3	-	171.19	7	2	-
Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	11,343.38	100	100	99	11,396.24	100	100	98
Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area)	460.77	40	5	-	973.95	39	10	-
Southern Right Whale - Migration and resting on migration (Philip Island area)	-	-	-	-	18.47	4	-	-
Wandering Albatross - Foraging (The whole South-east Marine Region)**	11,343.38	100	100	99	11,396.24	100	100	98
Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	11,343.38	100	100	99	11,396.24	100	100	98
White Shark - Distribution (Between the 120 - 1,000m depth contour)	133.33	22	1	-	53.66	4	-	-
White Shark - Distribution (Between the 60-120m depth contour)**	11,343.38	100	100	99	11,396.24	100	100	98
White Shark - Distribution (low density) (Australian waters from Barrow	11,343.38	100	100	99	11,396.24	100	100	98

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
	Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**								
	White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region)	75.53	14	-	-	25.74	6	-	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	11,343.38	100	100	99	11,396.24	100	100	98
	White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)	70.8	25	-	-	241.89	76	3	-
IBRA	South East Coastal Plain	-	-	-	-	11.75	1	-	-
	South Eastern Highlands	26.06	6	-	-	68.53	8	-	-
IMCRA-MESO	Central Bass Strait	56.02	22	-	-	231.61	67	3	-
	Central Victoria	70.92	26	-	-	240.62	72	4	-
	Otway**	11,343.38	100	100	99	11,396.24	100	100	98
	Victorian Embayments	-	-	-	-	42.25	3	-	-
IMCRA-PROV	Bass Strait Shelf Province	70.92	27	-	-	240.62	77	4	-
	West Tasmania Transition	75.95	9	-	-	15.7	2	-	-
	Western Bass Strait Shelf Transition**	11,343.38	100	100	99	11,396.24	100	100	98
KEF	Bonney Coast Upwelling	14.69	1	-	-	-	-	-	-
	West Tasmania Canyons	24.69	1	-	-	-	-	-	-
MNP	Twelve Apostles	29.16	10	-	-	114.01	7	1	-
MR	South-east (Marine)**	11,343.38	100	100	99	11,396.24	100	100	98
MS	Mushroom Reef	-	-	-	-	13.34	1	-	-
	The Arches	14.18	2	-	-	-	-	-	-
NHPH	Great Ocean Road and Scenic Environs	337.81	18	2	-	255.31	17	1	-
NHPN	Summerland Peninsula	-	-	-	-	15.76	1	-	-
NIW	Western Port	-	-	-	-	18.47	1	-	-
NP	Great Otway	26.06	5	-	-	68.53	8	-	-

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
NRMR	Corangamite (VIC)	460.77	48	5	-	973.95	48	12	-
	Glenelg Hopkins (VIC)	17.1	2	-	-	42.29	2	-	-
	Port Phillip and Western Port (VIC)	-	-	-	-	42.25	3	-	-
OP	Phillip Island Nature Park	-	-	-	-	15.76	1	-	-
RSB	Bravenes Rock	56.22	14	-	-	92.78	20	-	-
SHORE-VIC-MPRA	Apollo Bay	69.54	17	-	-	292.15	24	3	-
	Bay of Islands	32.37	3	-	-	25.9	2	-	-
	Cape Otway West	460.77	31	4	-	973.95	32	9	-
	Cape Patton	45.79	9	-	-	21.13	10	-	-
	Childers Cove	-	-	-	-	16.5	1	-	-
	Lorne	21.87	2	-	-	-	-	-	-
	Moonlight Head	337.81	15	2	-	255.31	15	2	-
	Mornington Peninsula - South	-	-	-	-	17.65	1	-	-
	Mornington Peninsula - Southwest	-	-	-	-	13.26	1	-	-
	Port Campbell	44.21	5	-	-	49.24	5	-	-
	Westernport	-	-	-	-	13.36	1	-	-
State Waters	Victoria	460.77	48	5	-	973.95	55	12	-

*The release location resides within the receptor boundaries.

Table 14-9 Predicted minimum time to entrained hydrocarbon exposure and maximum residence time for entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill trajectories per season.

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)			Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
AMP	Apollo	1.79	-	-	122.75	-	-	1.01	1.09	-	237.25	11	-
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.01	0.01	0.01	496.25	76	19	0.01	0.01	0.01	389.5	76.75	18
	Australasian Gannet - Foraging (Buffer around the coast off Portland Vic)	4.17	-	-	74	-	-	-	-	-	-	-	-
	Australasian Gannet - Foraging (Port Phillip Bay)	-	-	-	-	-	-	4.27	-	-	81.25	-	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	0.01	0.01	0.01	496.5	76	19	0.01	0.01	0.01	389.5	76.75	18
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	0.01	0.01	0.01	496.5	76	19	0.01	0.01	0.01	389.5	76.75	18
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.01	0.01	0.01	496.5	76	19	0.01	0.01	0.01	389.5	76.75	18
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	0.01	0.01	0.01	496.5	87.25	19	0.01	0.01	0.01	394	119.5	18
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	0.01	0.01	0.01	496.5	76	19	0.01	0.01	0.01	389.5	76.75	18
	Little Penguin - Breeding (Phillip Island)	-	-	-	-	-	-	16.02	-	-	1.75	-	-
	Little Penguin - Foraging (Buffer around Phillip Island)	-	-	-	-	-	-	12.11	-	-	45.75	-	-
	Pygmy Blue Whale - Distribution (None)**	0.01	0.01	0.01	496.5	87.25	19	0.01	0.01	0.01	394	119.5	18
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	0.35	0.4	-	496.5	87.25	-	0.42	0.43	0.74	394	119.5	1
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	0.01	0.01	0.01	496.25	87.25	19	0.01	0.01	0.01	394	119.5	18
	Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)	2.77	-	-	496.5	-	-	1.31	1.4	-	237.25	13.75	-
	Short-tailed Shearwater - Breeding (Phillip Island)	-	-	-	-	-	-	16.02	-	-	1.75	-	-
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)	0.29	0.31	-	496.5	87.25	-	0.35	0.39	0.49	394	119.5	3.25
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	0.01	0.01	0.01	496.5	87.25	19	0.01	0.01	0.01	394	119.5	18
	Southern Right Whale - Aggregation (Bridgewater Bay, Portland to E of Logan's Beach, Warrnambool)	1.3	1.53	-	191	25	-	1.06	1.16	-	171.5	24	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	0.01	0.01	0.01	496.5	87.25	19	0.01	0.01	0.01	394	119.5	18
	Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area)	2.89	4.54	-	484.75	87.25	-	1.29	1.4	-	380.75	119.5	-
	Southern Right Whale - Migration and resting on migration (Philip Island area)	-	-	-	-	-	-	7.56	-	-	72.5	-	-
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	0.01	0.01	0.01	496.5	76	19	0.01	0.01	0.01	389.5	76.75	18
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer-Muttonbird Island (VIC))**	0.01	0.01	0.01	496.5	87.25	19	0.01	0.01	0.01	394	119.5	18
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	1.71	1.92	-	124.25	10.75	-	2.15	-	-	91.5	-	-
	White Shark - Distribution (Between the 60-120m depth contour)**	0.01	0.01	0.01	496.5	76	19	0.01	0.01	0.01	391.75	68	18
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	0.01	0.01	0.01	496.5	76	19	0.01	0.01	0.01	389.5	76.75	18
	White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region)	3	-	-	96.75	-	-	6.68	-	-	86.25	-	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	0.01	0.01	0.01	496.5	76	19	0.01	0.01	0.01	389.5	76.75	18
	White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)	2.84	-	-	496.5	-	-	1.36	1.46	-	223.75	9	-
IBRA	South East Coastal Plain	-	-	-	-	-	-	16.02	-	-	1.75	-	-
	South Eastern Highlands	6.18	-	-	73	-	-	2.02	-	-	47.25	-	-
IMCRA-MESO	Central Bass Strait	2.78	-	-	110.75	-	-	1.45	1.59	-	173.25	9	-
	Central Victoria	2.76	-	-	496.5	-	-	1.31	1.4	-	237.25	9	-

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)			Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	Otway**	0.01	0.01	0.01	496.25	87.25	19	0.01	0.01	0.01	394	119.5	18
	Victorian Embayments	-	-	-	-	-	-	12.21	-	-	45.75	-	-
IMCRA-PROV	Bass Strait Shelf Province	2.76	-	-	496.5	-	-	1.31	1.4	-	237.25	9	-
	West Tasmania Transition	2.41	-	-	86.25	-	-	7.31	-	-	32.75	-	-
	Western Bass Strait Shelf Transition**	0.01	0.01	0.01	496.25	87.25	19	0.01	0.01	0.01	394	119.5	18
KEF	Bonney Coast Upwelling	9.11	-	-	67	-	-	-	-	-	-	-	-
	West Tasmania Canyons	6.21	-	-	59.25	-	-	-	-	-	-	-	-
MNP	Twelve Apostles	3.38	-	-	122.25	-	-	1.54	2.15	-	204	6.75	-
MR	South-east (Marine)**	0.01	0.01	0.01	496.5	76	19	0.01	0.01	0.01	389.5	76.75	18
MS	Mushroom Reef	-	-	-	-	-	-	13.19	-	-	8	-	-
	The Arches	18.19	-	-	35.5	-	-	-	-	-	-	-	-
NHPH	Great Ocean Road and Scenic Environs	4.08	8.2	-	214.5	39	-	2.02	5.63	-	83	57.25	-
NHPN	Summerland Peninsula	-	-	-	-	-	-	12.33	-	-	15.5	-	-
NIW	Western Port	-	-	-	-	-	-	12.21	-	-	45.75	-	-
NP	Great Otway	6.18	-	-	19.75	-	-	2.02	-	-	47.25	-	-
NRMR	Corangamite (VIC)	1.42	4.52	-	496.5	87.25	-	0.98	1.05	-	394	119.5	-
	Glenelg Hopkins (VIC)	11.71	-	-	102.5	-	-	1.67	-	-	38	-	-
	Port Phillip and Western Port (VIC)	-	-	-	-	-	-	10.43	-	-	72.5	-	-
OP	Phillip Island Nature Park	-	-	-	-	-	-	12.33	-	-	15.5	-	-
RSB	Bravenes Rock	2.77	-	-	150.5	-	-	2.31	-	-	126.75	-	-
SHORE-VIC-MPRA	Apollo Bay	3.47	-	-	375.5	-	-	1.45	1.53	-	182.5	15.25	-
	Bay of Islands	11.66	-	-	111.75	-	-	3.09	-	-	48.25	-	-
	Cape Otway West	3.45	4.65	-	484.75	87.25	-	1.34	1.43	-	372.75	114.5	-
	Cape Patton	6.42	-	-	382	-	-	5.59	-	-	66.25	-	-
	Childers Cove	-	-	-	-	-	-	2.44	-	-	18	-	-
	Lorne	11.45	-	-	47.25	-	-	-	-	-	-	-	-
	Moonlight Head	3.54	5.72	-	200	40	-	1.72	5.63	-	212	57.25	-
	Mornington Peninsula - South	-	-	-	-	-	-	12.11	-	-	50.75	-	-
	Mornington Peninsula - Southwest	-	-	-	-	-	-	11.64	-	-	9.5	-	-
	Port Campbell	6.96	-	-	192.75	-	-	3.06	-	-	71.5	-	-
	Westernport	-	-	-	-	-	-	12.8	-	-	8.75	-	-
State Waters	Victoria	1.42	4.52	-	496.5	87.25	-	0.98	1.05	-	394	119.5	-

*The release location resides within the receptor boundaries.

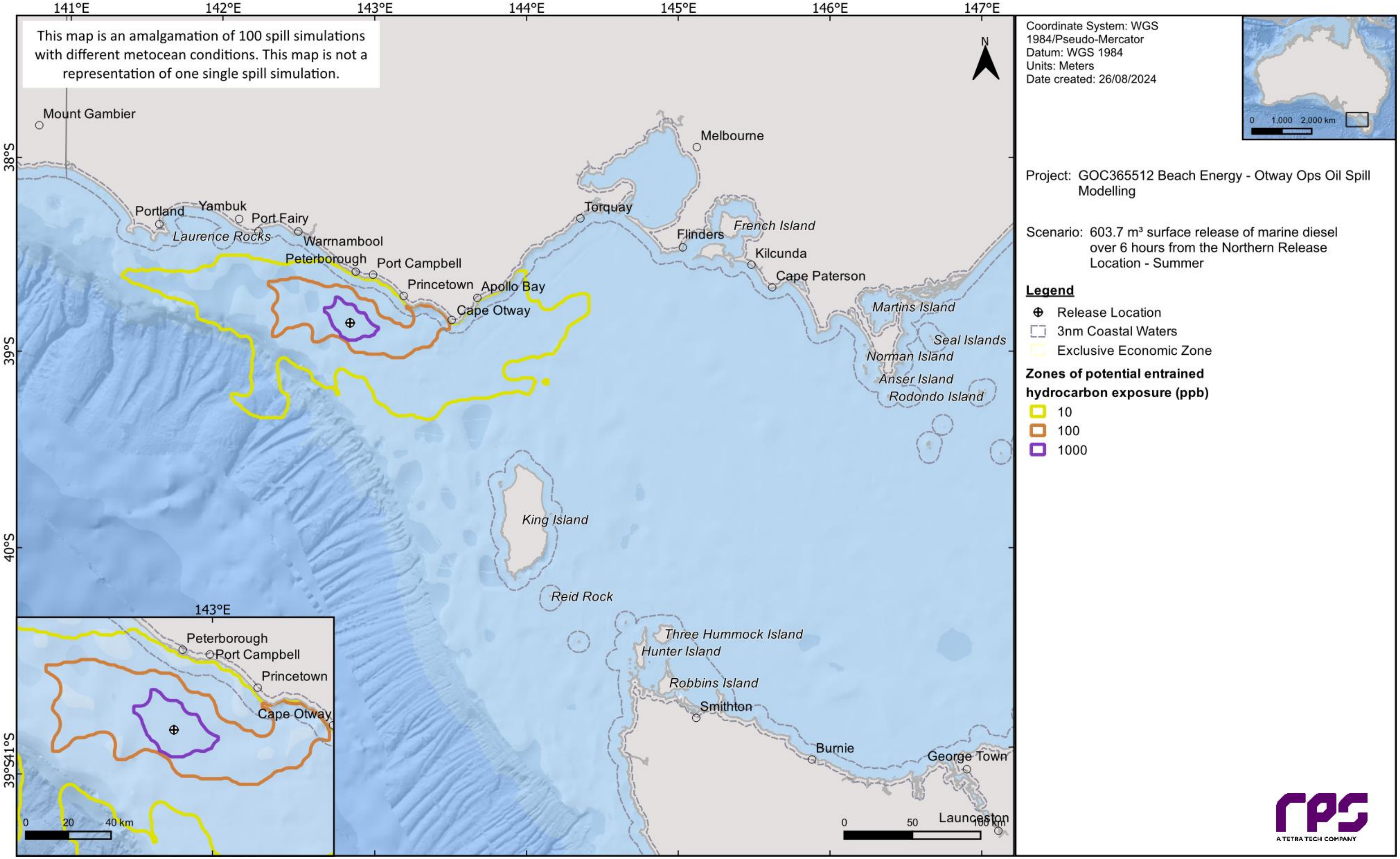


Figure 14-18 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

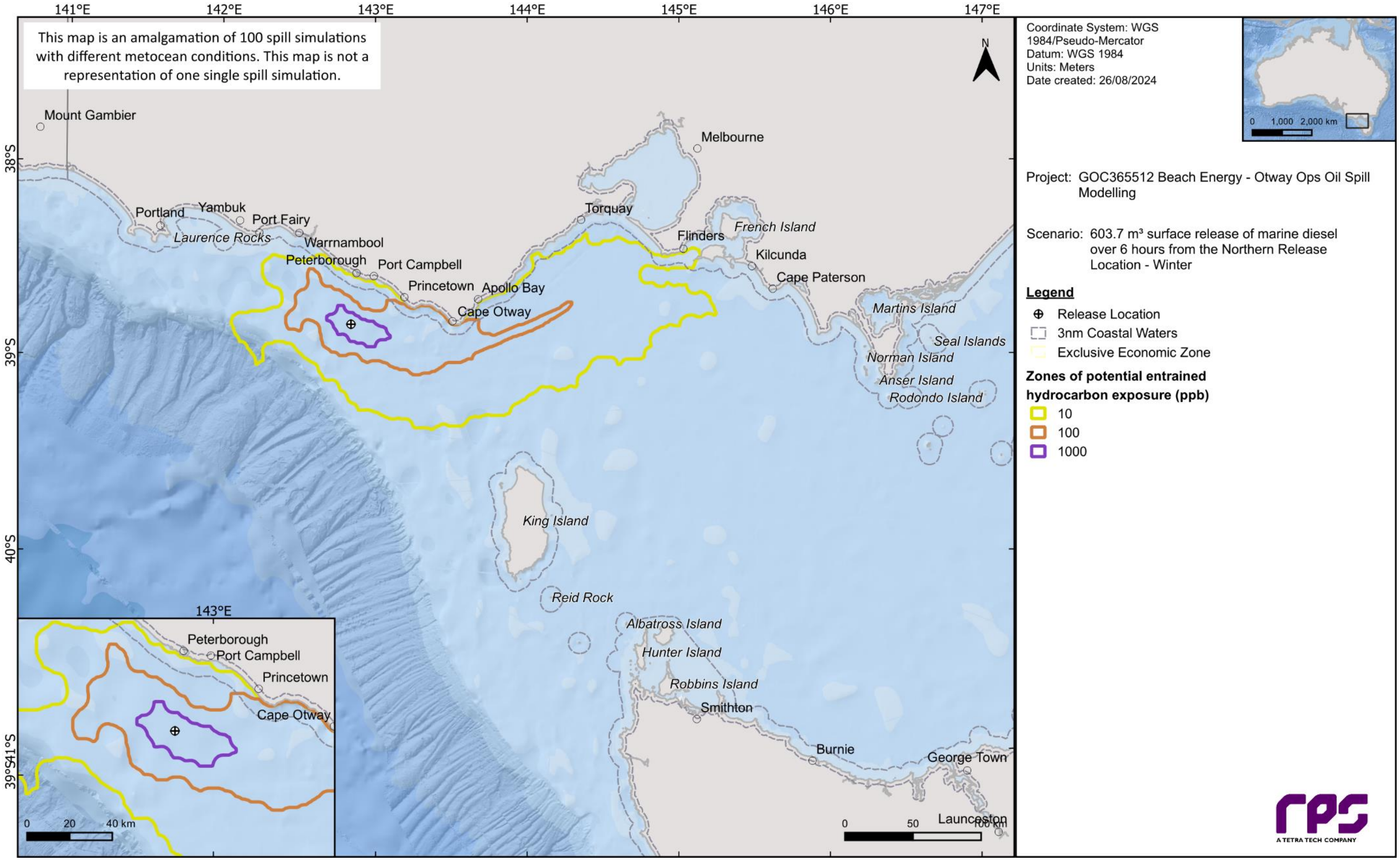


Figure 14-19 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

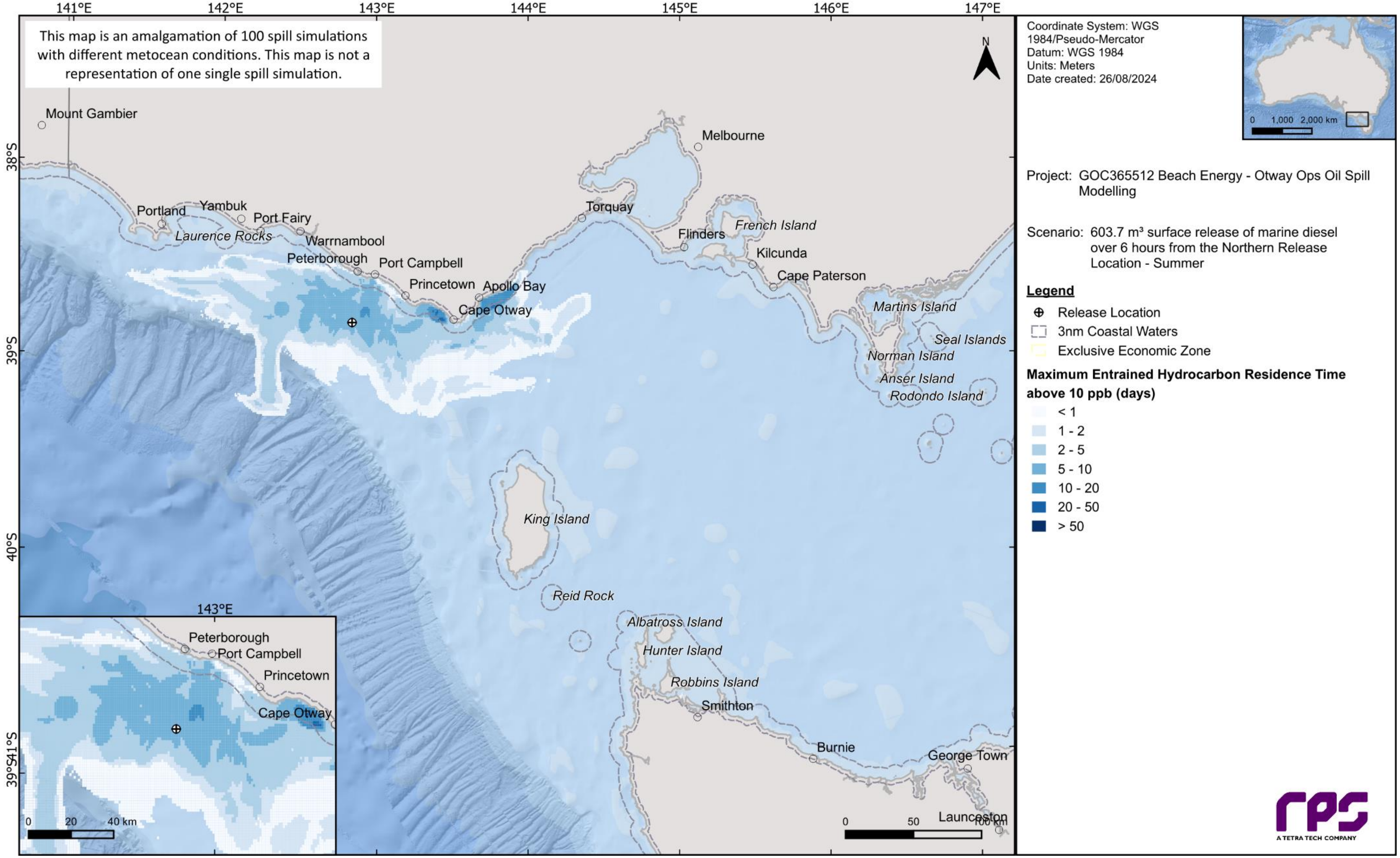
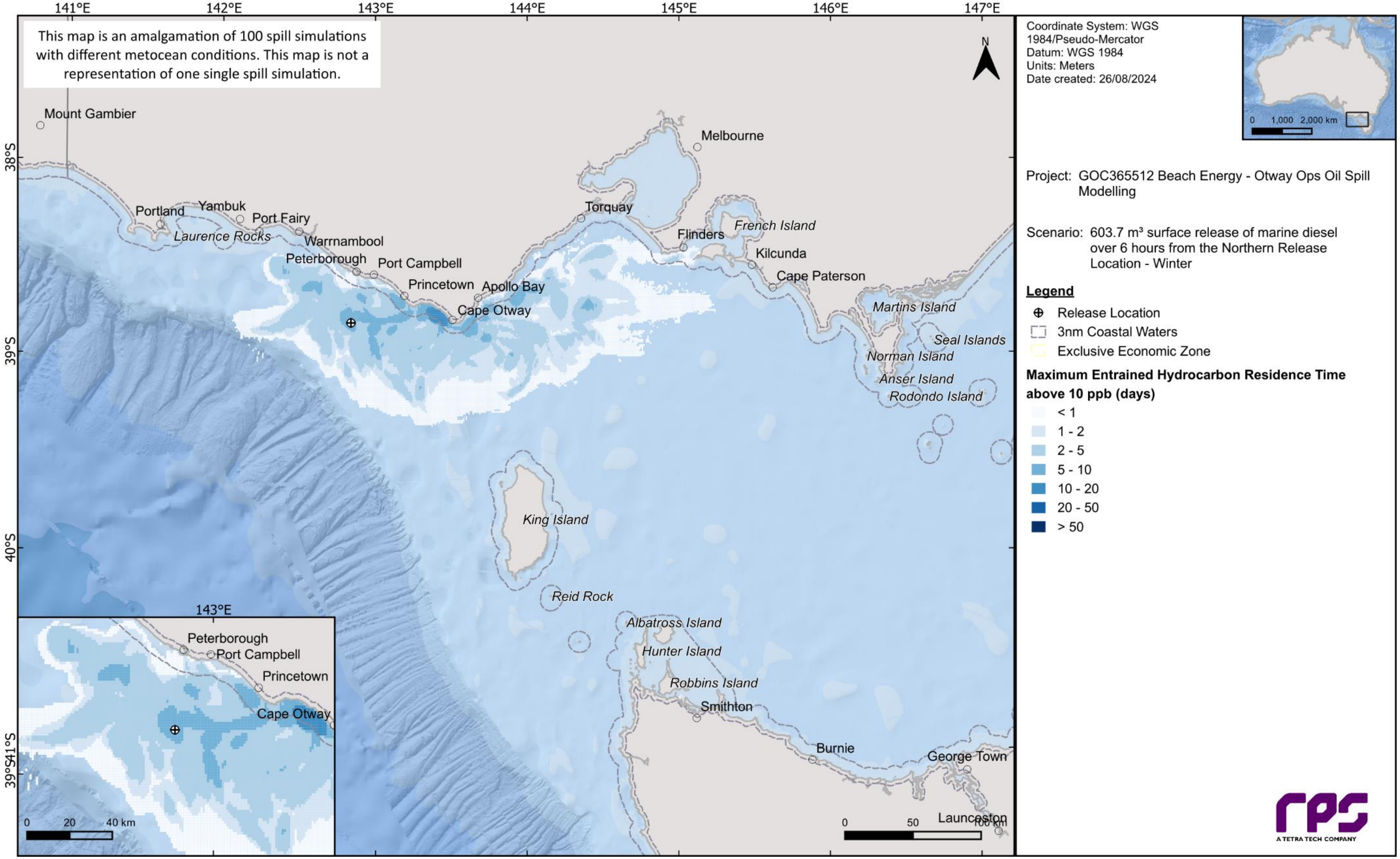


Figure 14-20 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.



Coordinate System: WGS 1984/Pseudo-Mercator
Datum: WGS 1984
Units: Meters
Date created: 26/08/2024

Project: GOC365512 Beach Energy - Otway Ops Oil Spill Modelling

Scenario: 603.7 m³ surface release of marine diesel over 6 hours from the Northern Release Location - Winter

Legend

- ⊕ Release Location
- ⬚ 3nm Coastal Waters
- ☐ Exclusive Economic Zone

Maximum Entrained Hydrocarbon Residence Time above 10 ppb (days)

- ☐ < 1
- ▨ 1 - 2
- ▨ 2 - 5
- ▨ 5 - 10
- ▨ 10 - 20
- ■ 20 - 50
- ■ > 50

Figure 14-21 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

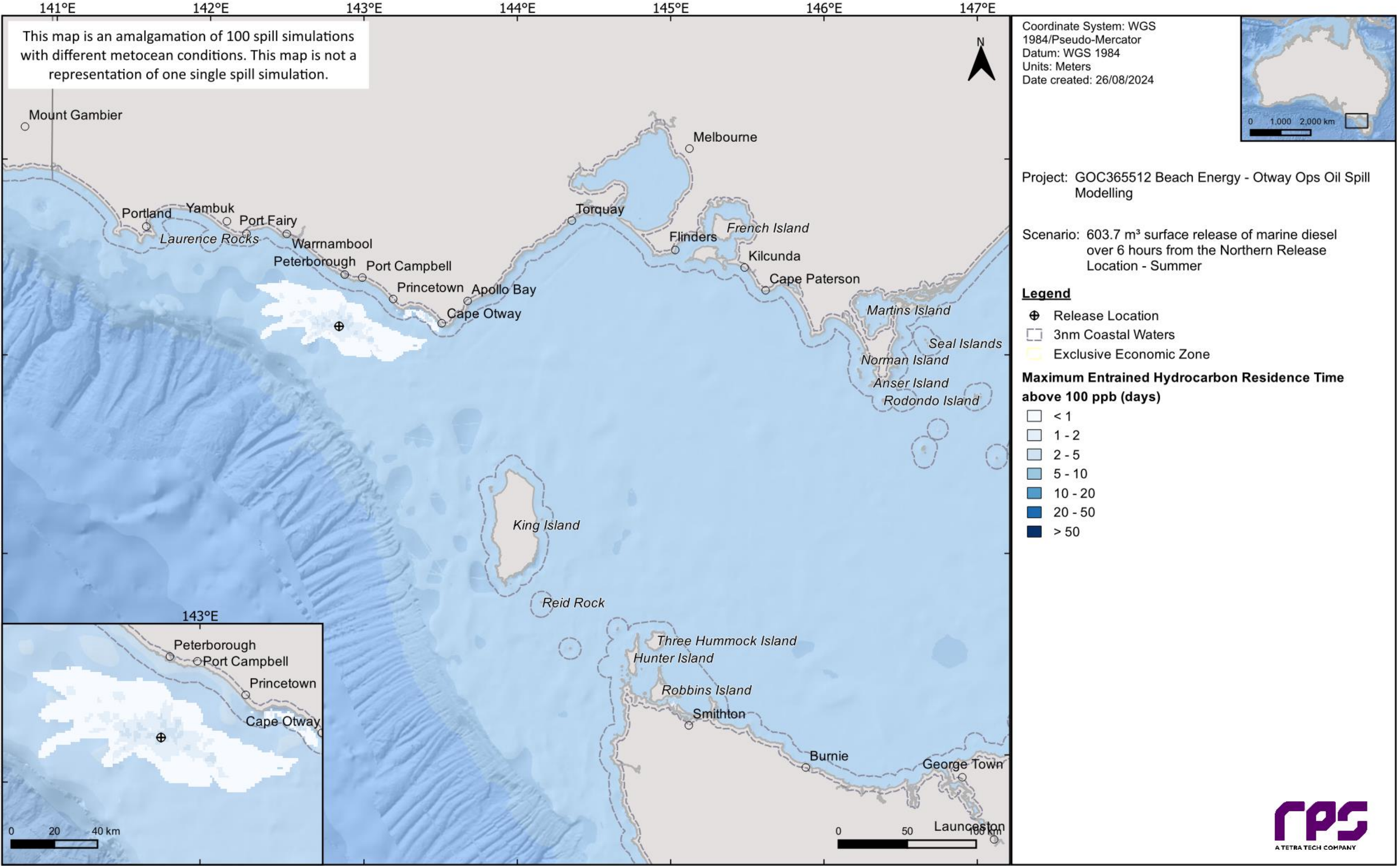
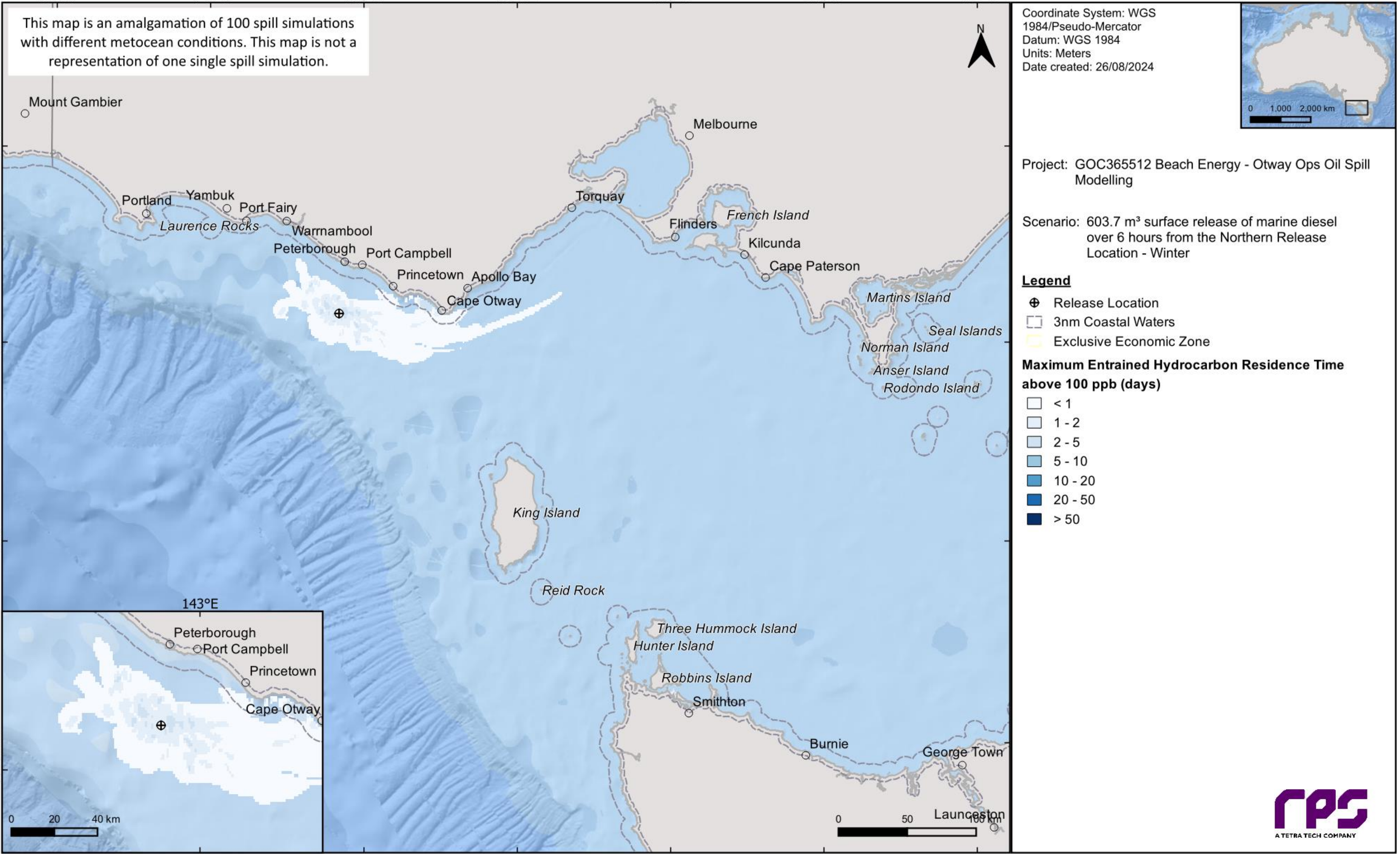


Figure 14-22 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.



This map is an amalgamation of 100 spill simulations with different metocean conditions. This map is not a representation of one single spill simulation.

Coordinate System: WGS 1984/Pseudo-Mercator
Datum: WGS 1984
Units: Meters
Date created: 26/08/2024

Project: GOC365512 Beach Energy - Otway Ops Oil Spill Modelling

Scenario: 603.7 m³ surface release of marine diesel over 6 hours from the Northern Release Location - Winter

Legend

- ⊕ Release Location
- ☐ 3nm Coastal Waters
- ☐ Exclusive Economic Zone

Maximum Entrained Hydrocarbon Residence Time above 100 ppb (days)

- ☐ < 1
- ☐ 1 - 2
- ☐ 2 - 5
- ☐ 5 - 10
- ☐ 10 - 20
- ☐ 20 - 50
- ☐ > 50

Figure 14-23 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

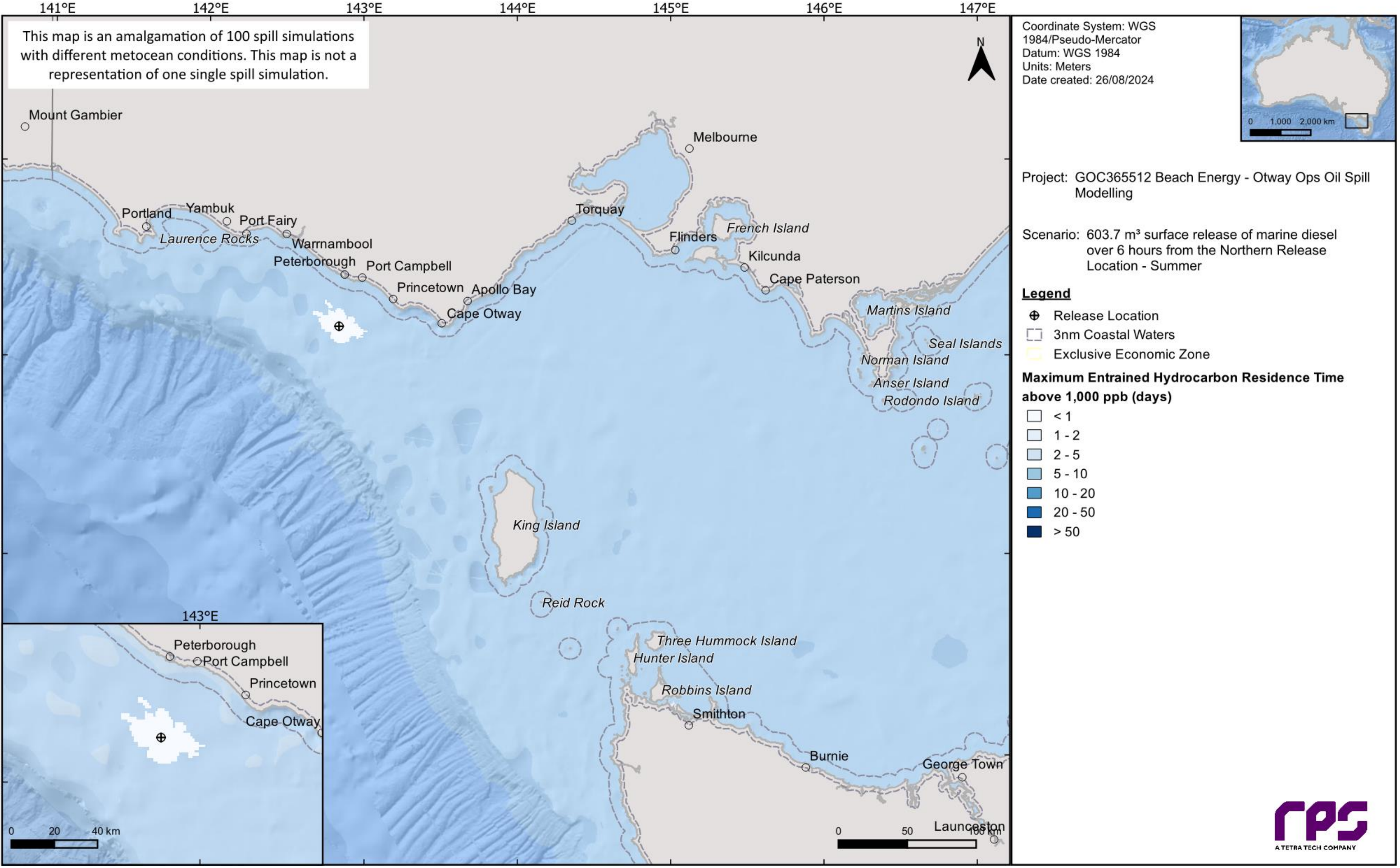


Figure 14-24 Maximum residence time for entrained hydrocarbon exposure above 1,000 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during summer conditions.

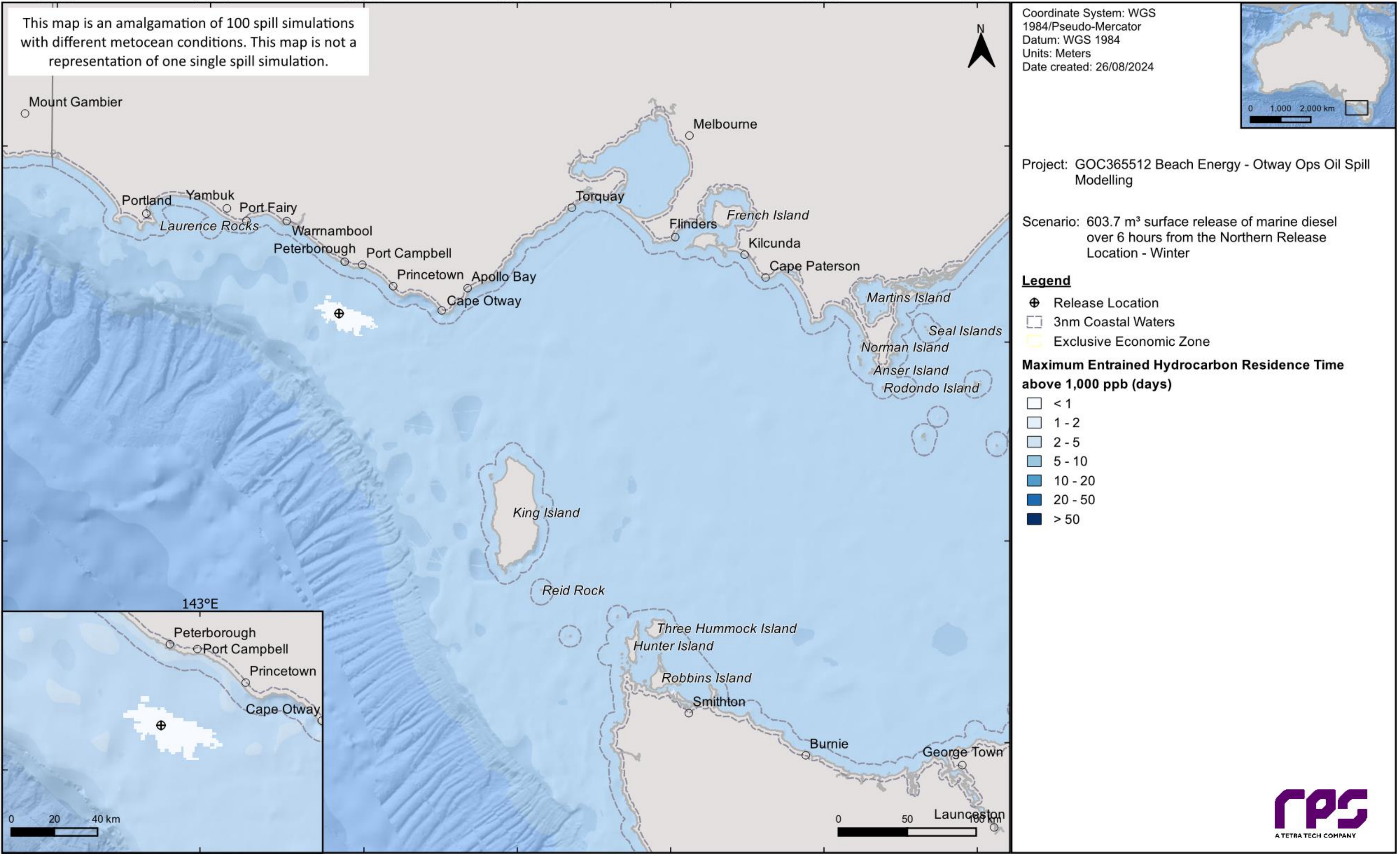


Figure 14-25 Maximum residence time for entrained hydrocarbon exposure above 1,000 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at Northern Release Location. The results were calculated from 100 spill simulations during winter conditions.

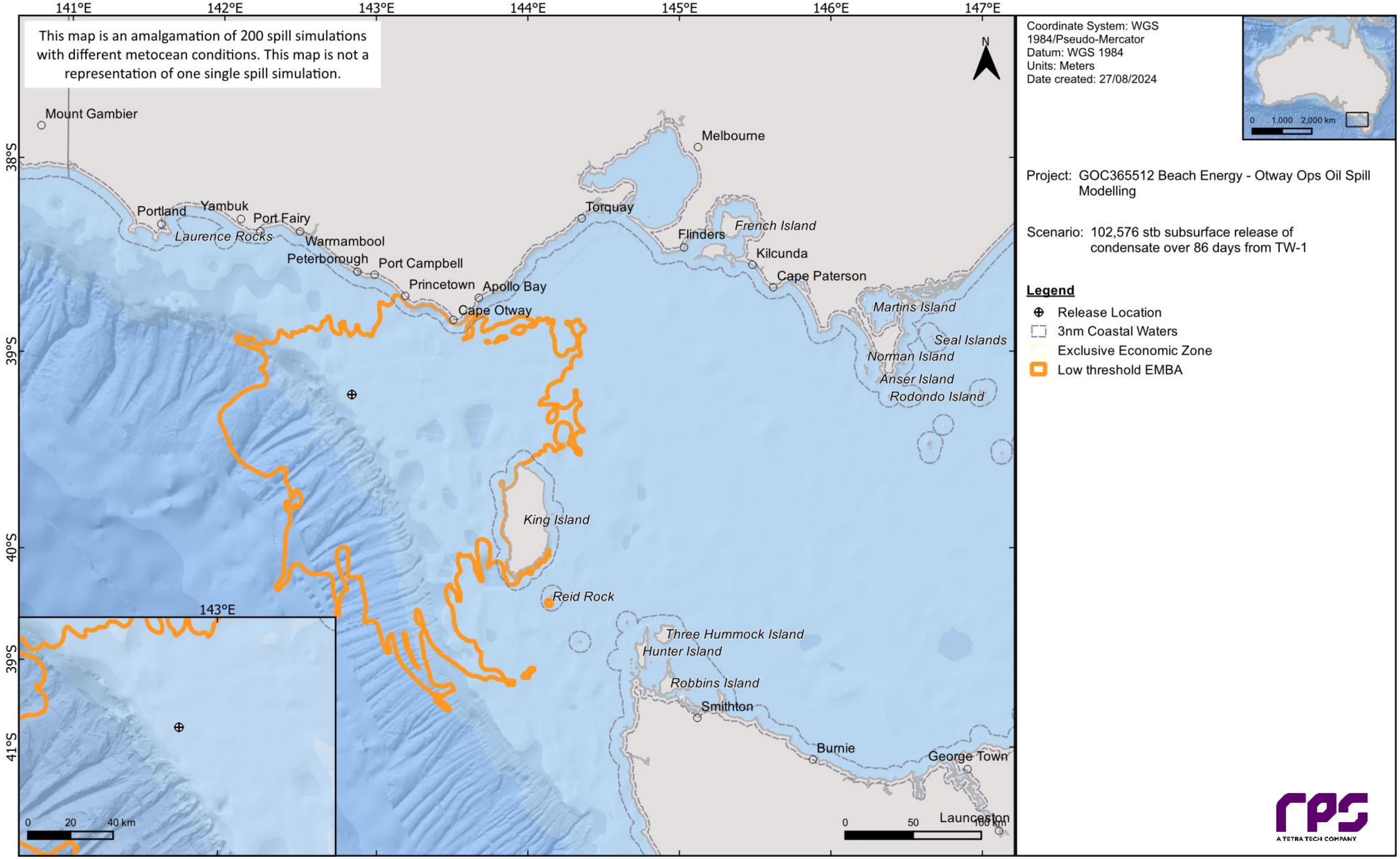
15 RESULTS – LOSS OF WELL CONTROL AT TW1

This scenario examined a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. A total of 200 spill simulations were run (i.e., 100 spills per season) and tracked for 100 days. The results for all 100 simulations per season were combined and are presented on a seasonal basis (i.e., summer and winter).

15.1 Stochastic Analysis

15.1.1 Area of Exposure

Figure 15-1 presents the combined area of potential exposure for surface, shoreline, entrained and dissolved, by overlaying the results from all 200 simulations (i.e., 100 per season) during summer and winter conditions.



Coordinate System: WGS 1984/Pseudo-Mercator
Datum: WGS 1984
Units: Meters
Date created: 27/08/2024

Project: GOC365512 Beach Energy - Otway Ops Oil Spill Modelling

Scenario: 102,576 stb subsurface release of condensate over 86 days from TW-1

Legend

- ⊕ Release Location
- ☐ 3nm Coastal Waters
- ☐ Exclusive Economic Zone
- ☐ Low threshold EMBA

Figure 15-1 **Predicted area of exposure for low thresholds produced by overlaying the results from all 200 simulations, resulting from a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1 during summer and winter conditions.**

15.1.2 Floating Oil Exposure

Table 15-1 summarises the maximum distance travelled by floating oil on the sea surface at each threshold. The maximum distance from the release location to the low (1–10 g/m^2) exposure zone was 24.49 km (southeast) during summer conditions and 18.35 km (south) during winter conditions, respectively. No contact was predicted for the moderate (10–50 g/m^2) or high (> 50 g/m^2) thresholds.

Table 15-2 summarises the potential floating oil exposure to individual receptors during the summer and winter conditions. Outside of the receptors that the Northern Release Location resides within (refer to Table 12-1), the highest probability of floating oil exposure above the low threshold was predicted at the Pygmy Blue Whale – Foraging BIA (28% summer, 25% winter).

Table 15-3 presents the maximum residence time of floating oil exposure for each individual grid cell within each individual receptor during summer and winter.

Figure 15-2 and Figure 15-3 present the zones of potential floating oil exposure for all relevant thresholds under summer and winter conditions, respectively.

Figure 15-4 and Figure 15-5 present the minimum time before floating oil exposure for the low NOPSEMA threshold during summer and winter, respectively.

Table 15-1 Maximum distance and direction from the release location to the edge of floating oil exposure. Results are based on a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations per season.

Season	Distance and direction travelled	Zones of potential floating oil exposure		
		Low	Moderate	High
Summer	Maximum distance (km) from release location	24.49	-	-
	Direction	Southeast	-	-
Winter	Maximum distance (km) from release location	18.35	-	-
	Direction	South	-	-

Table 15-2 Summary of the potential floating oil exposure to individual receptors. Results are based on a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations per season.

Receptor		Summer (November through to March)						Winter (April to October)					
		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)			Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	Pygmy Blue Whale - Distribution (None)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	28	-	-	4.45	-	-	25	-	-	5.43	-	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer-Muttonbird Island (VIC))**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	100	-	-	0.24	-	-	96	-	-	0.93	-	-
	White Shark - Distribution (Between the 60-120m depth contour)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
IMCRA-MESO	Otway**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
IMCRA-PROV	West Tasmania Transition	1	-	-	59.94	-	-	1	-	-	26.18	-	-
IMCRA-PROV	Western Bass Strait Shelf Transition**	100	-	-	0.04	-	-	100	-	-	0.05	-	-
KEF	West Tasmania Canyons	4	-	-	21.05	-	-	1	-	-	26.18	-	-
MR	South-east (Marine)**	100	-	-	0.04	-	-	100	-	-	0.05	-	-

*The release location resides within the receptor boundaries.

Table 15-3 **Summary of the maximum residence time of floating oil exposure for each individual grid cell within each individual receptor. Results are based on a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations per season.**

Receptor		Summer (November through to March)			Winter (April to October)		
		Maximum residence time of floating oil exposure (days)			Maximum residence time of floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	10.25	-	-	14	-	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	10.25	-	-	14	-	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	10.25	-	-	14	-	-
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	10.25	-	-	14	-	-
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	10.25	-	-	14	-	-
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	10.25	-	-	14	-	-
	Pygmy Blue Whale - Distribution (None)**	10.25	-	-	14	-	-
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	1	-	-	1.5	-	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	10.25	-	-	14	-	-
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)**	9.25	-	-	9	-	-
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	10.25	-	-	14	-	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	10.25	-	-	14	-	-
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	10.25	-	-	14	-	-
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	10.25	-	-	14	-	-
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	3.25	-	-	4.25	-	-
	White Shark - Distribution (Between the 60-120m depth contour)**	10.25	-	-	14	-	-
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	10.25	-	-	14	-	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	10.25	-	-	14	-	-
IMCRA-MESO	Otway**	10.25	-	-	14	-	-
IMCRA-PROV	West Tasmania Transition	0.5	-	-	0.75	-	-
	Western Bass Strait Shelf Transition**	10.25	-	-	14	-	-
KEF	West Tasmania Canyons	0.75	-	-	0.75	-	-
MR	South-east (Marine)**	10.25	-	-	14	-	-

*The release location resides within the receptor boundaries.

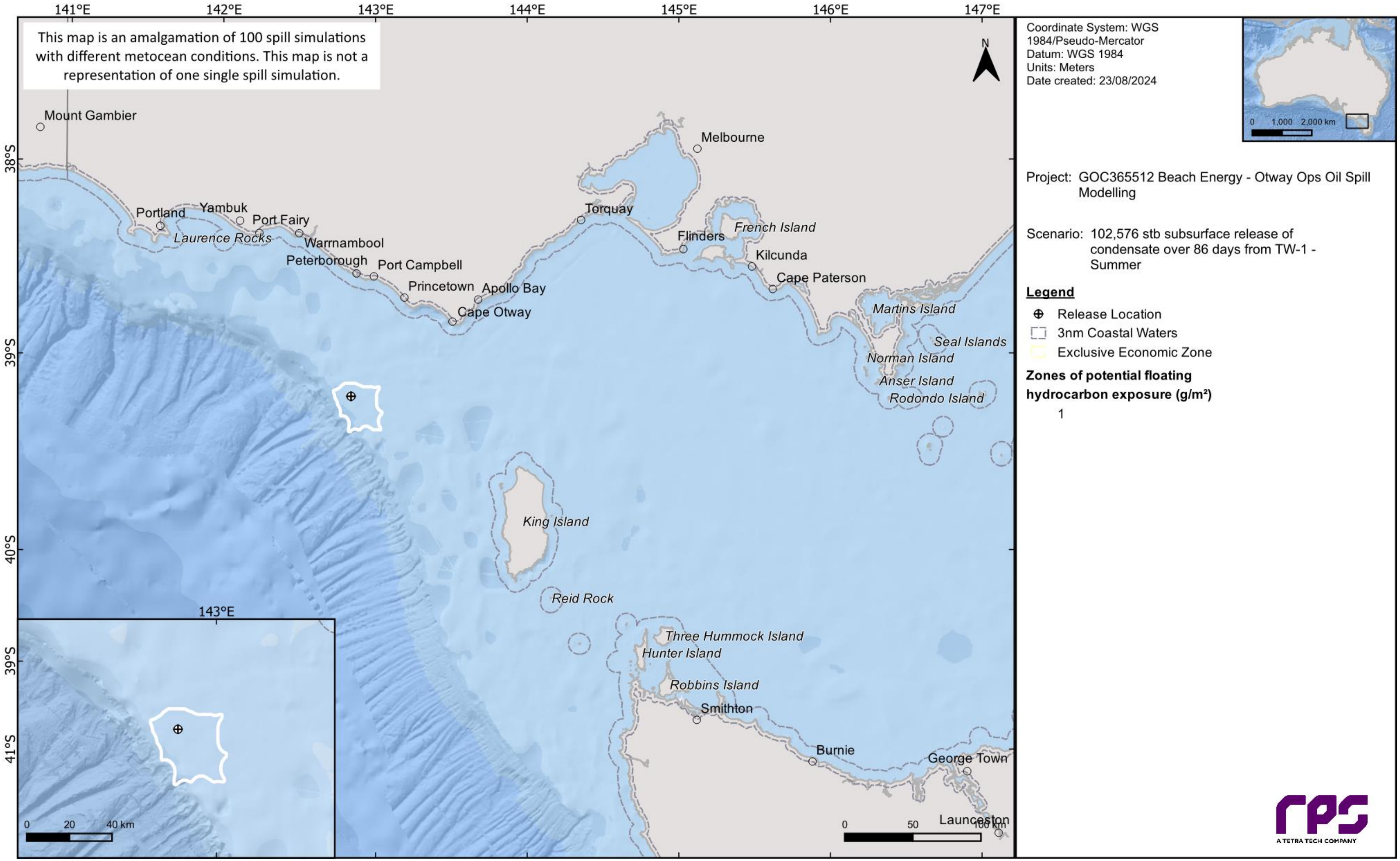


Figure 15-2 Zones of potential floating oil exposure in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during summer conditions.

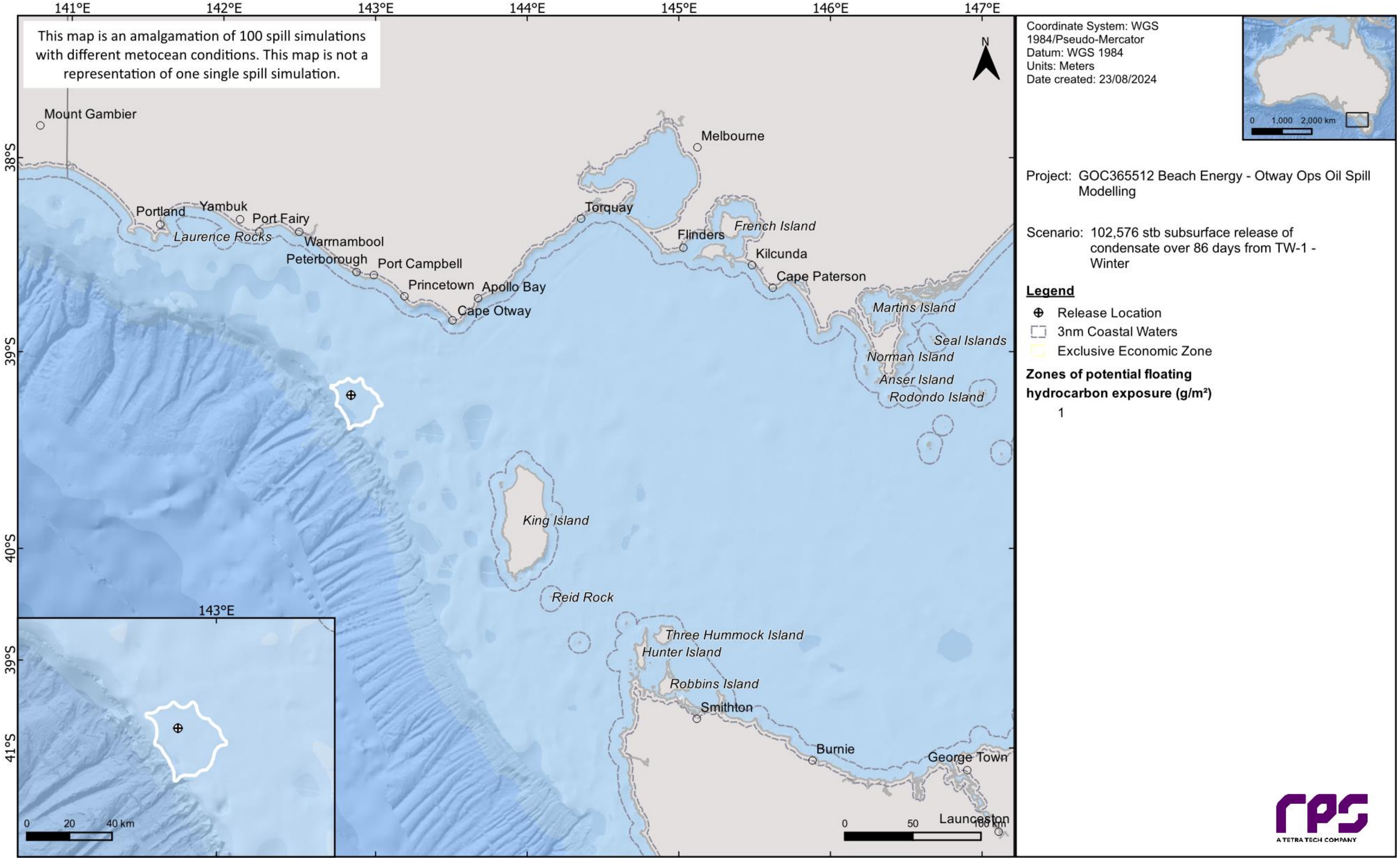


Figure 15-3 Zones of potential floating oil exposure in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during winter conditions.

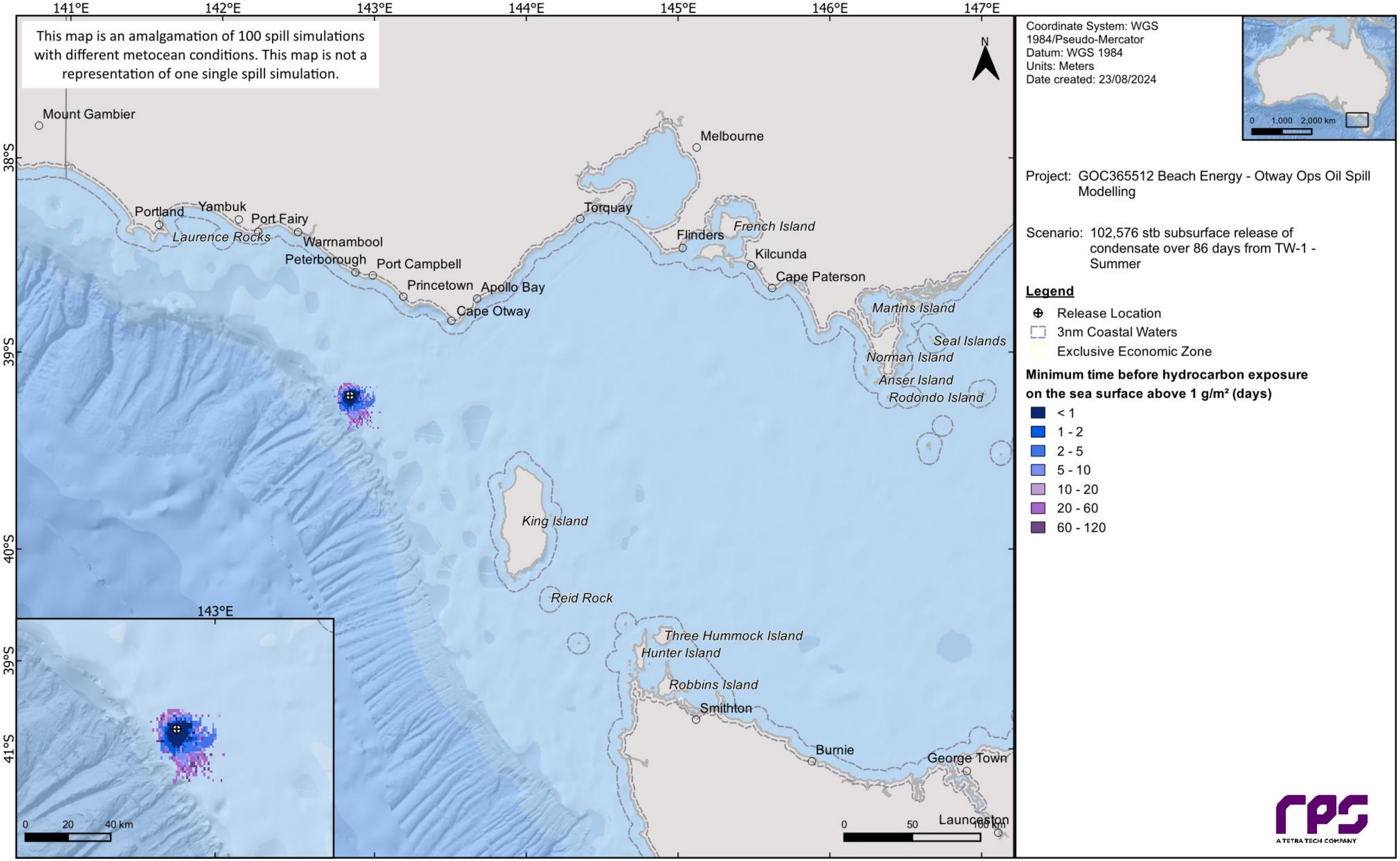


Figure 15-4 Maximum residence time of floating oil exposure above 1 g/m^2, in the event of 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during summer conditions.

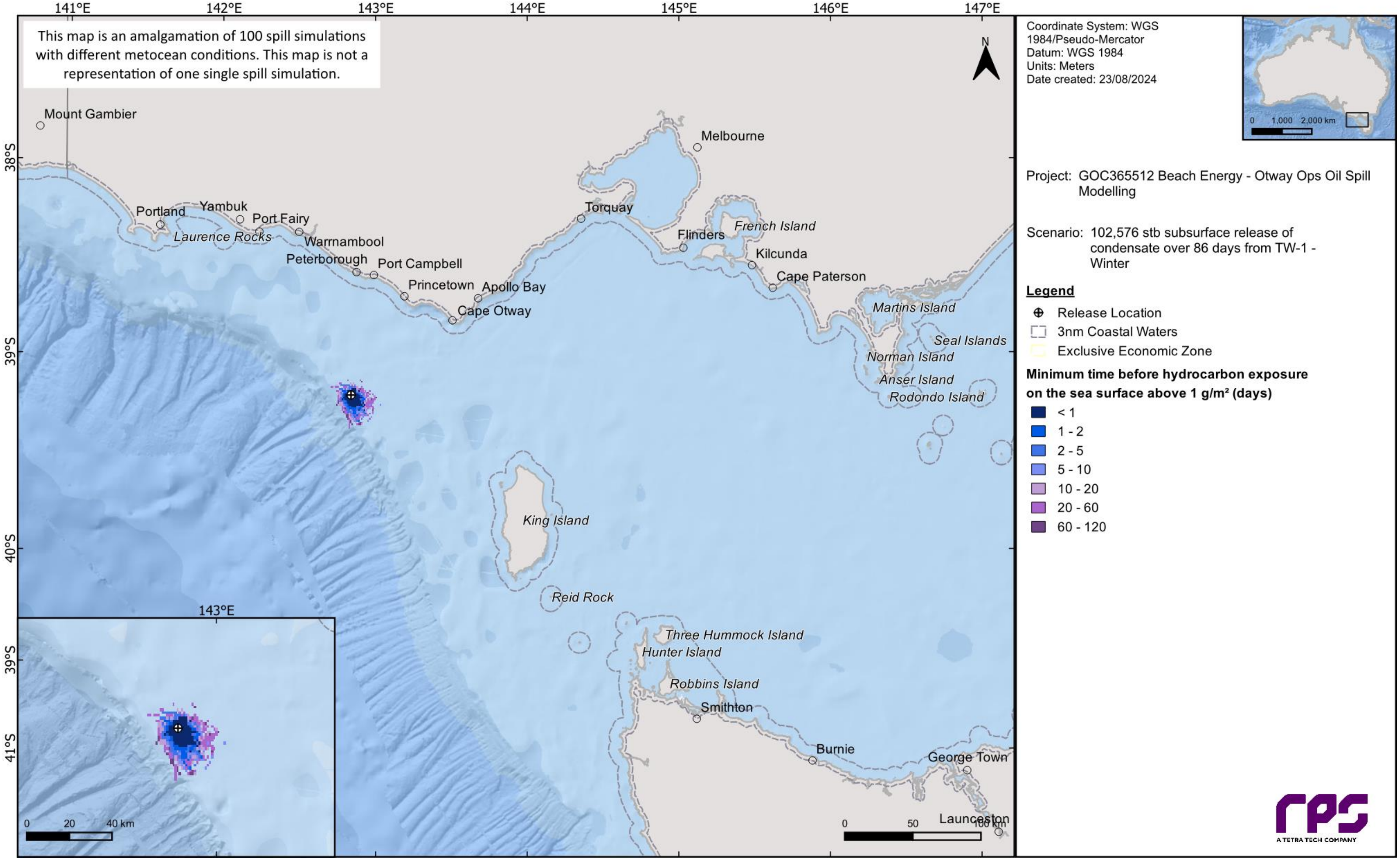


Figure 15-5 Maximum residence time of floating oil exposure above 1 g/m^2, in the event of 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during winter conditions.

15.1.3 Shoreline Accumulation

Table 15-4 presents a summary of the predicted potential shoreline accumulation during the summer and winter conditions. The probability of accumulation to any shoreline at, or above, the low level (10 g/m^2) threshold was 32% during summer conditions and 57% during winter conditions. The minimum time before oil accumulation at, or above, the low threshold was 25.38 days during summer conditions, and 21.93 days during winter conditions. The maximum volume ashore for a single spill trajectory during the summer and winter conditions was 6.15 m^3 and 8.36 m^3, respectively, whilst the maximum length of shoreline accumulation at the low threshold was 12.62 km and 13.90 km, respectively. No shoreline accumulation was predicted for the moderate (100 g/m^2) and high (1,000 g/m^2) thresholds.

Table 15-5 summarises the shoreline accumulation on individual receptors during the summer and winter conditions. The King Island Council (TAS) shoreline recorded the highest probability of shoreline accumulation at the low threshold, being 26% and 48% during summer and winter respectively. The minimum time before shoreline accumulation above the low threshold was 25.38 and 21.93 days during summer and winter, predicted for the same receptor.

The summer and winter conditions maximum potential shoreline loading above the low, moderate and high shoreline thresholds are presented in Figure 15-6 and Figure 15-7, respectively.

Table 15-4 Summary of oil accumulation across all shorelines. Results are based on a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations per season.

Shoreline Statistics	Summer	Winter
Probability of accumulation on any shoreline (%)	32	57
Absolute minimum time for visible oil to shore (days)	25.38	21.93
Maximum total volume of hydrocarbons ashore (m^3)	6.15	8.36
Average volume of hydrocarbons ashore (m^3)	2.52	3.78
Maximum length of the shoreline at **10 g/m^2** (km)	12.62	13.90
Average shoreline length (km) at **10 g/m^2** (km)	1.21	2.16
Maximum length of the shoreline at **100 g/m^2** (km)	-	-
Average shoreline length (km) at **100 g/m^2** (km)	-	-
Maximum length of the shoreline at **1,000 g/m^2** (km)	-	-
Average shoreline length (km) at **1,000 g/m^2** (km)	-	-

Table 15-5 Summary of oil accumulation on individual shoreline receptors. Results are based on a 102,576 stb subsea release of condensate over 86 days from a loss of well control at the TW1. The results were calculated from 100 spill simulations per season.

Shoreline Receptor		Summer																Winter															
		Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline accumulation (km)			Maximum length of shoreline accumulation (km)			Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline accumulation (km)			Maximum length of shoreline accumulation (km)		
		Low	Mod	High	Low	Mod	High	Mean	Peak	Mean	Peak	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High	Mean	Peak	Mean	Peak	Low	Mod	High	Low	Mod	High
SHORE-LGA	King Island Council (TAS)	26	-	-	25.38	-	-	7.42	38.81	0.12	0.61	1.11	-	-	12.62	-	-	48	-	-	21.93	-	-	12.25	52.64	0.19	0.83	1.69	-	-	12.62	-	-
SHORE-VIC-MPRA	Cape Otway West	6	-	-	56.38	-	-	2.67	19.34	0.04	0.31	0.09	-	-	2.54	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Moonlight Head	1	-	-	61.97	-	-	0.93	10.25	0.01	0.16	0.01	-	-	1.27	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

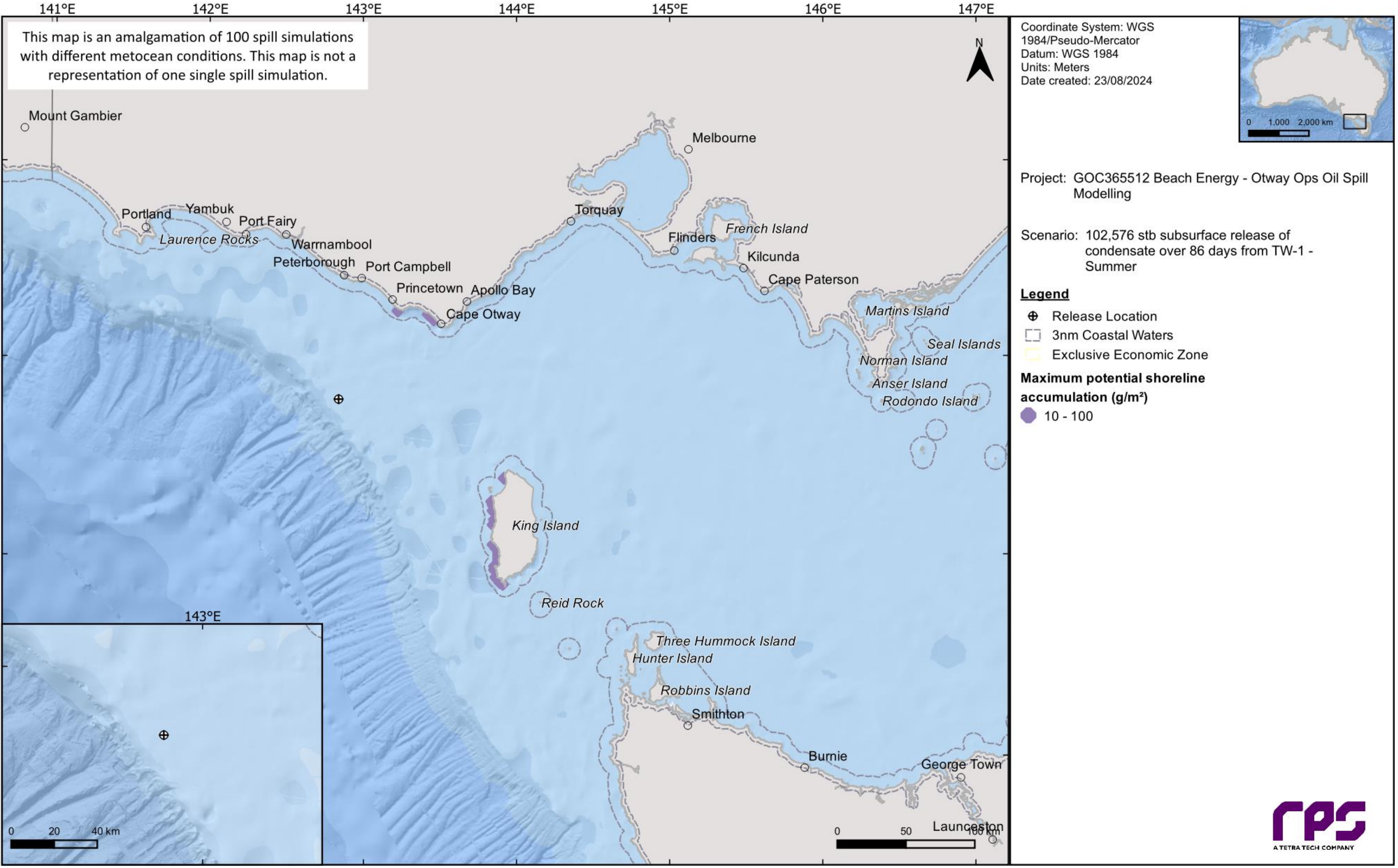


Figure 15-6 Maximum potential shoreline loading in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during summer conditions.

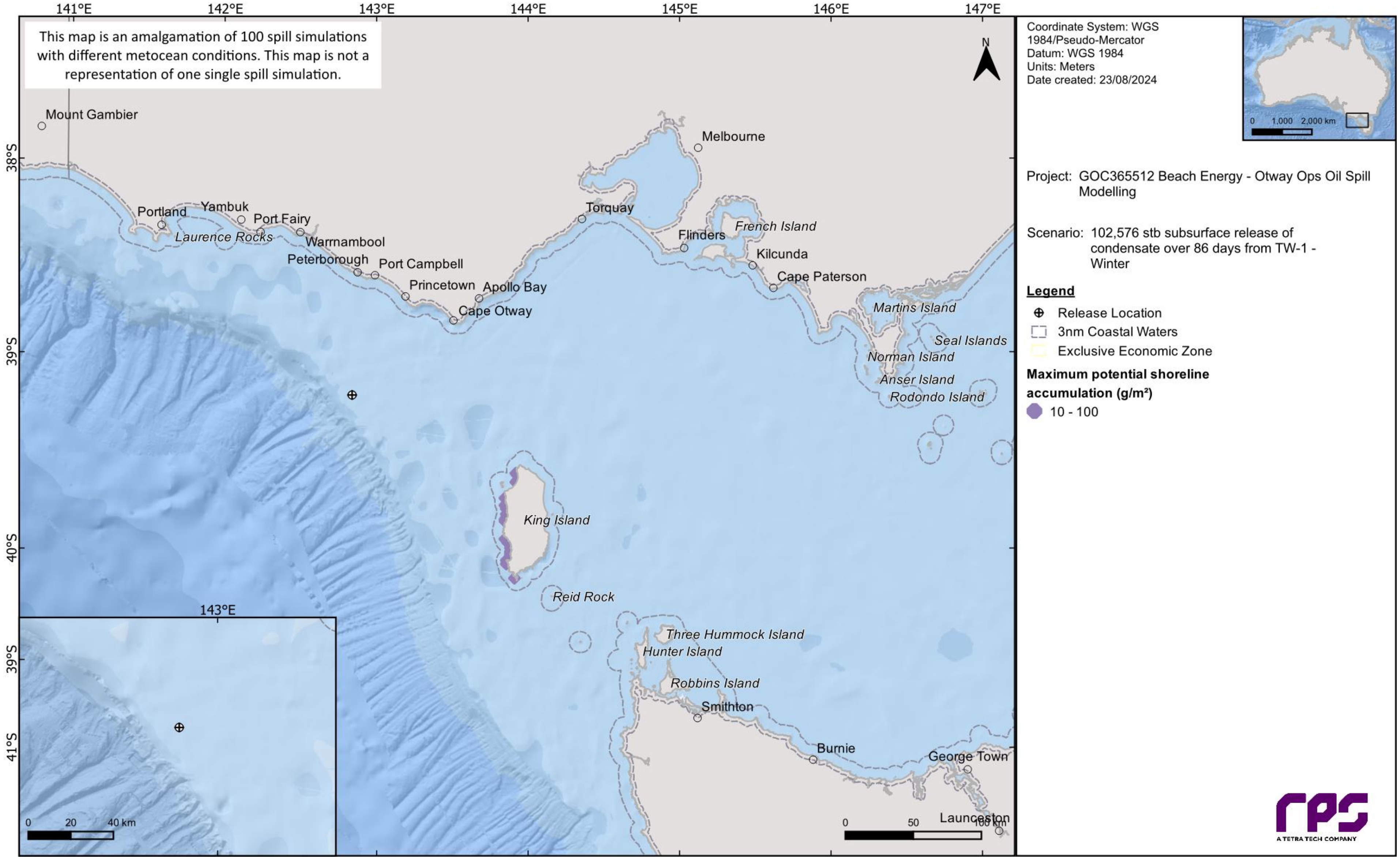


Figure 15-7 Maximum potential shoreline loading in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during winter conditions.

15.1.4 In-water exposure

15.1.4.1 Dissolved Hydrocarbons

Table 15-6 summarises the probability of exposure to individual receptors from dissolved hydrocarbons in the 0-10 m layer during the summer and winter conditions.

Outside of the receptors that the Northern Release Location resides within (refer to Table 12-1), the highest concentration of dissolved hydrocarbon was 553.15 ppb during summer and 528.54 ppb during winter.

Table 15-7 presents the predicted minimum time to dissolved hydrocarbon exposure and maximum residence time for dissolved hydrocarbon exposure to individual receptors, in the 0-10 m depth layer, for all seasonal conditions and all thresholds assessed.

Figure 15-8 and Figure 15-9 present the zones of potential dissolved hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 15-10 to Figure 15-15 present the maximum residence time of dissolved hydrocarbon exposure for the NOPSEMA thresholds in summer and winter.

Table 15-6 Probability of dissolved hydrocarbons exposure to marine based receptors in the 0–10 m dept. Results are based on a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations per season.

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure			Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	204.71	46	7	-	196.64	66	17	-
	Zeehan	91.61	52	5	-	275.96	33	2	-
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	617.38	100	100	66	547.66	100	100	47
	Australasian Gannet - Foraging (Buffer around Black Pyramid)	-	-	-	-	13.64	1	-	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	617.38	100	100	66	547.66	100	100	47
	Black-faced Cormorant - Foraging (Buffer around Christmas Island Tasmania)	22.45	2	-	-	137.95	5	1	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	617.38	100	100	66	547.66	100	100	47
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	617.38	100	100	66	547.66	100	100	47
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	770.64	100	100	66	1,280.79	100	100	48
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	617.38	100	100	66	547.66	100	100	47
	Little Penguin - Foraging (Buffer around Christmas Island Tasmania)	17.87	1	-	-	66.1	4	1	-
	Pygmy Blue Whale - Distribution (None)**	770.64	100	100	65	1,280.79	100	100	46
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	770.64	100	100	13	1,280.79	100	100	9
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	770.64	100	100	65	1,280.79	100	100	47
	Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)	72.46	58	3	-	245.01	43	3	-
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)**	770.64	100	100	61	1,280.79	100	100	44

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure			Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	770.64	100	100	66	1,280.79	100	100	48
	Southern Right Whale - Connecting habitat (King Island area)	14.4	1	-	-	16.38	1	-	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	770.64	100	100	64	1,280.79	100	100	42
	Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area)	770.64	9	6	2	1,280.79	3	3	3
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	617.38	100	100	66	547.66	100	100	47
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	770.64	100	100	66	1,280.79	100	100	48
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	553.15	100	100	21	528.54	100	100	15
	White Shark - Distribution (Between the 60-120m depth contour)**	617.38	100	100	59	547.66	100	100	40
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	617.38	100	100	66	547.66	100	100	47
	White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region)	-	-	-	-	16.38	2	-	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	617.38	100	100	65	547.66	100	100	45
	White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)	17.53	5	-	-	33.76	4	-	-
	White-faced Storm-petrel - Foraging (Buffer around the northern side of Tasmania into Bass Strait)	14.4	5	-	-	40.75	4	-	-
IMCRA-MESO	Central Bass Strait	62.94	20	1	-	40.36	36	-	-
	Central Victoria	10.08	1	-	-	33.76	2	-	-
	Otway**	770.64	100	100	64	1,280.79	100	100	42
IMCRA-PROV	Bass Strait Shelf Province	62.94	20	1	-	40.36	36	-	-
	West Tasmania Transition	553.15	100	87	9	528.54	87	56	12
	Western Bass Strait Shelf Transition**	770.64	100	100	64	1,280.79	100	100	42

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure			Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
KEF	West Tasmania Canyons	553.15	98	77	10	528.54	86	46	9
MR	South-east (Marine)**	617.38	100	100	66	547.66	100	100	47
NHPH	Great Ocean Road and Scenic Environs	216.63	2	1	-	-	-	-	-
NRMR	Corangamite (VIC)	770.64	9	7	2	1,280.79	3	3	3
	North West NRM Region (TAS)	15.52	2	-	-	31.2	7	-	-
SHORE-LGA	King Island Council (TAS)	14.4	1	-	-	16.38	1	-	-
SHORE-VIC-MPRA	Apollo Bay	51.47	2	1	-	-	-	-	-
	Cape Otway West	103.23	6	4	-	326.53	2	1	-
	Moonlight Head	770.64	6	4	2	1,280.79	3	3	3
State Waters	Tasmania	15.52	2	-	-	31.2	7	-	-
	Victoria	770.64	9	7	2	1,280.79	3	3	3

*The release location resides within the receptor boundaries.

Table 15-7 Predicted minimum time to dissolved hydrocarbon exposure and maximum residence time for dissolved hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill trajectories per season.

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)			Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
AMP	Apollo	16.03	29.64	-	10.5	4.25	-	6.93	28.11	-	14.25	5.5	-
	Zeehan	16.42	49.04	-	11	1.5	-	14.41	82.28	-	10.25	1.75	-
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.02	0.03	8.88	84.5	23	1.75	0.02	0.04	11.28	110.75	33.25	2
	Australasian Gannet - Foraging (Buffer around Black Pyramid)	-	-	-	-	-	-	85.21	-	-	0.5	-	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	0.02	0.03	8.88	84.5	23	1.75	0.02	0.04	11.28	110.75	33.25	2
	Black-faced Cormorant - Foraging (Buffer around Christmas Island Tasmania)	46.29	-	-	3.5	-	-	38.71	62.84	-	14.75	4.5	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	0.02	0.03	8.88	84.5	23	1.75	0.02	0.04	11.28	110.75	33.25	2
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.02	0.03	8.88	84.5	23	1.75	0.02	0.04	11.28	110.75	33.25	2
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	0.02	0.03	8.88	84.5	32.5	3.25	0.02	0.04	11.28	110.75	33.25	8
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	0.02	0.03	8.88	84.5	23	1.75	0.02	0.04	11.28	110.75	33.25	2
	Little Penguin - Foraging (Buffer around Christmas Island Tasmania)	60.52	-	-	3.25	-	-	39.03	63.51	-	7.75	1.25	-
	Pygmy Blue Whale - Distribution (None)**	0.02	0.03	8.88	84.5	32.5	3.25	0.02	0.04	11.28	110.75	33.25	8
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	0.29	0.71	46.03	54	32.5	3.25	0.22	0.61	22.35	61.75	19.75	8
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	0.02	0.03	8.88	84.5	32.5	3.25	0.02	0.04	11.28	110.75	33.25	8
	Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)	16.21	38.65	-	11	1.5	-	10.78	43.56	-	9.5	1.75	-

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)			Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)**	0.02	0.03	8.88	84.5	32.5	3.25	0.02	0.04	11.28	110.75	33.25	4.75
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	0.02	0.03	8.88	84.5	32.5	3.25	0.02	0.04	11.28	110.75	33.25	8
	Southern Right Whale - Connecting habitat (King Island area)	94.23	-	-	2.25	-	-	45.71	-	-	0.25	-	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	0.02	0.03	8.88	84.5	32.5	3.25	0.02	0.04	11.28	110.75	33.25	8
	Southern Right Whale - Migration and resting on migration (E of Warrnambool to Philip Island area)	50.45	50.76	63.53	54	32.5	3.25	53.2	53.22	54.16	34.75	19.75	8
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	0.02	0.03	8.88	84.5	23	1.75	0.02	0.04	11.28	110.75	33.25	2
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	0.02	0.03	8.88	84.5	32.5	3.25	0.02	0.04	11.28	110.75	33.25	8
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	0.15	0.29	25.35	61.25	13.5	1	0.17	0.32	22.85	49.25	16.5	0.75
	White Shark - Distribution (Between the 60-120m depth contour)**	0.02	0.03	8.88	84.5	23	1.75	0.02	0.04	11.28	110.75	33.25	2
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	0.02	0.03	8.88	84.5	23	1.75	0.02	0.04	11.28	110.75	33.25	2
	White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region)	-	-	-	-	-	-	45.71	-	-	0.5	-	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	0.02	0.03	8.88	84.5	23	1.75	0.02	0.04	11.28	110.75	33.25	2
	White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)	30.99	-	-	5.75	-	-	39.66	-	-	5.5	-	-
	White-faced Storm-petrel - Foraging (Buffer around the northern side of Tasmania into Bass Strait)	62.14	-	-	3.75	-	-	45.71	-	-	3	-	-
	Central Bass Strait	29.53	38.5	-	8.75	1	-	10.65	-	-	9.5	-	-

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)			Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
IMCRA-MESO	Central Victoria	51.75	-	-	0.25	-	-	58.42	-	-	5.5	-	-
	Otway**	0.02	0.03	8.88	84.5	32.5	3.25	0.02	0.04	11.28	110.75	33.25	8
IMCRA-PROV	Bass Strait Shelf Province	29.53	38.5	-	8.75	1	-	10.65	-	-	9.5	-	-
	West Tasmania Transition	0.96	3.54	52.18	27.5	8.5	0.5	2.04	13.13	22.85	31	9.25	0.5
	Western Bass Strait Shelf Transition**	0.02	0.03	8.88	84.5	32.5	3.25	0.02	0.04	11.28	110.75	33.25	8
KEF	West Tasmania Canyons	1.17	5.55	52.18	26.75	8.5	0.5	2.76	14.07	22.85	31	6	0.5
MR	South-east (Marine)**	0.02	0.03	8.88	84.5	23	1.75	0.02	0.04	11.28	110.75	33.25	2
NHPH	Great Ocean Road and Scenic Environs	62.94	64.24	-	35.5	13.75	-	-	-	-	-	-	-
NRMR	Corangamite (VIC)	49.06	50.76	63.53	54	32.5	3.25	52.42	53.22	54.16	34.75	19.75	8
	North West NRM Region (TAS)	60.59	-	-	2.25	-	-	26.79	-	-	4.25	-	-
SHORE-LGA	King Island Council (TAS)	94.23	-	-	1	-	-	45.71	-	-	0.25	-	-
SHORE-VIC-MPRA	Apollo Bay	51.03	51.17	-	4	0.5	-	-	-	-	-	-	-
	Cape Otway West	50.45	50.76	-	28.25	4.75	-	57.73	84.16	-	20.75	11	-
	Moonlight Head	57.51	57.73	63.53	54	32.5	3.25	53.2	53.22	54.16	34.75	19.75	8
State Waters	Tasmania	60.59	-	-	2.25	-	-	26.79	-	-	4.25	-	-
	Victoria	49.06	50.76	63.53	54	32.5	3.25	52.42	53.22	54.16	34.75	19.75	8

*The release location resides within the receptor boundaries.

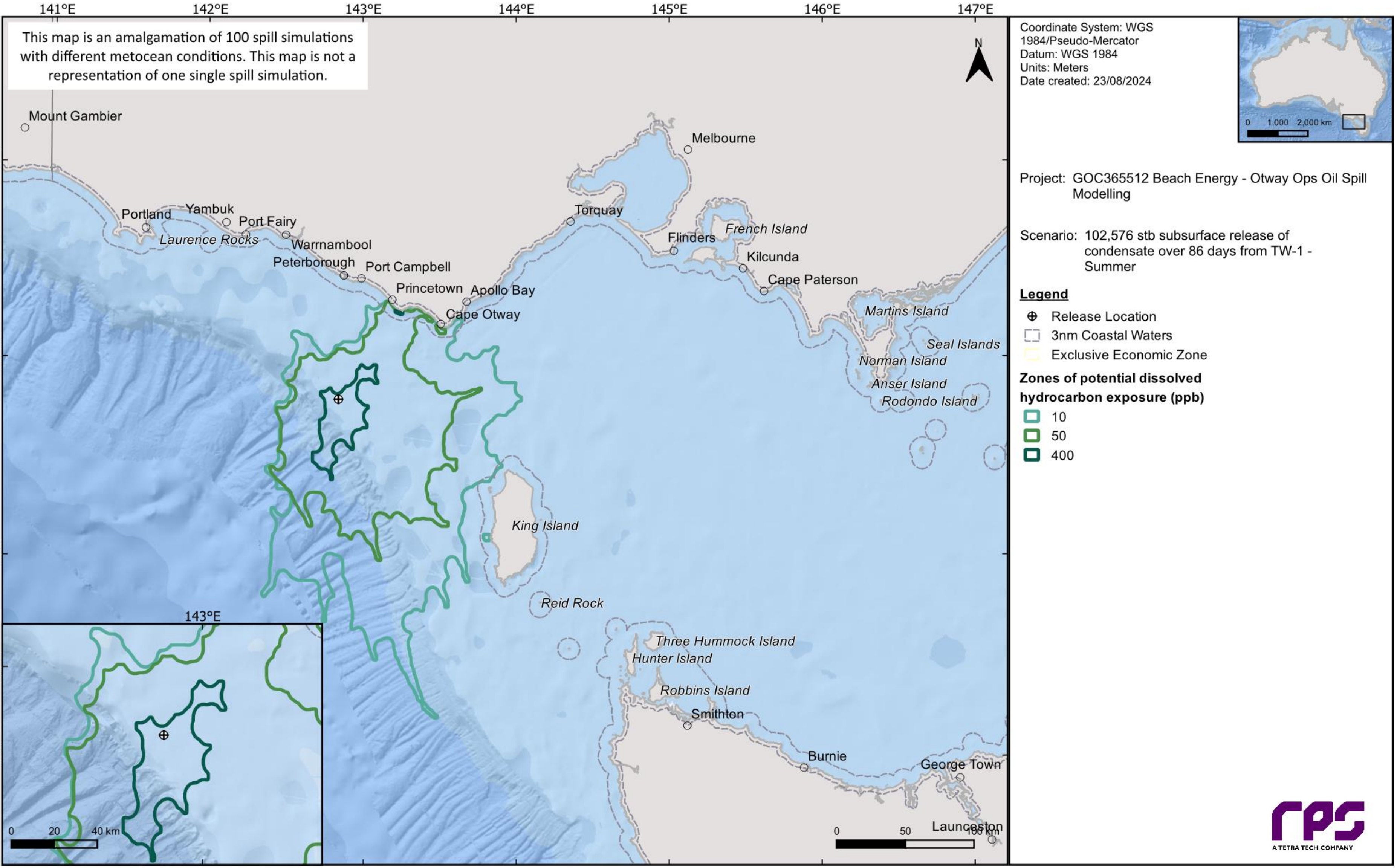


Figure 15-8 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during summer conditions.

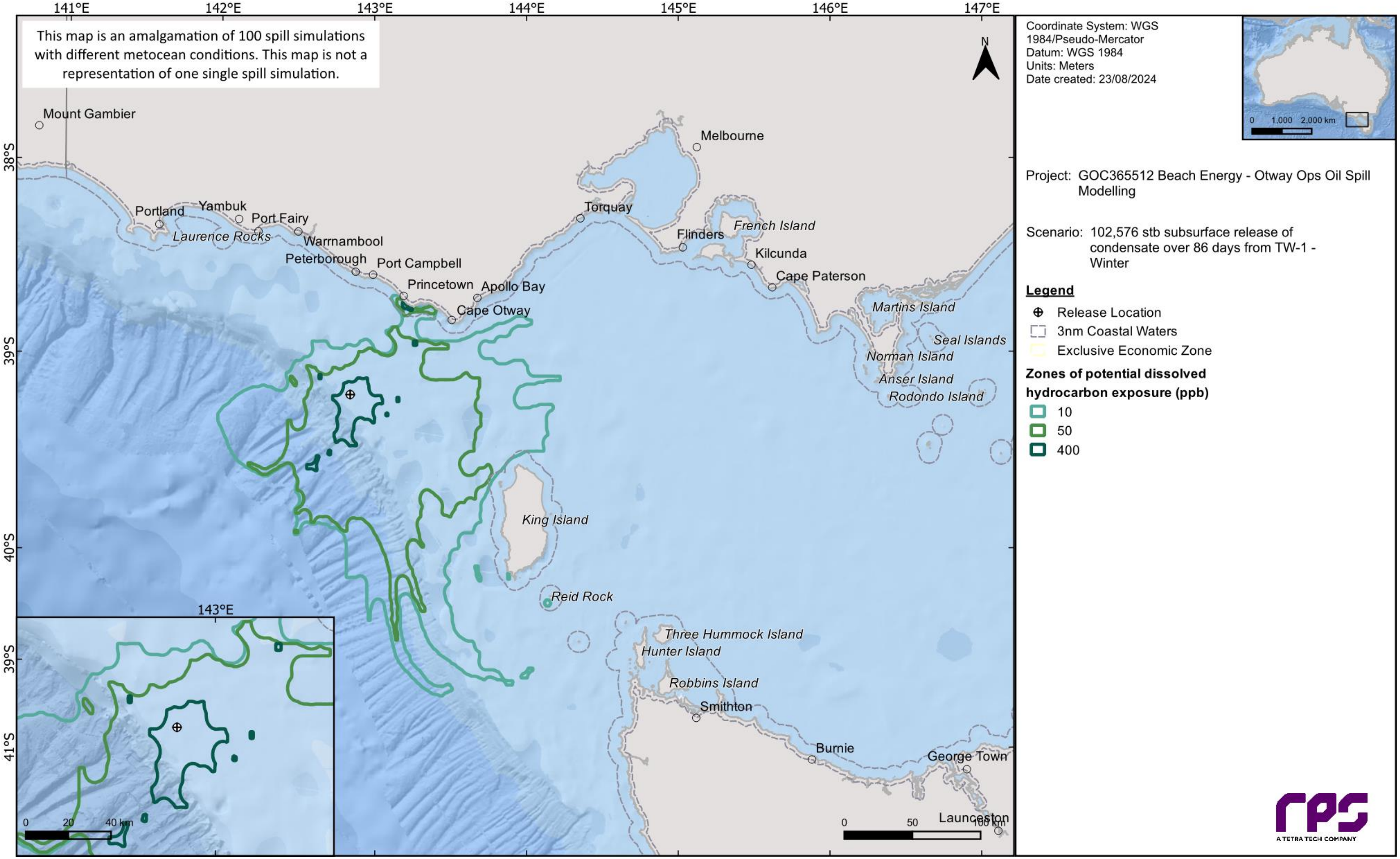


Figure 15-9 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during winter conditions.

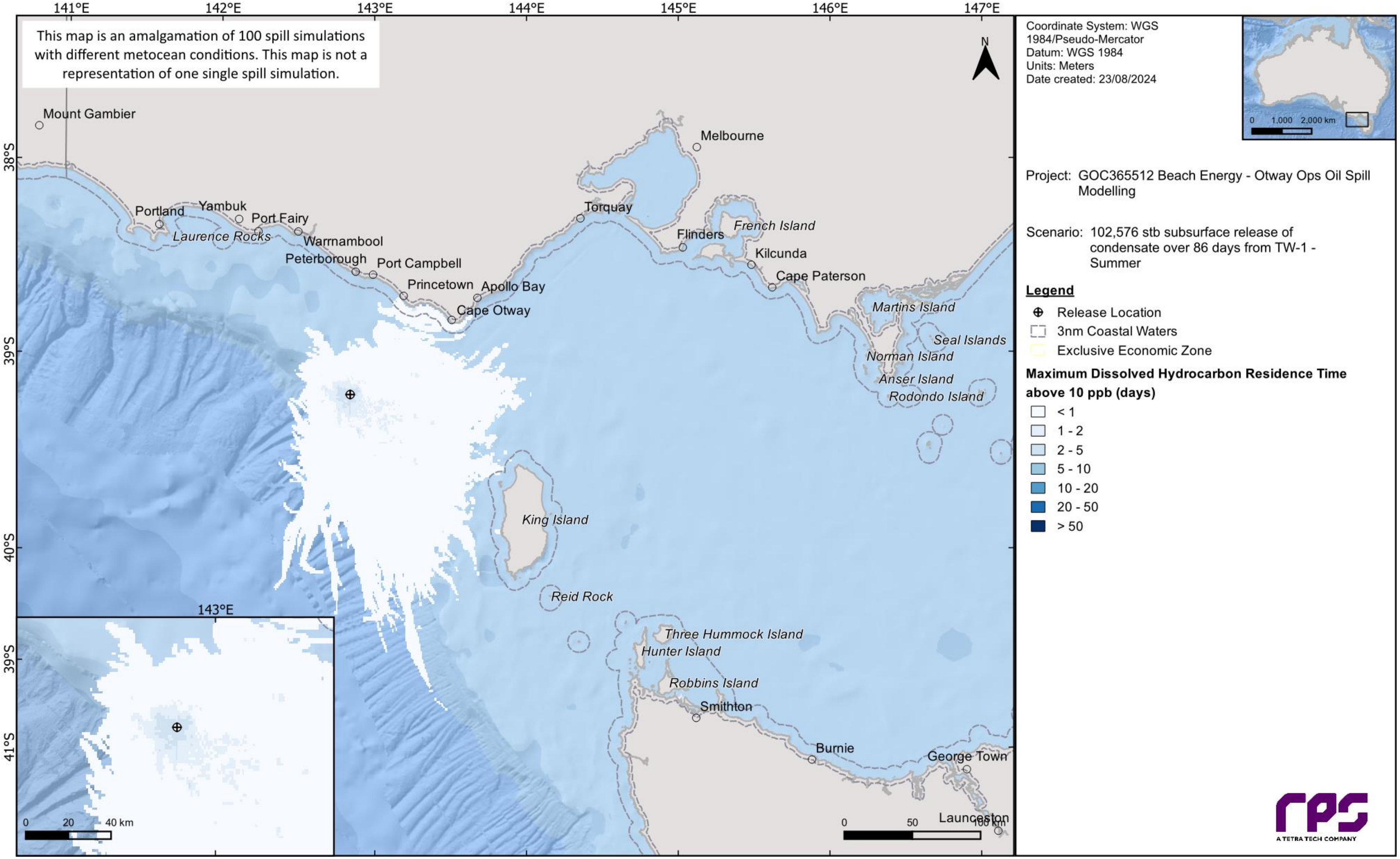


Figure 15-10 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during summer conditions.

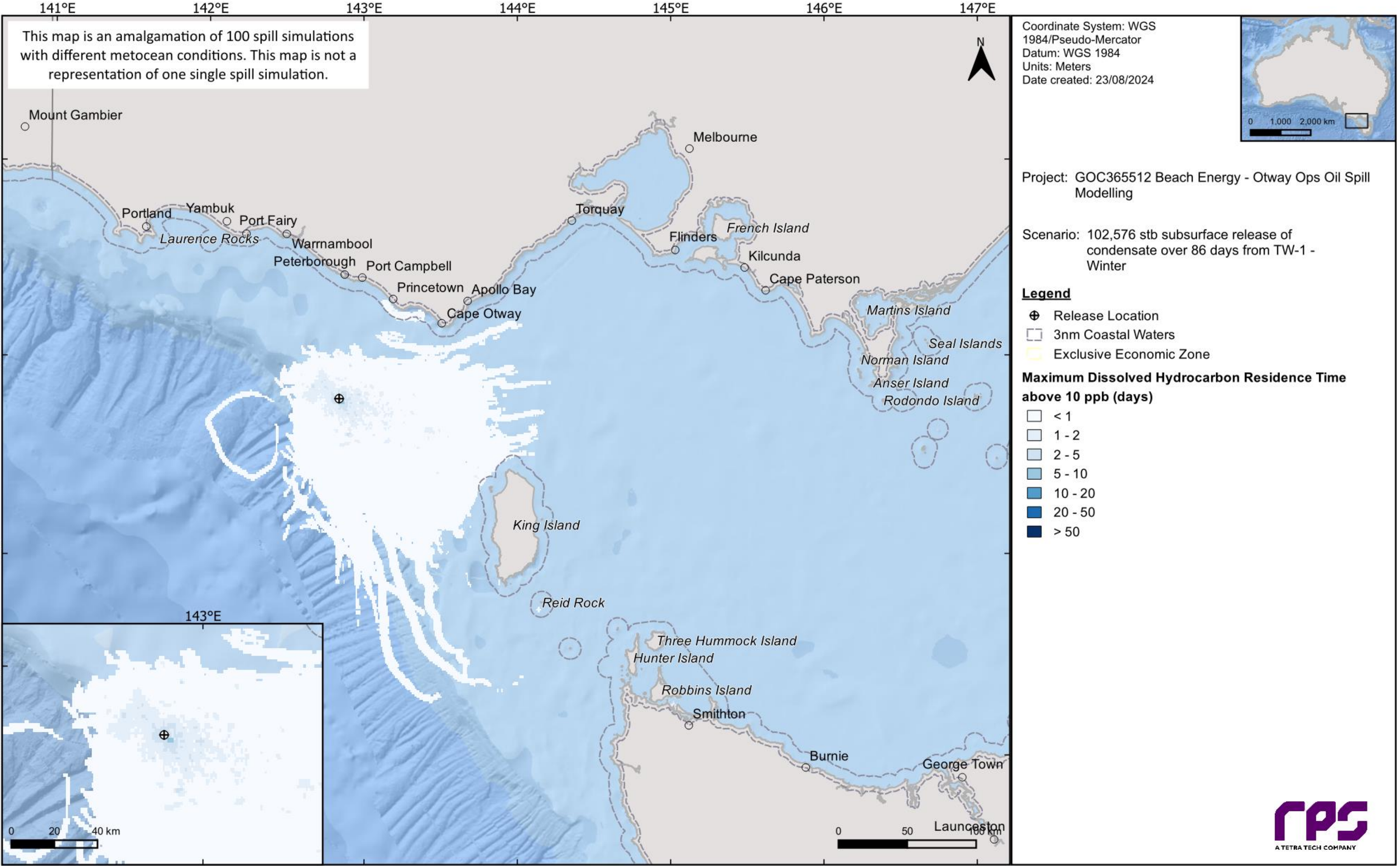


Figure 15-11 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during winter conditions.

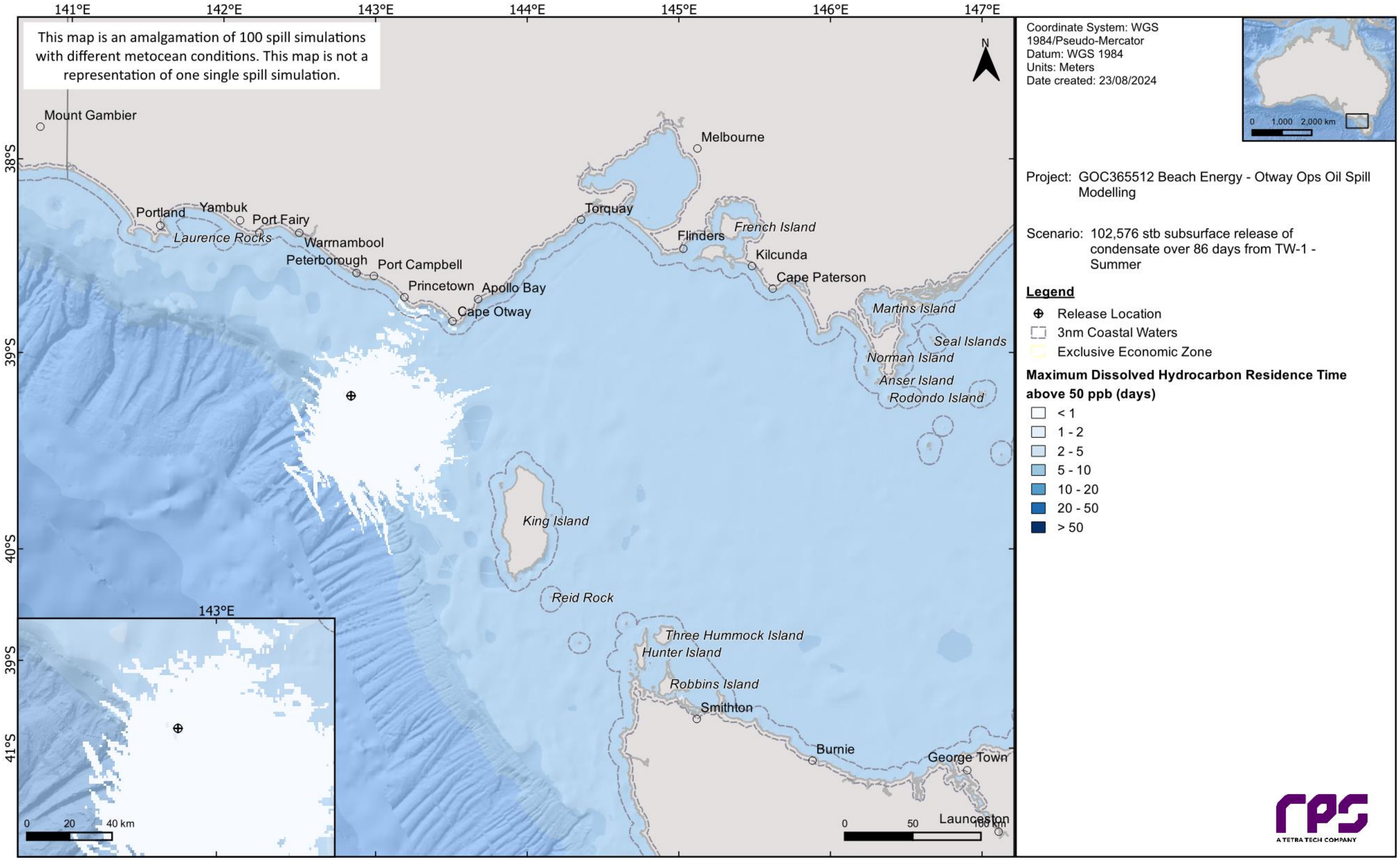


Figure 15-12 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during summer conditions.

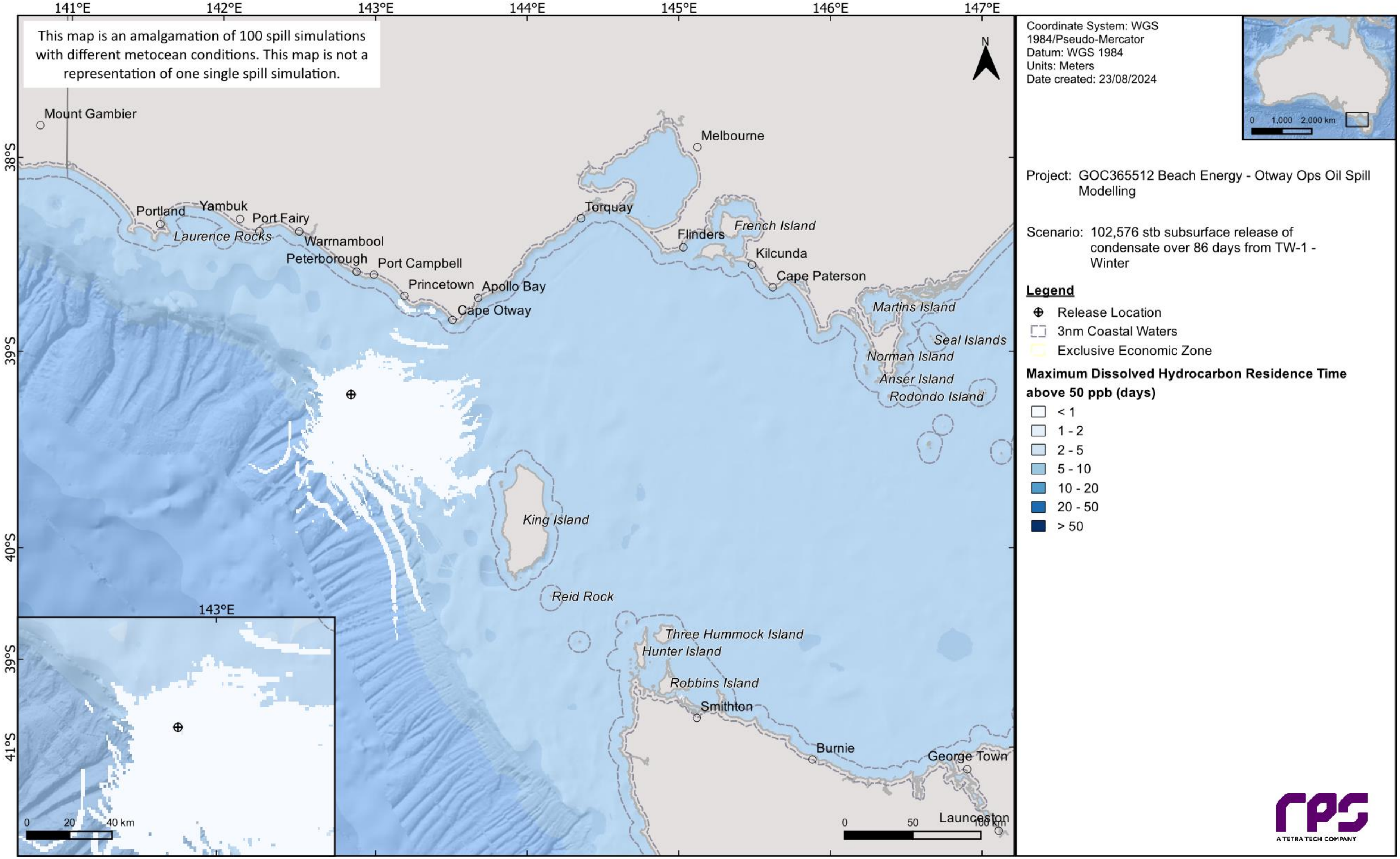


Figure 15-13 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during winter conditions.

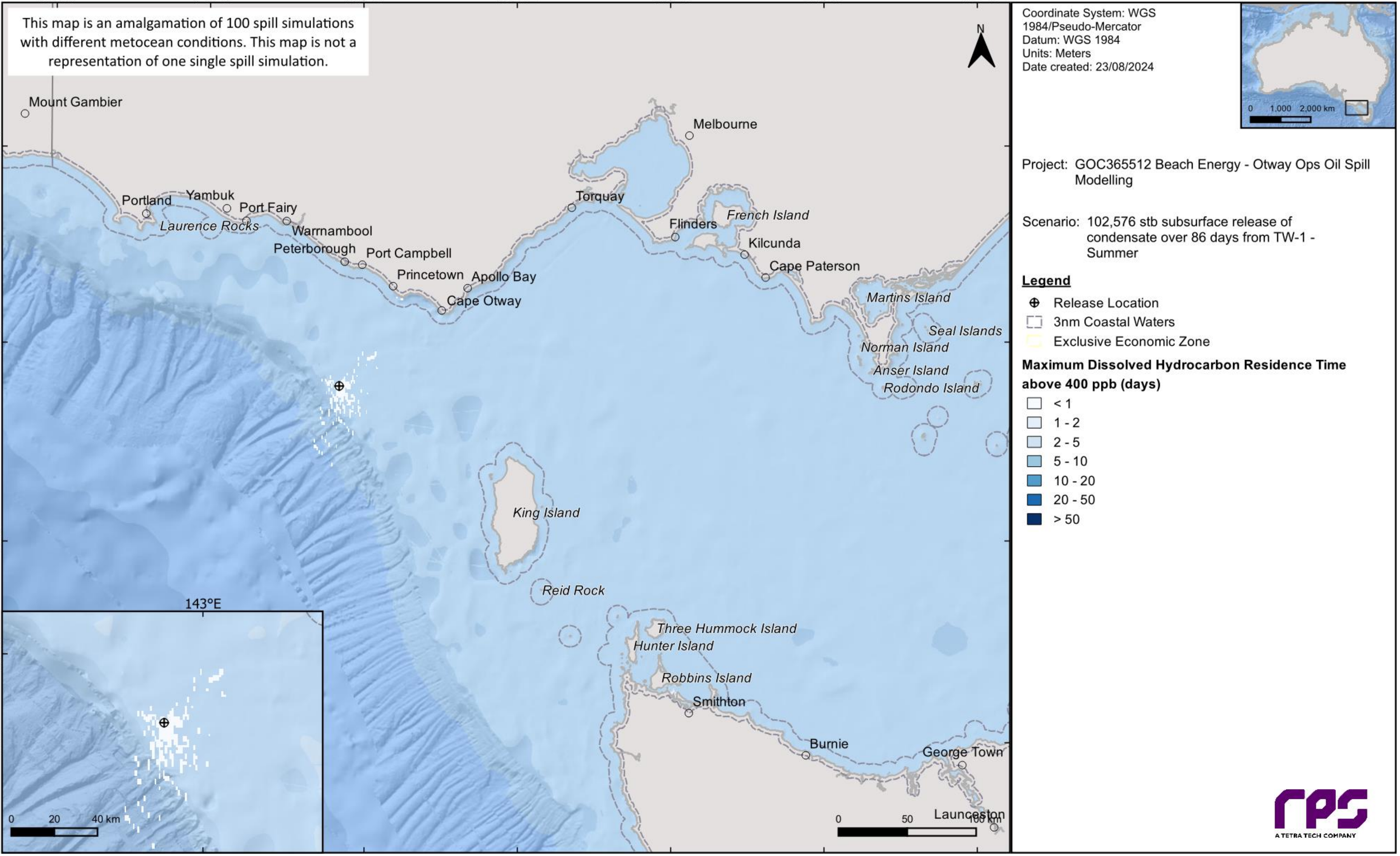


Figure 15-14 Maximum residence time for dissolved hydrocarbon exposure above 400 ppb, at 0-10 m below the sea surface in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during summer conditions.

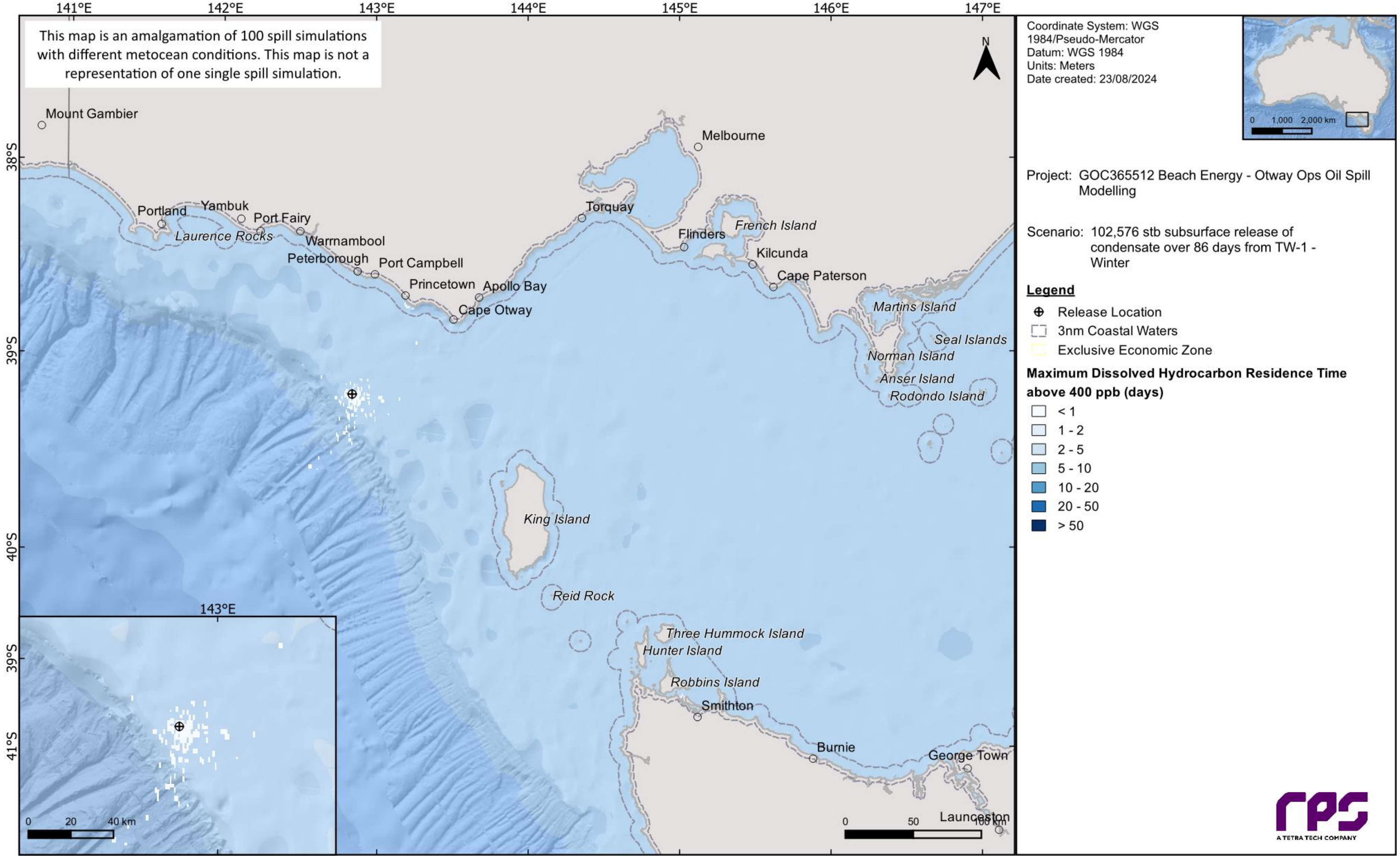


Figure 15-15 Maximum residence time for dissolved hydrocarbon exposure above 400 ppb, at 0-10 m below the sea surface in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during winter conditions.

15.1.4.2 Entrained Hydrocarbons

Table 15-8 presents the probability of exposure to individual receptors from entrained hydrocarbons in the 0-10 m depth layer for the summer and winter conditions.

Outside of the receptors that the Northern Release Location resides within (refer to Table 12-1), the highest concentration of entrained hydrocarbon was predicted for White Shark – Distribution (Between 120 – 1,000 m depth contour) (summer – 338.67 ppb, winter – 328.89 ppb).

Table 15-9 presents the predicted minimum time to entrained hydrocarbon exposure and maximum residence time for entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer, for all seasonal conditions and all thresholds assessed.

Figure 15-16 and Figure 15-17 present the zones of potential entrained hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 15-18 to Figure 15-21 present the maximum residence time of entrained hydrocarbon exposure for the NOPSEMA thresholds in summer and winter.

Table 15-8 Probability of entrained hydrocarbons exposure to marine based receptors in the 0–10 m depth layer. Results are based on a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations per season.

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	18.35	82	-	-	20.69	99	-	-
	Zeehan	15.15	40	-	-	13.79	35	-	-
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	1,111.04	100	100	17	1,179.85	100	100	24
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	1,111.04	100	100	17	1,179.85	100	100	24
	Black-faced Cormorant - Breeding (Christmas Island)	15.47	12	-	-	22	33	-	-
	Black-faced Cormorant - Foraging (Buffer around Christmas Island Tasmania)	29.89	35	-	-	39.55	66	-	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	1,111.04	100	100	17	1,179.85	100	100	24
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	1,111.04	100	100	17	1,179.85	100	100	24
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	1,111.04	100	100	17	1,179.85	100	100	24
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	1,111.04	100	100	17	1,179.85	100	100	24
	Little Penguin - Breeding (Christmas Island)	15.47	12	-	-	22	33	-	-
	Little Penguin - Foraging (Buffer around Christmas Island Tasmania)	29.89	25	-	-	34.95	62	-	-
	Pygmy Blue Whale - Distribution (None)**	1,111.04	100	100	17	1,179.85	100	100	24
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	128.75	100	29	-	134.25	100	44	-

Receptor	Summer (November through to March)				Winter (April to October)			
	Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
		Low	Moderate	High		Low	Moderate	High
Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	1,111.04	100	100	17	1,179.85	100	100	24
Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)	85.51	74	-	-	88.1	97	-	-
Short-tailed Shearwater - Breeding (Christmas Island)	15.47	12	-	-	22	33	-	-
Short-tailed Shearwater - Breeding (New Year Island)	13.82	2	-	-	13.08	3	-	-
Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)**	1,111.04	100	100	17	1,179.85	100	100	24
Shy Albatross - Foraging likely (The whole South-east Marine Region)**	1,111.04	100	100	17	1,179.85	100	100	24
Southern Right Whale - Connecting habitat (King Island area)	85.51	50	-	-	88.1	80	-	-
Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	1,111.04	100	100	17	1,179.85	100	100	24
Southern Right Whale - Migration and resting on migration (Gippsland coast region)	-	-	-	-	10.59	1	-	-
Wandering Albatross - Foraging (The whole South-east Marine Region)**	1,111.04	100	100	17	1,179.85	100	100	24
Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer-Muttonbird Island (VIC))**	1,111.04	100	100	17	1,179.85	100	100	24
White Shark - Distribution (Between the 120 - 1,000m depth contour)	338.67	100	100	-	328.89	100	100	-
White Shark - Distribution (Between the 60-120m depth contour)**	1,111.04	100	100	17	1,179.85	100	100	24

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	1,111.04	100	100	17	1,179.85	100	100	24
	White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region)	30.08	34	-	-	29.36	56	-	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	1,111.04	100	100	17	1,179.85	100	100	24
	White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)	14.78	24	-	-	21.94	50	-	-
	White-faced Storm-petrel - Foraging (Buffer around the northern side of Tasmania into Bass Strait)	85.51	50	-	-	88.1	77	-	-
	White-faced Storm-petrel - Foraging (Gabo Island)	-	-	-	-	10.59	1	-	-
CA	Red Hut Point	-	-	-	-	11.28	2	-	-
GR	New Year Island	13.82	2	-	-	13.08	3	-	-
IBRA	King	15.47	14	-	-	22	34	-	-
IMCRA-MESO	Central Bass Strait	17.87	52	-	-	19	94	-	-
	Central Victoria	14.13	11	-	-	21.94	10	-	-
	Otway**	1,111.04	100	100	17	1,179.85	100	100	24
	Twofold Shelf	-	-	-	-	72.34	31	-	-
IMCRA-PROV	Bass Strait Shelf Province	17.87	52	-	-	21.94	94	-	-
	Southeast Shelf Transition	-	-	-	-	72.34	32	-	-
	West Tasmania Transition	119.63	100	1	-	88.87	100	-	-
	Western Bass Strait Shelf Transition**	1,111.04	100	100	17	1,179.85	100	100	24
KEF	Upwelling East of Eden	-	-	-	-	10.59	1	-	-
	West Tasmania Canyons	105.71	100	1	-	72.3	99	-	-
MNP	Point Hicks	-	-	-	-	10.59	1	-	-
MR	South-east (Marine)**	1,111.04	100	100	17	1,179.85	100	100	24

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
NR	Christmas Island	15.47	12	-	-	22	33	-	-
NRMR	Corangamite (VIC)	-	-	-	-	21.94	5	-	-
	East Gippsland (VIC)	-	-	-	-	10.59	1	-	-
	North West NRM Region (TAS)	85.51	54	-	-	88.1	80	-	-
SHORE-LGA	King Island Council (TAS)	85.51	50	-	-	88.1	79	-	-
SHORE-VIC-MPRA	Point Hicks	-	-	-	-	10.59	1	-	-
State Waters	Tasmania	85.51	54	-	-	88.1	80	-	-
	Victoria	-	-	-	-	72.34	33	-	-

*The release location resides within the receptor boundaries.

Table 15-9 Predicted minimum time to entrained hydrocarbon exposure and maximum residence time for entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill trajectories per season.

Receptor		Summer (November through March)						Winter (April to October)					
		Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)			Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
AMP	Apollo	2.82	-	-	18.5	-	-	2.02	-	-	10.75	-	-
	Zeehan	7.01	-	-	0.75	-	-	10.36	-	-	1.5	-	-
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Black-faced Cormorant - Breeding (Christmas Island)	23.11	-	-	11.5	-	-	9.73	-	-	8.75	-	-
	Black-faced Cormorant - Foraging (Buffer around Christmas Island Tasmania)	23.11	-	-	49.25	-	-	8.99	-	-	136.25	-	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Little Penguin - Breeding (Christmas Island)	23.11	-	-	11.5	-	-	9.73	-	-	8.75	-	-
	Little Penguin - Foraging (Buffer around Christmas Island Tasmania)	23.11	-	-	11.75	-	-	9.16	-	-	85	-	-
	Pygmy Blue Whale - Distribution (None)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	0.19	10.59	-	203.75	0.75	-	0.21	2.19	-	360.75	1.75	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)	7.19	-	-	203.75	-	-	3.35	-	-	360.75	-	-
	Short-tailed Shearwater - Breeding (Christmas Island)	23.11	-	-	11.5	-	-	9.73	-	-	8.75	-	-
	Short-tailed Shearwater - Breeding (New Year Island)	40.92	-	-	0.75	-	-	31.51	-	-	0.5	-	-
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Southern Right Whale - Connecting habitat (King Island area)	13.4	-	-	203.75	-	-	9.73	-	-	360.75	-	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Southern Right Whale - Migration and resting on migration (Gippsland coast region)	-	-	-	-	-	-	76.51	-	-	0.5	-	-
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	0.11	0.16	-	138	8	-	0.15	0.19	-	84.75	7.25	-
	White Shark - Distribution (Between the 60-120m depth contour)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region)	23.83	-	-	63.75	-	-	13.68	-	-	17	-	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)	7.52	-	-	3	-	-	8.36	-	-	9.25	-	-
	White-faced Storm-petrel - Foraging (Buffer around the northern side of Tasmania into Bass Strait)	13.4	-	-	203.75	-	-	9.76	-	-	360.75	-	-
	White-faced Storm-petrel - Foraging (Gabo Island)	-	-	-	-	-	-	76.51	-	-	0.5	-	-
CA	Red Hut Point	-	-	-	-	-	-	16.43	-	-	0.75	-	-

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)			Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
GR	New Year Island	40.92	-	-	0.75	-	-	31.51	-	-	0.5	-	-
IBRA	King	23.11	-	-	11.5	-	-	9.73	-	-	8.75	-	-
IMCRA-MESO	Central Bass Strait	7.19	-	-	2.25	-	-	3.35	-	-	5.25	-	-
	Central Victoria	29.47	-	-	3	-	-	14.33	-	-	9.25	-	-
	Otway**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
	Twofold Shelf	-	-	-	-	-	-	25.36	-	-	327	-	-
IMCRA-PROV	Bass Strait Shelf Province	7.19	-	-	3	-	-	3.35	-	-	9.25	-	-
	Southeast Shelf Transition	-	-	-	-	-	-	15.52	-	-	327	-	-
	West Tasmania Transition	0.72	18.25	-	71.75	0.5	-	0.6	-	-	76.75	-	-
	Western Bass Strait Shelf Transition**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
KEF	Upwelling East of Eden	-	-	-	-	-	-	76.51	-	-	0.5	-	-
	West Tasmania Canyons	1.1	42.45	-	35	0.25	-	0.57	-	-	43.5	-	-
MNP	Point Hicks	-	-	-	-	-	-	76.51	-	-	0.5	-	-
MR	South-east (Marine)**	0.01	0.01	5.79	2,095.25	2,070.75	0.5	0.01	0.01	0.34	2,082	2,067.75	0.75
NR	Christmas Island	23.11	-	-	11.5	-	-	9.73	-	-	8.75	-	-
NRMR	Corangamite (VIC)	-	-	-	-	-	-	44.06	-	-	9.25	-	-
	East Gippsland (VIC)	-	-	-	-	-	-	76.51	-	-	0.5	-	-
	North West NRM Region (TAS)	13.4	-	-	203.75	-	-	9.73	-	-	360.75	-	-
SHORE-LGA	King Island Council (TAS)	13.4	-	-	159	-	-	9.73	-	-	341.75	-	-
SHORE-VIC-MPRA	Point Hicks	-	-	-	-	-	-	76.51	-	-	0.5	-	-
State Waters	Tasmania	13.4	-	-	203.75	-	-	9.73	-	-	360.75	-	-
	Victoria	-	-	-	-	-	-	25.36	-	-	327	-	-

*The release location resides within the receptor boundaries.

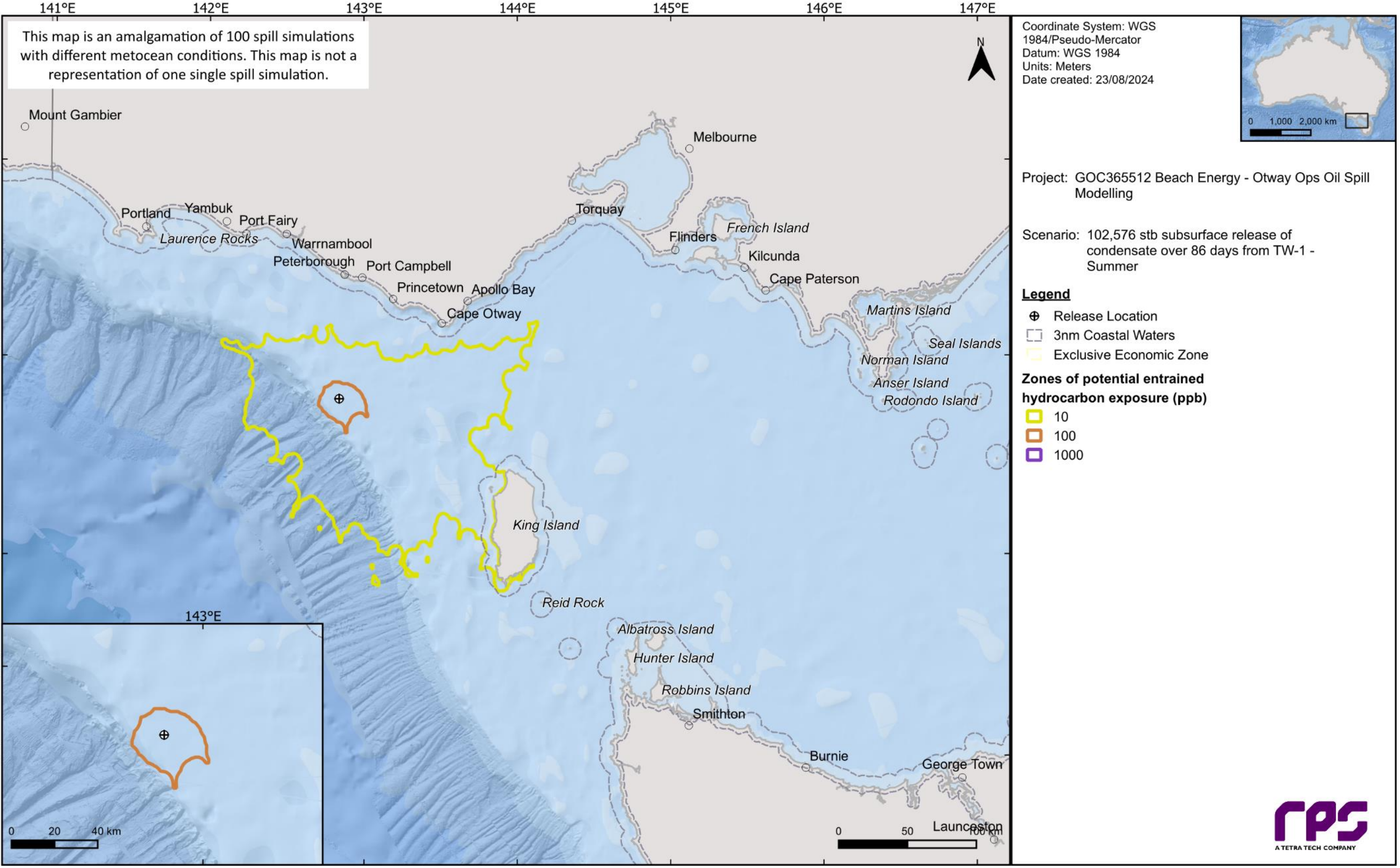


Figure 15-16 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during summer conditions.

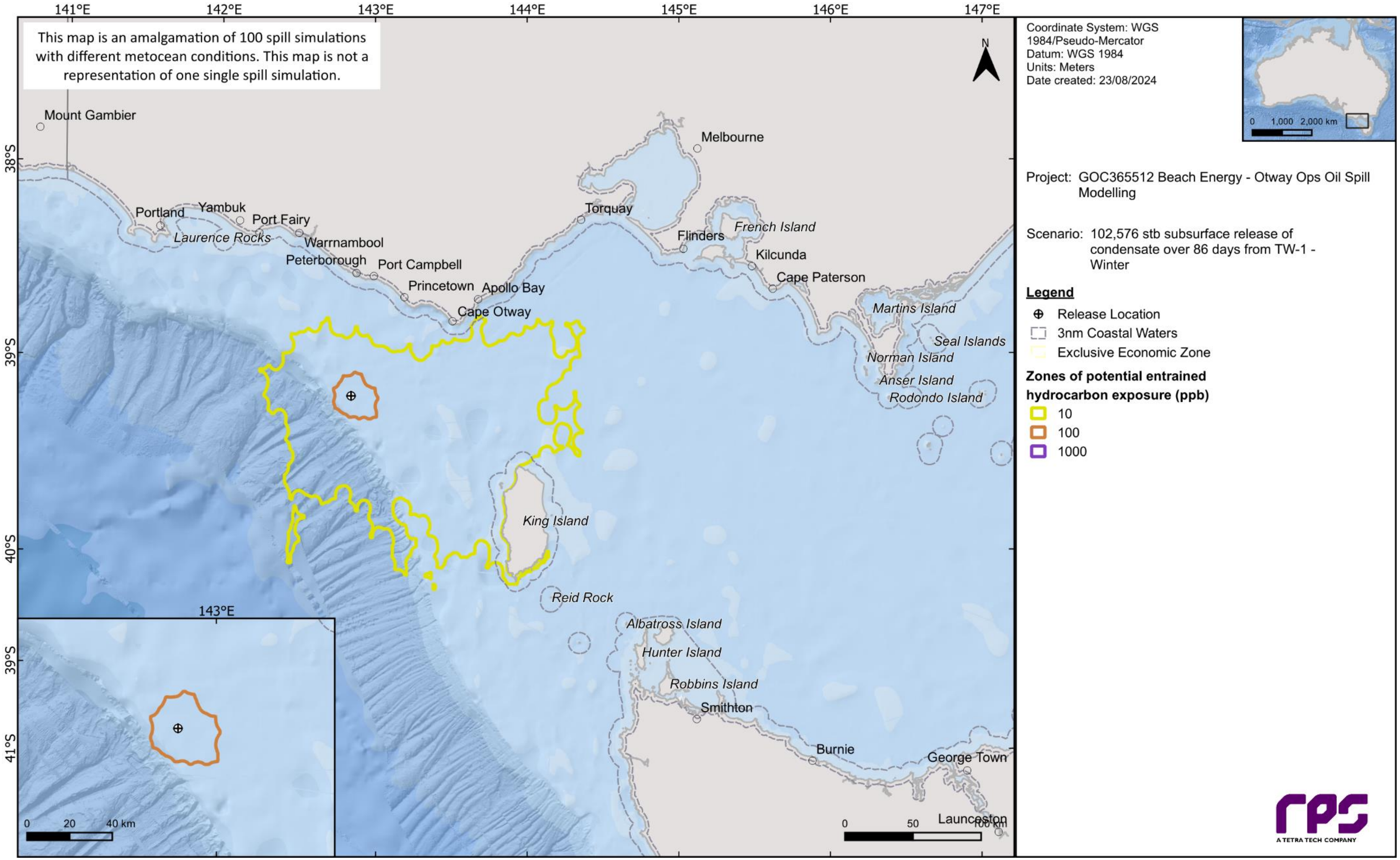


Figure 15-17 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during winter conditions.

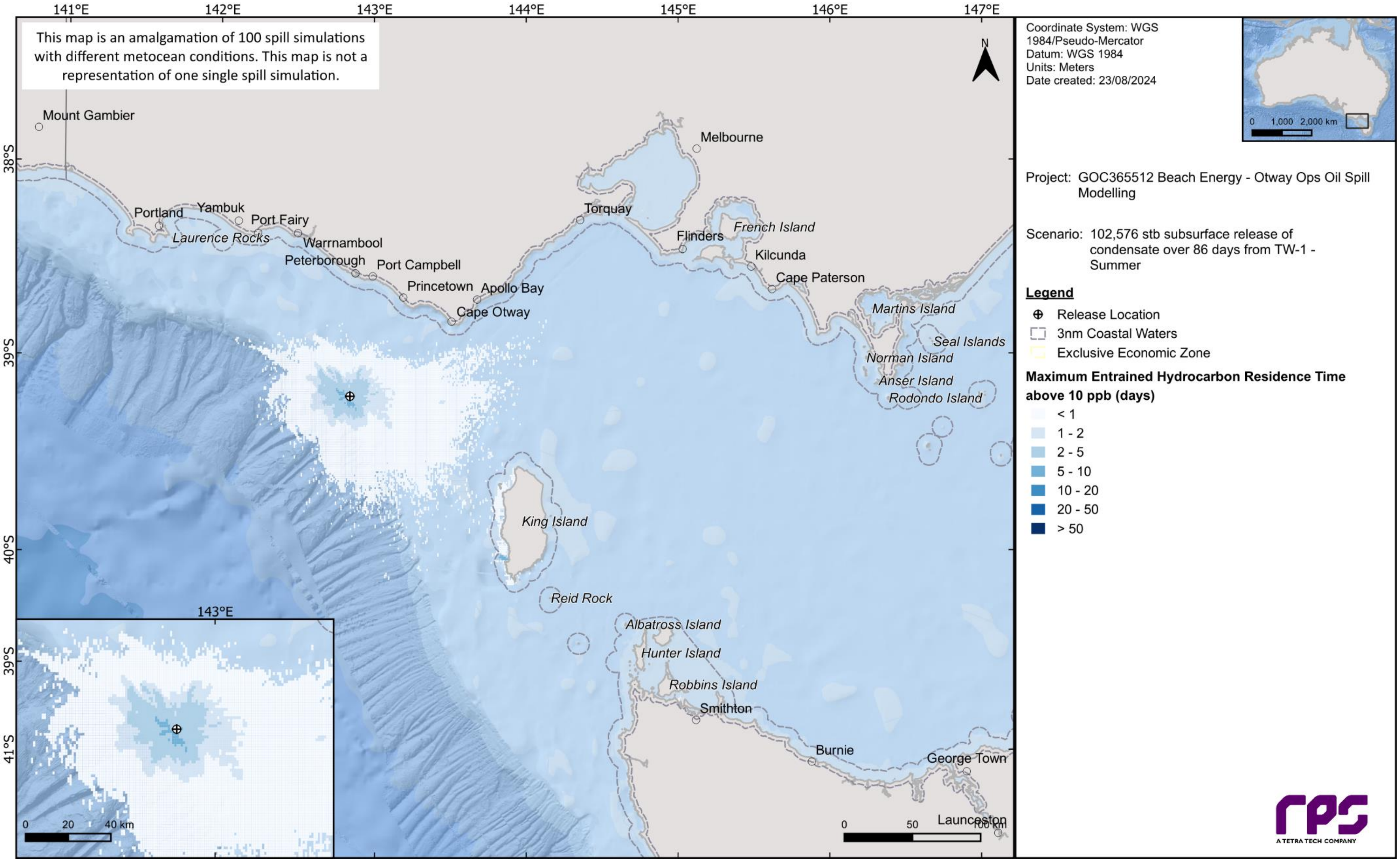


Figure 15-18 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during summer conditions.

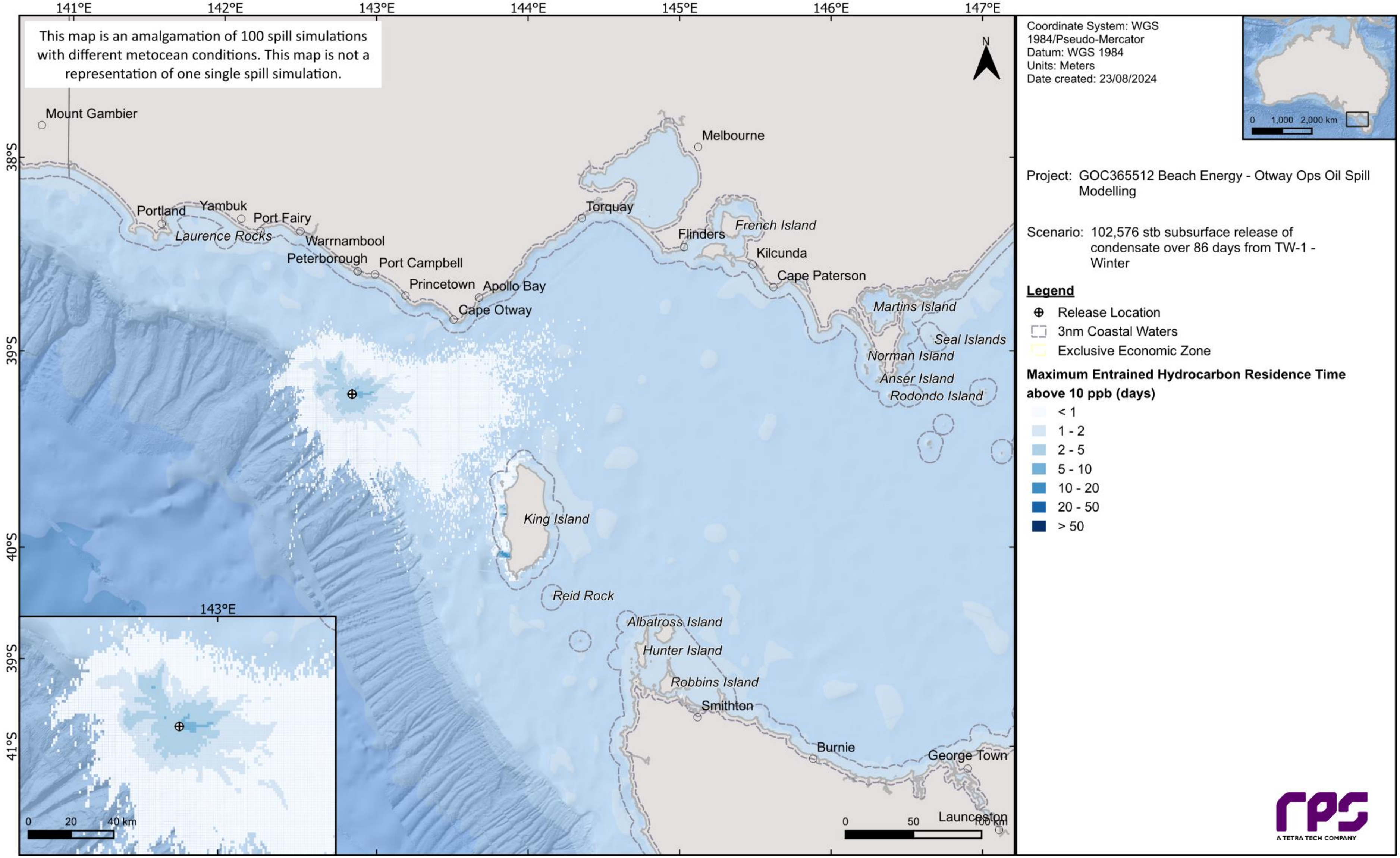


Figure 15-19 **Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during winter conditions.**

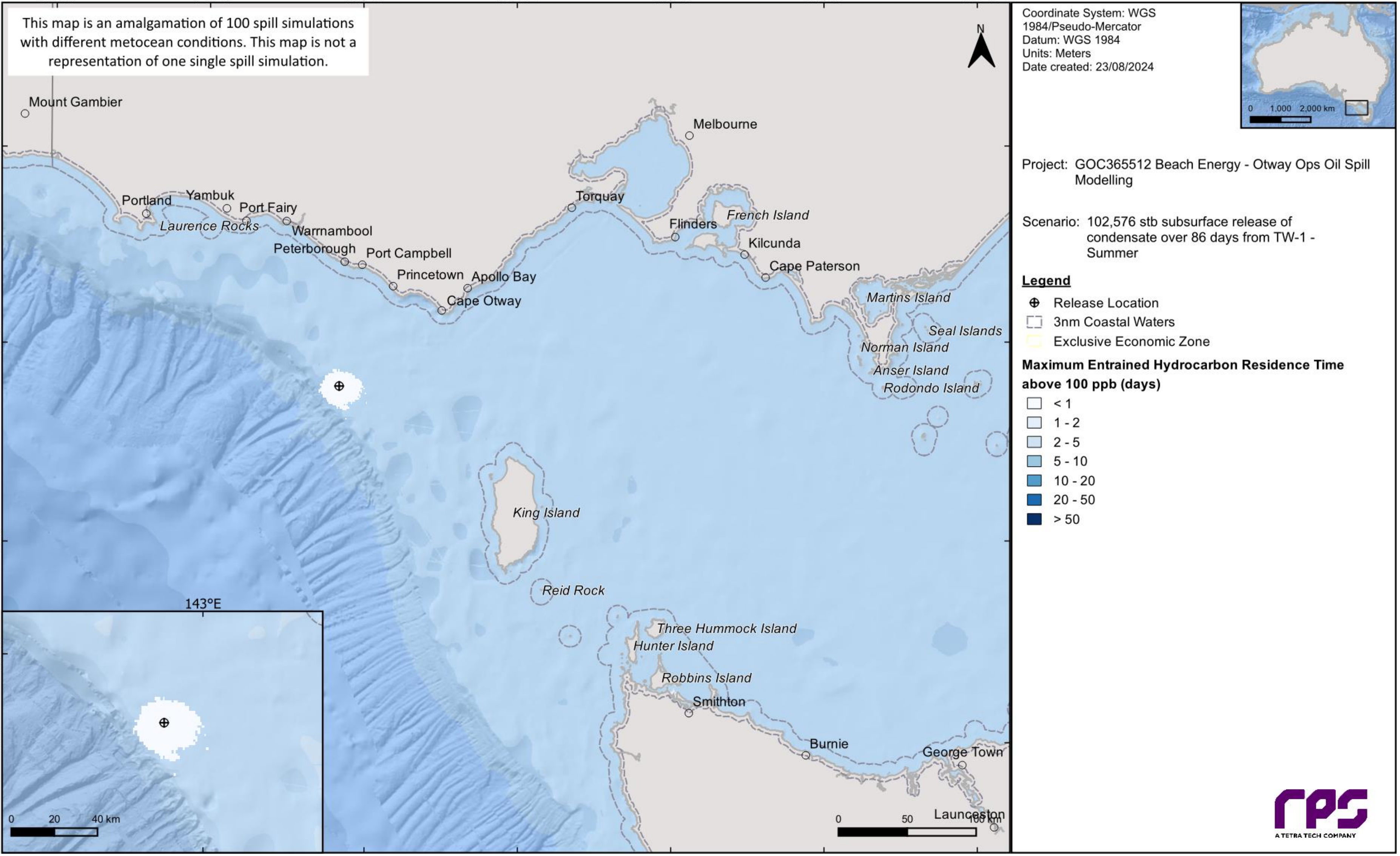
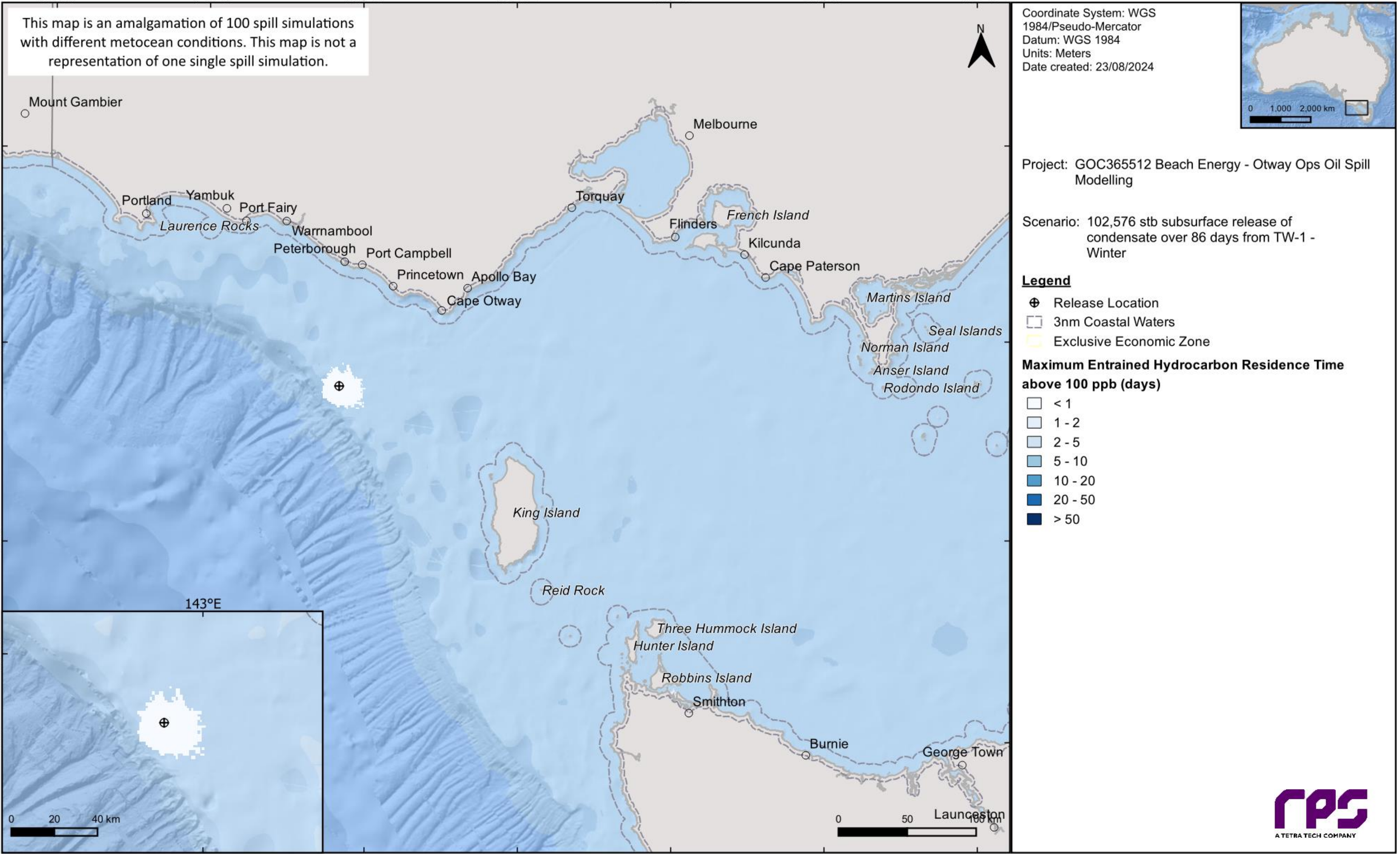


Figure 15-20 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during summer conditions.



This map is an amalgamation of 100 spill simulations with different metocean conditions. This map is not a representation of one single spill simulation.

Figure 15-21 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 102,576 stb subsea release of condensate over 86 days from a loss of well control at TW1. The results were calculated from 100 spill simulations during winter conditions.

16 RESULTS – LOSS OF CONTAINMENT FROM VESSEL COLLISION AT TW1

This scenario examined a 603.7 m^3 surface release of marine diesel for a loss of containment from a vessel collision at TW1. A total of 200 spill simulations were run (i.e., 100 spills per season) and tracked for 30 days. The results for all 100 simulations per season were combined and are presented on a seasonal basis (i.e., summer and winter).

16.1 Stochastic Analysis

16.1.1 Area of Exposure

Figure 16-1 presents the combined area of potential exposure for surface, shoreline, entrained and dissolved, by overlaying the results from all 200 simulations (i.e., 100 per season) during summer and winter conditions.

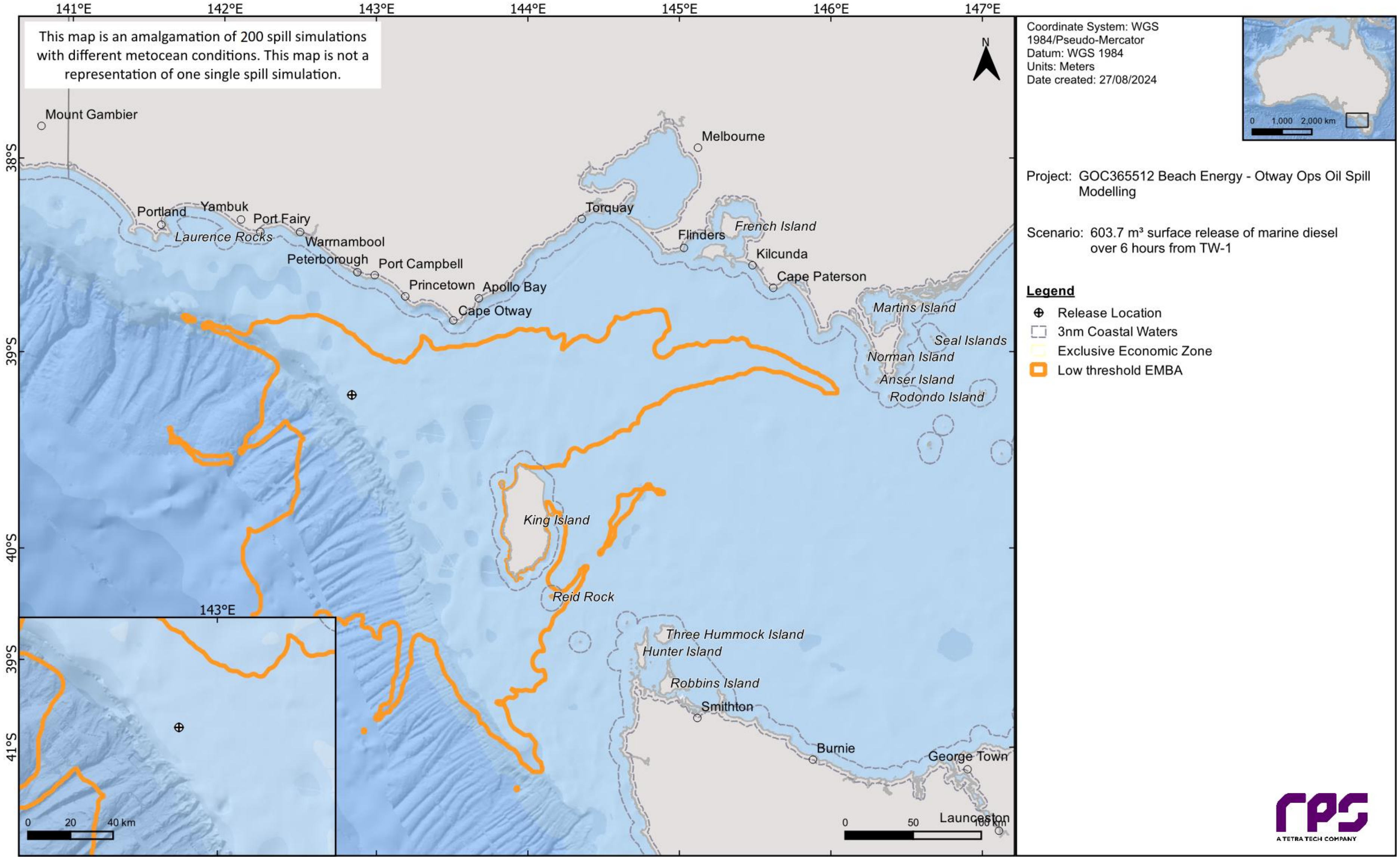


Figure 16-1 Predicted area of exposure for low thresholds produced by overlaying the results from all 200 simulations, resulting from a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1 during summer and winter conditions.

16.1.2 Floating Oil Exposure

Table 16-1 summarises the maximum distance travelled by floating oil on the sea surface at each threshold. The maximum distance from the release location to the low (1–10 g/m^2), moderate (10–50 g/m^2) and high (> 50 g/m^2) exposure zones was 64.97 km (southeast), 49 km (southeast) and 10.08 km (south-southeast) all during winter.

Table 16-2 summarises the potential floating oil exposure to individual receptors during the summer and winter conditions. Outside of the receptors that the Northern Release Location resides within (refer to Table 12-1), the highest probability of floating oil exposure above the low threshold was predicted at the White Shark - Distribution (Between the 120 - 1,000m depth contour) BIA (25% in summer and 14% in winter).

Table 16-3 presents the maximum residence time of floating oil exposure for each individual grid cell within each individual receptor during summer and winter.

Figure 16-2 and Figure 16-3 present the zones of potential floating oil exposure for all thresholds under summer and winter conditions, respectively.

Figure 16-4 to Figure 16-9 present the minimum time before floating oil exposure for the NOPSEMA thresholds during summer and winter, respectively.

Table 16-1 Maximum distance and direction from the release location to the edge of floating oil exposure. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations per season.

Season	Distance and direction travelled	Zones of potential floating oil exposure		
		Low	Moderate	High
Summer	Maximum distance (km) from release location	32.39	28.56	9.47
	Direction	Southeast	Southeast	South-Southwest
Winter	Maximum distance (km) from release location	64.97	49	10.08
	Direction	Southeast	Southeast	South-Southeast

Table 16-2 Summary of the potential floating oil exposure to individual receptors. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations per season.

Receptor		Summer (November through to March)						Winter (April to October)					
		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)			Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	Pygmy Blue Whale - Distribution (None)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	6	3	-	0.34	0.46	-	13	8	-	0.35	0.43	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)**	100	100	69	0.01	0.01	0.02	100	100	56	0.01	0.01	0.02
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	25	14	4	0.09	0.1	0.22	14	7	1	0.22	0.24	0.35
	White Shark - Distribution (Between the 60-120m depth contour)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
IMCRA-MESO	Otway**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
IMCRA-PROV	West Tasmania Transition	1	-	-	0.79	-	-	2	1	-	0.78	0.89	-
	Western Bass Strait Shelf Transition**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02
KEF	West Tasmania Canyons	1	-	-	0.77	-	-	3	1	-	0.82	2.28	-
MR	South-east (Marine)**	100	100	72	0.01	0.01	0.02	100	100	57	0.01	0.01	0.02

*The release location resides within the receptor boundaries.

Table 16-3 Summary of the maximum residence time of floating oil exposure for each individual grid cell within each individual receptor. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations per season.

Receptor		Summer (November through to March)			Winter (April to October)		
		Maximum residence time of floating oil exposure (days)			Maximum residence time of floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	34.25	15.5	6.5	19.5	10.75	6.5
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	34.25	15.5	6.5	19.5	10.75	6.5
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	34.25	15.5	6.5	19.5	10.75	6.5
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	34.25	15.5	6.5	19.5	10.75	6.5
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	34.25	15.5	6.5	19.5	10.75	6.5
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	34.25	15.5	6.5	19.5	10.75	6.5
	Pygmy Blue Whale - Distribution (None)**	34.25	15.5	6.5	19.5	10.75	6.5
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	9.75	7	-	19.5	8.5	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	34.25	15.5	6.5	19.5	10.75	6.5
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)**	34.25	15.5	6.5	19.5	10.5	6.5
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	34.25	15.5	6.5	19.5	10.75	6.5
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	34.25	15.5	6.5	19.5	10.75	6.5
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	34.25	15.5	6.5	19.5	10.75	6.5
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	34.25	15.5	6.5	19.5	10.75	6.5
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	11.5	6.25	1.75	13.25	5.5	1.5
	White Shark - Distribution (Between the 60-120m depth contour)**	34.25	15.5	6.5	19.5	10.75	6.5
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	34.25	15.5	6.5	19.5	10.75	6.5
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	34.25	15.5	6.5	19.5	10.75	6.5
IMCRA-MESO	Otway**	34.25	15.5	6.5	19.5	10.75	6.5
IMCRA-PROV	West Tasmania Transition	0.75	-	-	5.5	0.25	-
	Western Bass Strait Shelf Transition**	34.25	15.5	6.5	19.5	10.75	6.5
KEF	West Tasmania Canyons	1.25	-	-	5.25	2.5	-
MR	South-east (Marine)**	34.25	15.5	6.5	19.5	10.75	6.5

*The release location resides within the receptor boundaries.

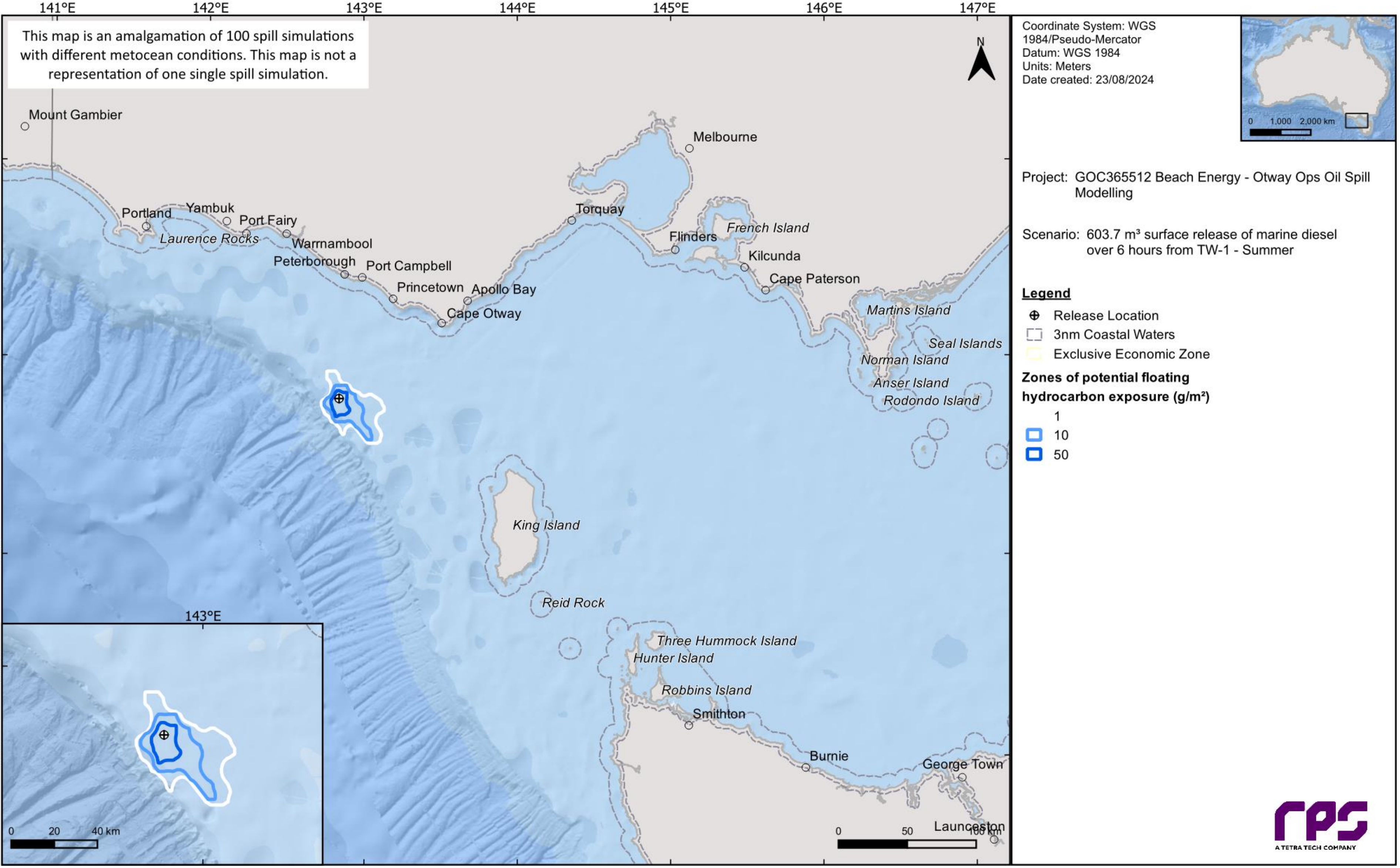


Figure 16-2 Zones of potential floating oil exposure in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during summer conditions.

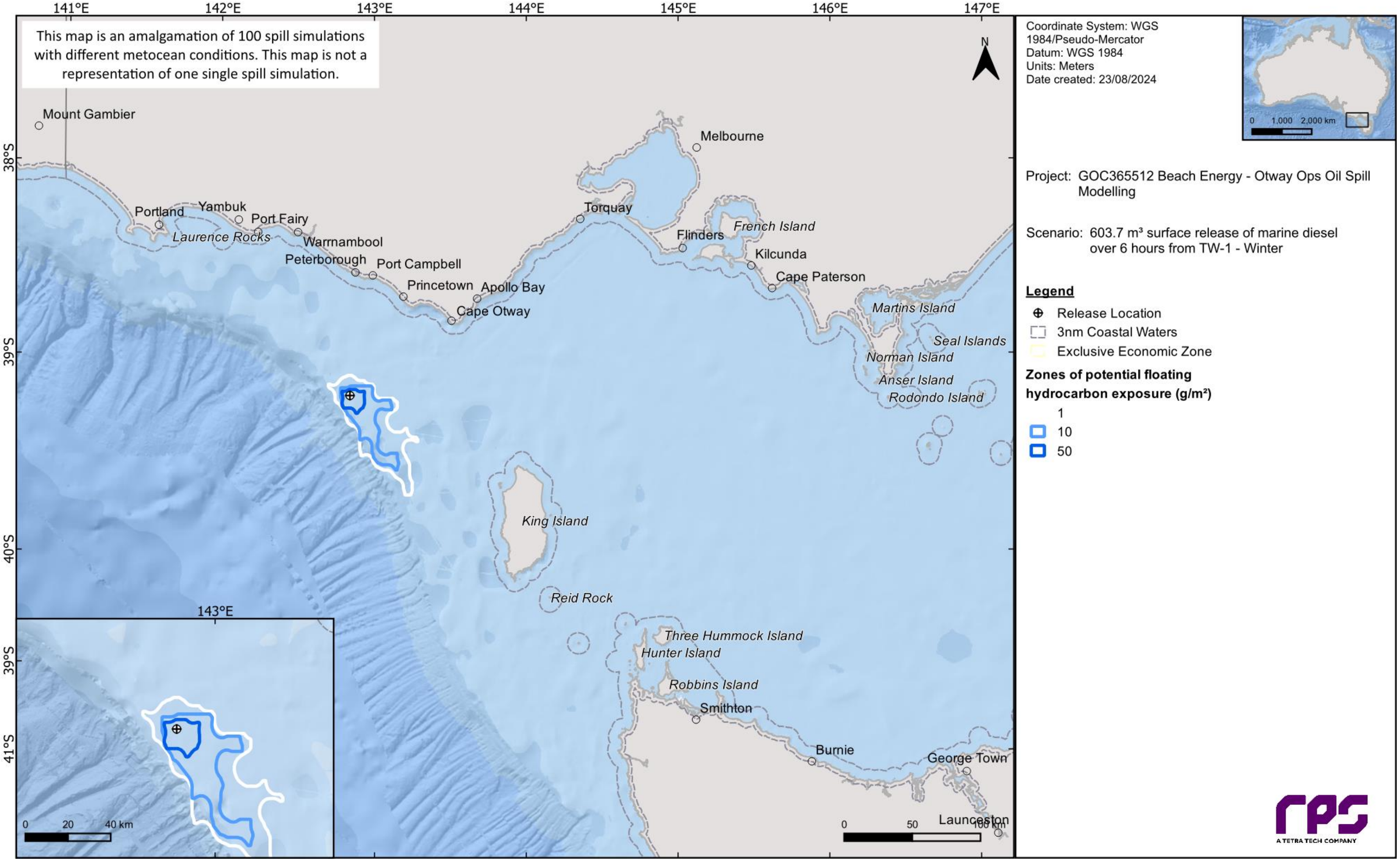


Figure 16-3 Zones of potential floating oil exposure in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during winter conditions.

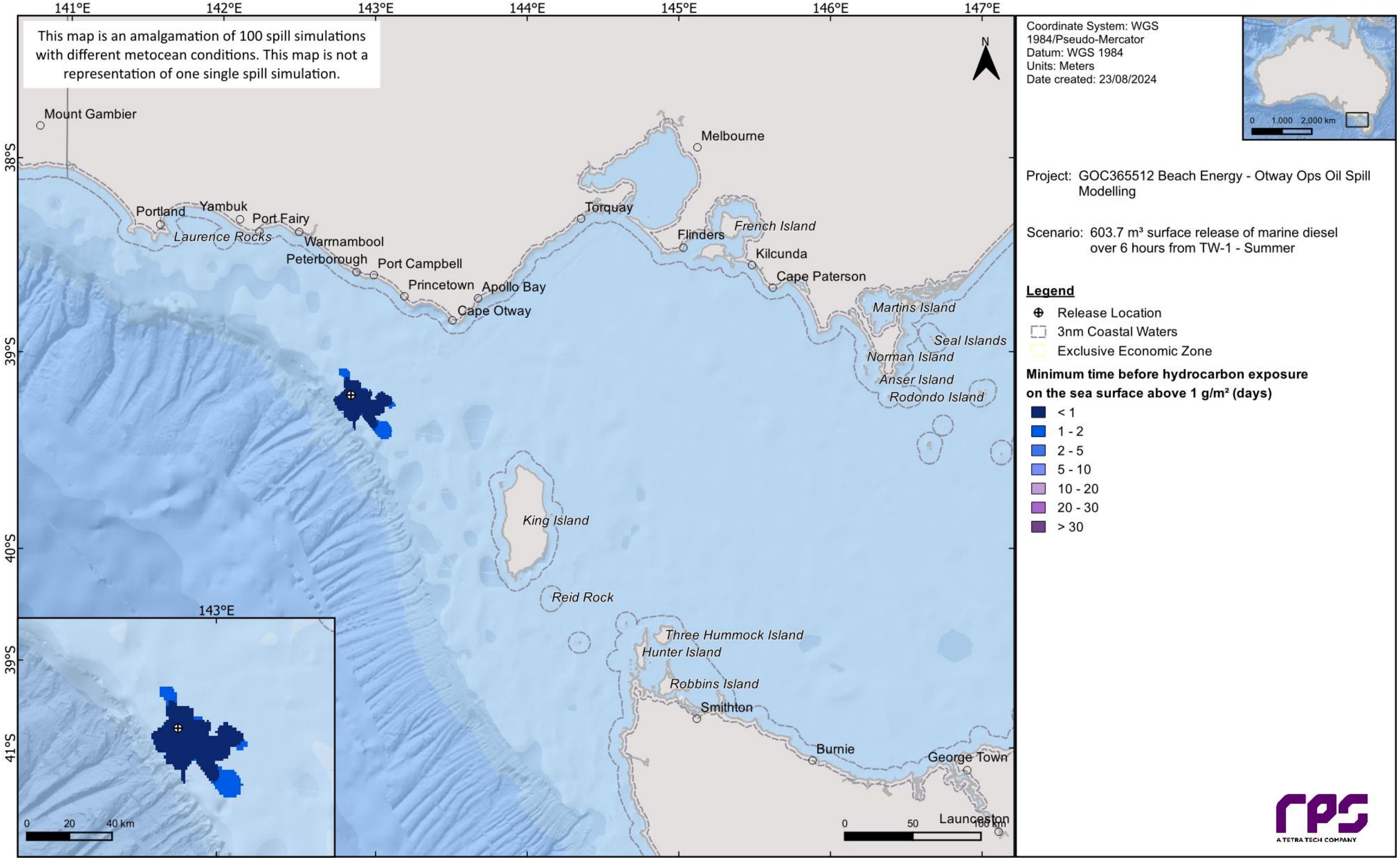


Figure 16-4 Minimum time before floating oil exposure above 1 g/m^2, in the event of 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during summer conditions.

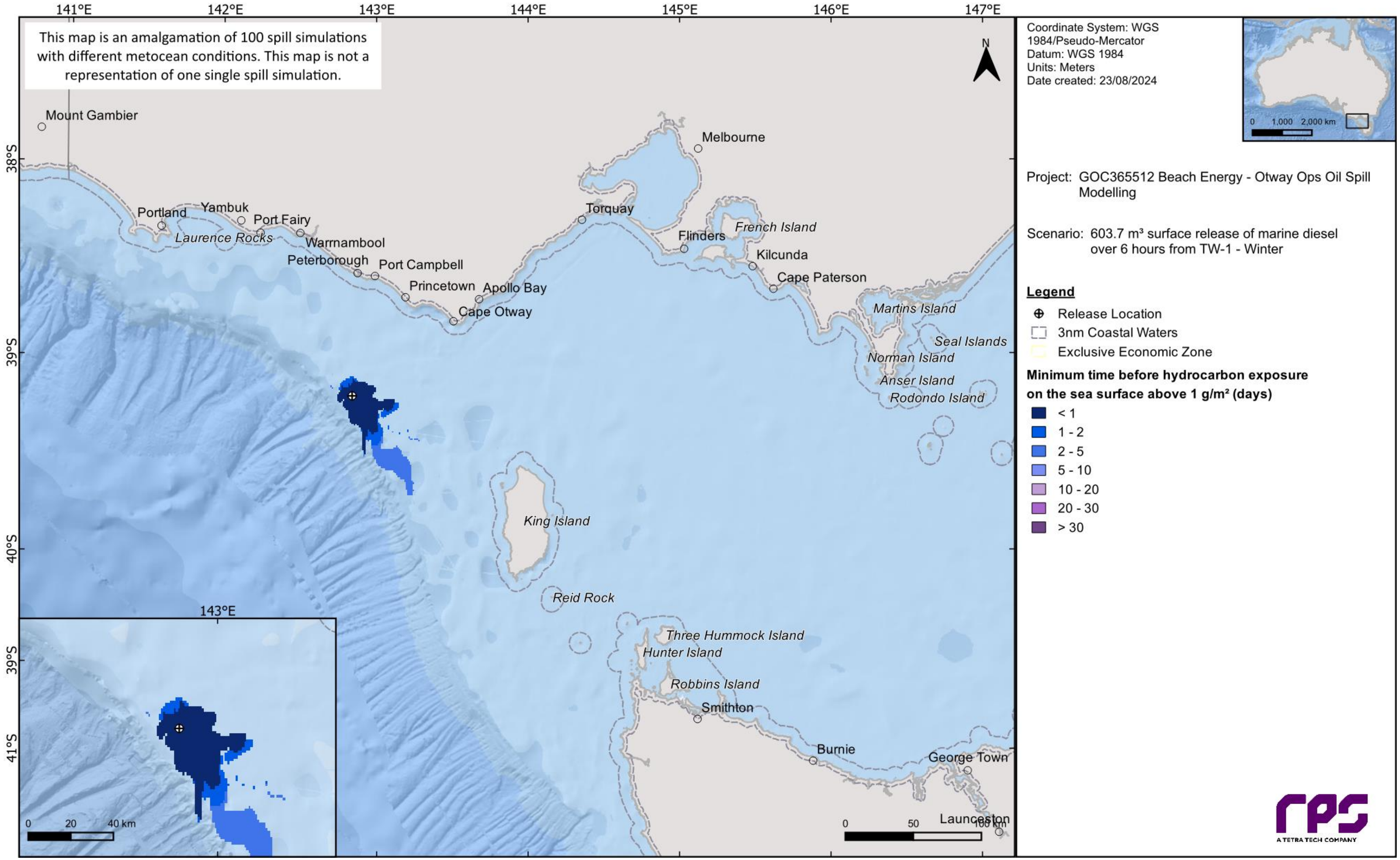


Figure 16-5 Minimum time before floating oil exposure above 1 g/m^2, in the event of 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during winter conditions.

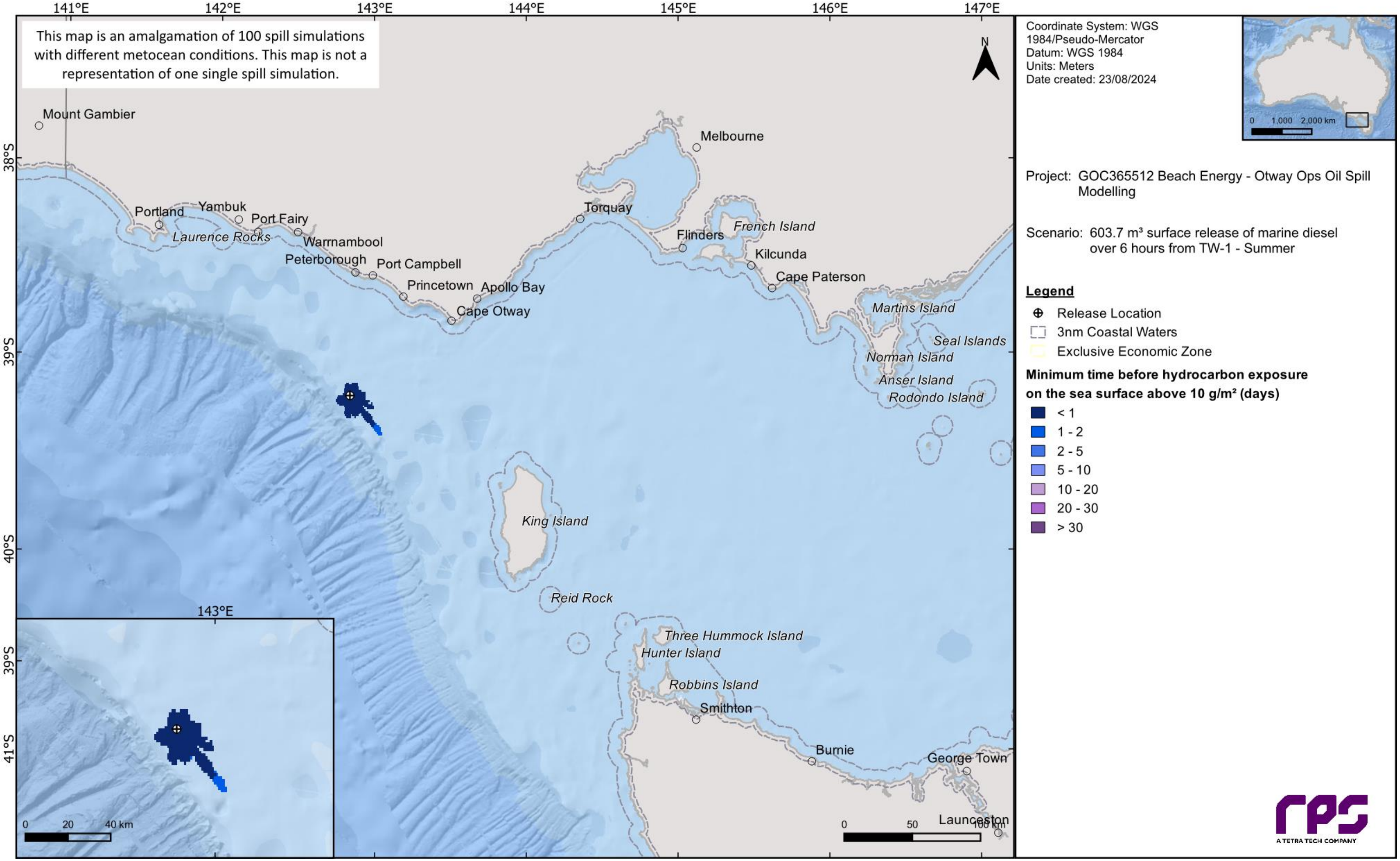


Figure 16-6 Minimum time before floating oil exposure above 10 g/m^2, in the event of 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during summer conditions.

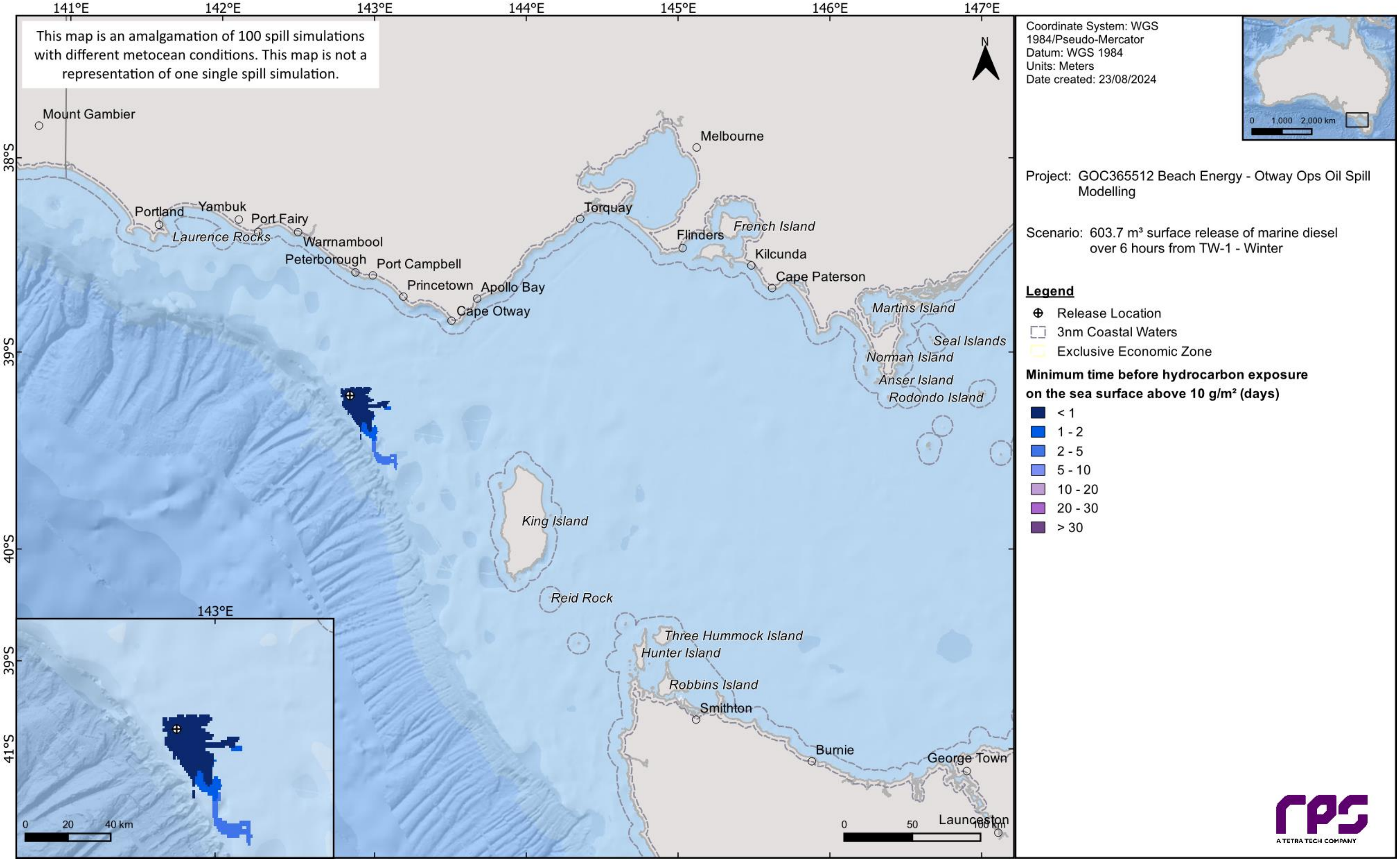


Figure 16-7 Minimum time before floating oil exposure above 10 g/m^2, in the event of 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during winter conditions.

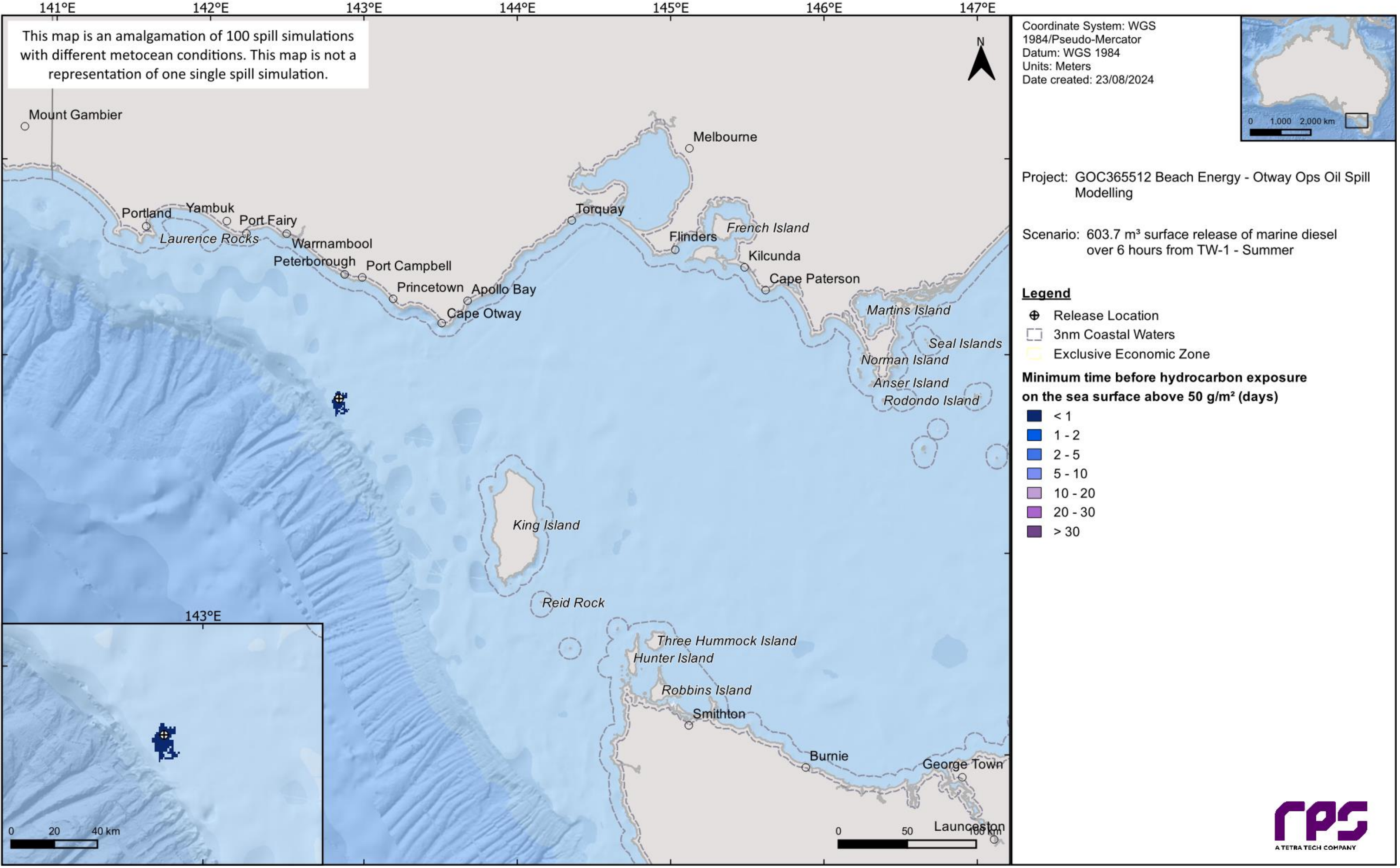


Figure 16-8 Minimum time before floating oil exposure above 50 g/m^2, in the event of 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during summer conditions.

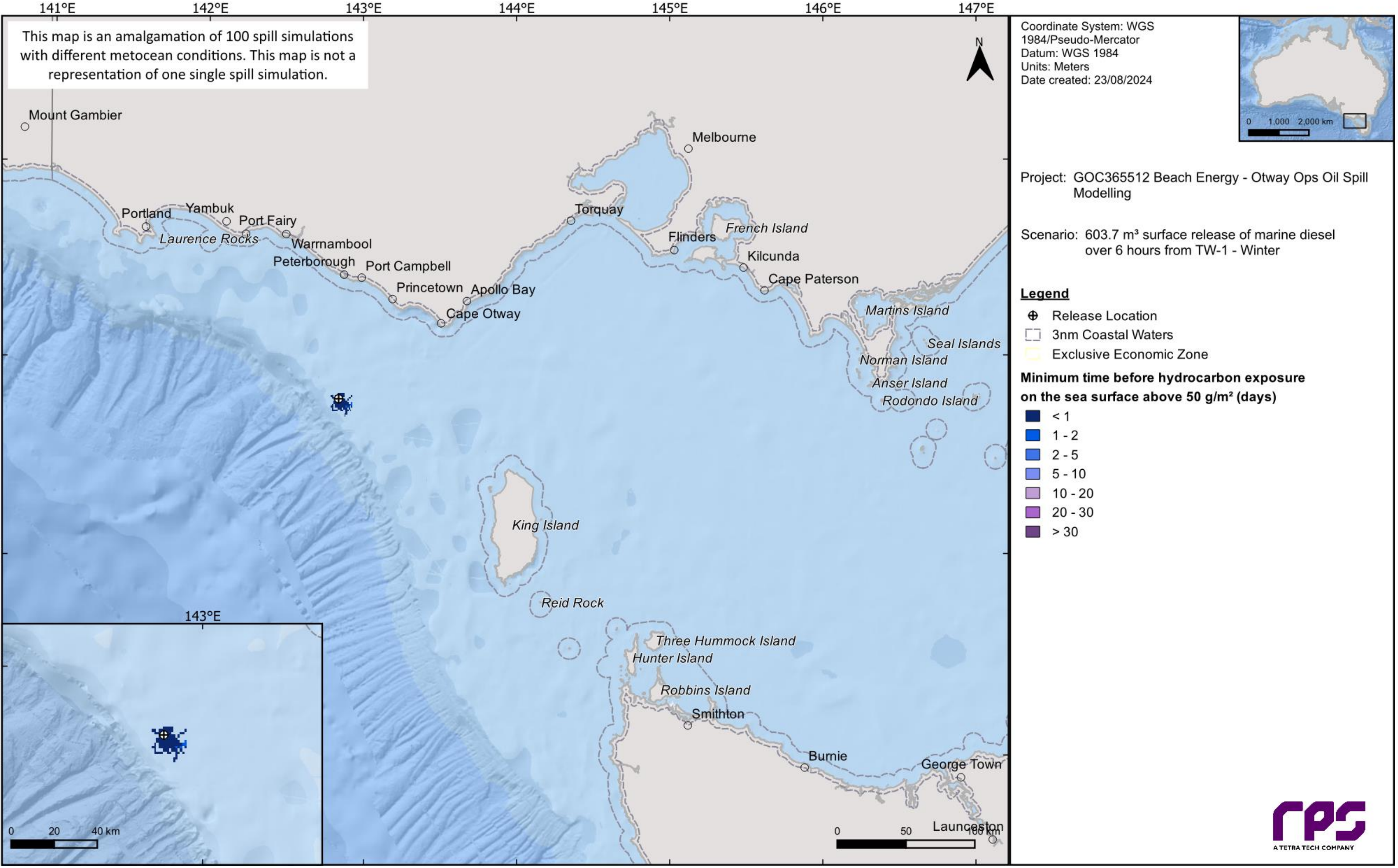


Figure 16-9 Minimum time before floating oil exposure above 50 g/m^2, in the event of 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during winter conditions.

16.1.3 Shoreline Accumulation

Table 16-4 presents a summary of the predicted potential shoreline accumulation during the summer and winter conditions. No shoreline contact was forecast during summer conditions. The probability of accumulation to any shoreline at, or above, the low level (10 g/m^2) threshold was 9% during winter conditions. The minimum time before oil accumulation at, or above, the low threshold was 15.02 days. The maximum volume ashore for a single spill trajectory was 9.67 m^3, whilst the maximum length of shoreline accumulation at the low threshold was 17.67 km. No shoreline accumulation was predicted for the moderate (100 g/m^2) or high (1,000 g/m^2) thresholds.

Table 16-5 summarises the shoreline accumulation on individual receptors during winter conditions. The only receptor recording a probability of shoreline accumulation at the low threshold was King Island Council (TAS) with 9% and the maximum shoreline accumulation was 1.38 m^3. The minimum time before shoreline accumulation above the low threshold was 15.02 days.

The winter conditions maximum potential shoreline loading is presented in Figure 16-10.

Table 16-4 Summary of oil accumulation across all shorelines. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations per season.

Shoreline Statistics	Summer	Winter
Probability of accumulation on any shoreline (%)	-	9
Absolute minimum time for visible oil to shore (days)	-	15.02
Maximum total volume of hydrocarbons ashore (m^3)	-	9.67
Average volume of hydrocarbons ashore (m^3)	-	0.45
Maximum length of the shoreline at **10 g/m^2** (km)	-	17.67
Average shoreline length (km) at **10 g/m^2** (km)	-	0.56
Maximum length of the shoreline at **100 g/m^2** (km)	-	-
Average shoreline length (km) at **100 g/m^2** (km)	-	-
Maximum length of the shoreline at **1,000 g/m^2** (km)	-	-
Average shoreline length (km) at **1,000 g/m^2** (km)	-	-

Table 16-5 Summary of oil accumulation on individual shoreline receptors. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations per season.

Shoreline Receptor		Summer																Winter															
		Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline accumulation (km)			Maximum length of shoreline accumulation (km)			Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline accumulation (km)			Maximum length of shoreline accumulation (km)		
		Low	Mod	High	Low	Mod	High	Mean	Peak	Mean	Peak	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High	Mean	Peak	Mean	Peak	Low	Mod	High	Low	Mod	High
SHORE-LGA	King Island Council (TAS)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	15.02	-	-	4.29	91.71	0.06	1.38	0.56	-	-	17.67	-	-

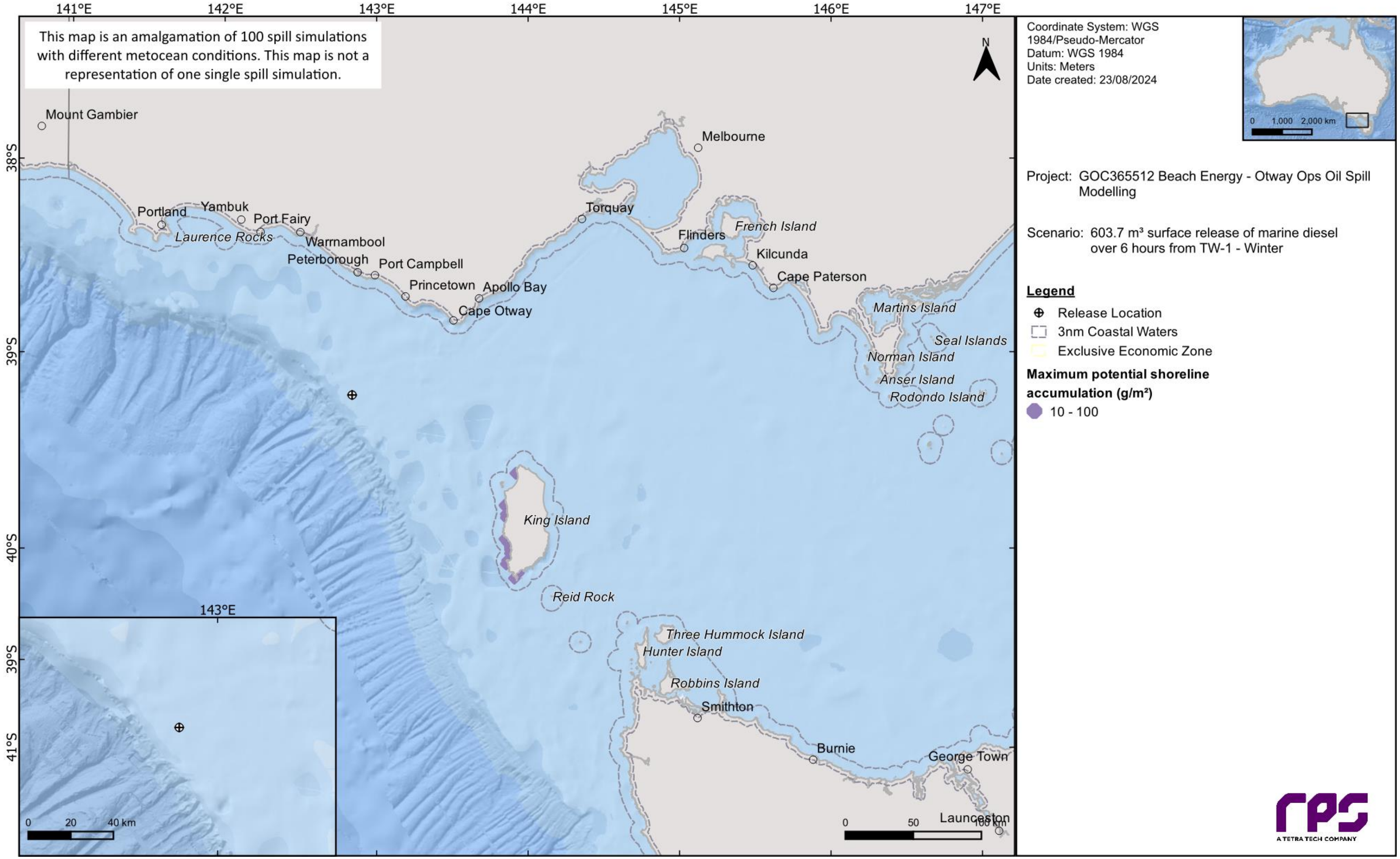


Figure 16-10 Maximum potential shoreline loading in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during winter conditions.

16.1.4 In-water exposure

16.1.4.1 Dissolved Hydrocarbons

Table 16-6 summarises the probability of exposure to individual receptors from dissolved hydrocarbons in the 0-10 m layer during the summer and winter conditions. No dissolved hydrocarbon exposure at the high (400 ppb) threshold was predicted,

Outside of the receptors that the Northern Release Location resides within (refer to Table 12-1), the highest concentration of dissolved hydrocarbon was predicted for the White Shark - Distribution (Between the 120 - 1,000m depth contour) BIA, being 23.94 ppb in summer and 23.23 ppb in winter. The highest probability of low dissolved hydrocarbon exposure was recorded for Pygmy Blue Whale - Foraging BIA (summer – 3%, winter – 14%).

Table 16-7 presents the predicted minimum time to dissolved hydrocarbon exposure and maximum residence time for dissolved hydrocarbon exposure to individual receptors, in the 0-10 m depth layer, for all seasonal conditions and all thresholds assessed. The maximum residence time of dissolved hydrocarbon exposure at the low threshold was 11 hours during winter.

Figure 16-11 and Figure 16-12 present the zones of potential dissolved hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 16-13 to Figure 16-16 present the maximum residence time of dissolved hydrocarbon exposure for the NOPSEMA thresholds in summer and winter.

Table 16-6 **Probability of dissolved hydrocarbons exposure to marine based receptors in the 0–10 m dept. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations per season.**

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure			Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	67.28	78	11	-	73.23	72	10	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	67.28	78	11	-	73.23	72	10	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	67.28	78	11	-	73.23	72	10	-
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	67.28	78	11	-	73.23	72	10	-
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	67.28	78	11	-	73.23	72	10	-
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	67.28	78	11	-	73.23	72	10	-
	Pygmy Blue Whale - Distribution (None)**	67.28	78	11	-	73.23	72	10	-
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	19.34	3	-	-	20.13	14	-	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	67.28	78	11	-	73.23	72	10	-
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)**	67.28	78	7	-	73.23	69	8	-
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	67.28	78	11	-	73.23	72	10	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	67.28	78	11	-	73.23	72	10	-
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	67.28	78	11	-	73.23	72	10	-
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	67.28	78	11	-	73.23	72	10	-
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	23.94	3	-	-	23.23	3	-	-

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure			Maximum dissolved hydrocarbon exposure	Probability of dissolved hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
	White Shark - Distribution (Between the 60-120m depth contour)**	67.28	78	11	-	73.23	72	10	-
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	67.28	78	11	-	73.23	72	10	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	67.28	78	11	-	73.23	72	10	-
IMCRA-MESO	Otway**	67.28	78	11	-	73.23	72	10	-
IMCRA-PROV	Western Bass Strait Shelf Transition**	67.28	78	11	-	73.23	72	10	-
MR	South-east (Marine)**	67.28	78	11	-	73.23	72	10	-

*The release location resides within the receptor boundaries.

Table 16-7 Predicted minimum time to dissolved hydrocarbon exposure and maximum residence time for dissolved hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill trajectories per season.

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)			Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	Pygmy Blue Whale - Distribution (None)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	0.51	-	-	1.25	-	-	0.25	-	-	2.5	-	-
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)**	0.04	0.21	-	8	0.25	-	0.03	0.14	-	7.75	1	-
	Shy Albatross - Foraging likely (The whole South-east Marine Region)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	Wandering Albatross - Foraging (The whole South-east Marine Region)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)			Minimum time before dissolved hydrocarbon exposure (days)			Maximum residence time for dissolved hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	0.32	-	-	6.75	-	-	0.25	-	-	3	-	-
	White Shark - Distribution (Between the 60-120m depth contour)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
IMCRA-MESO	Otway**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
IMCRA-PROV	Western Bass Strait Shelf Transition**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-
MR	South-east (Marine)**	0.03	0.18	-	9	0.75	-	0.03	0.14	-	11	1	-

*The release location resides within the receptor boundaries.

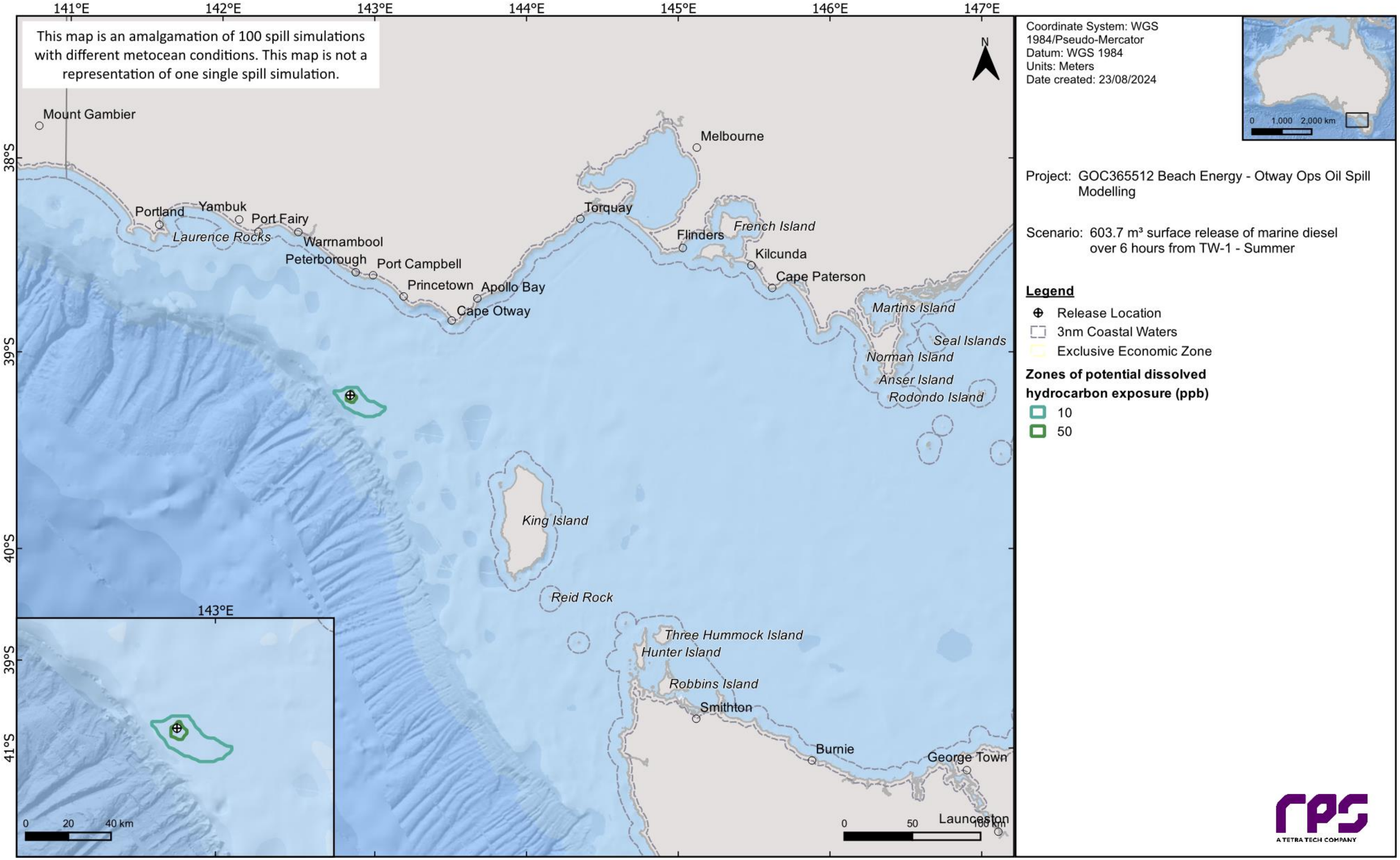


Figure 16-11 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during summer conditions.

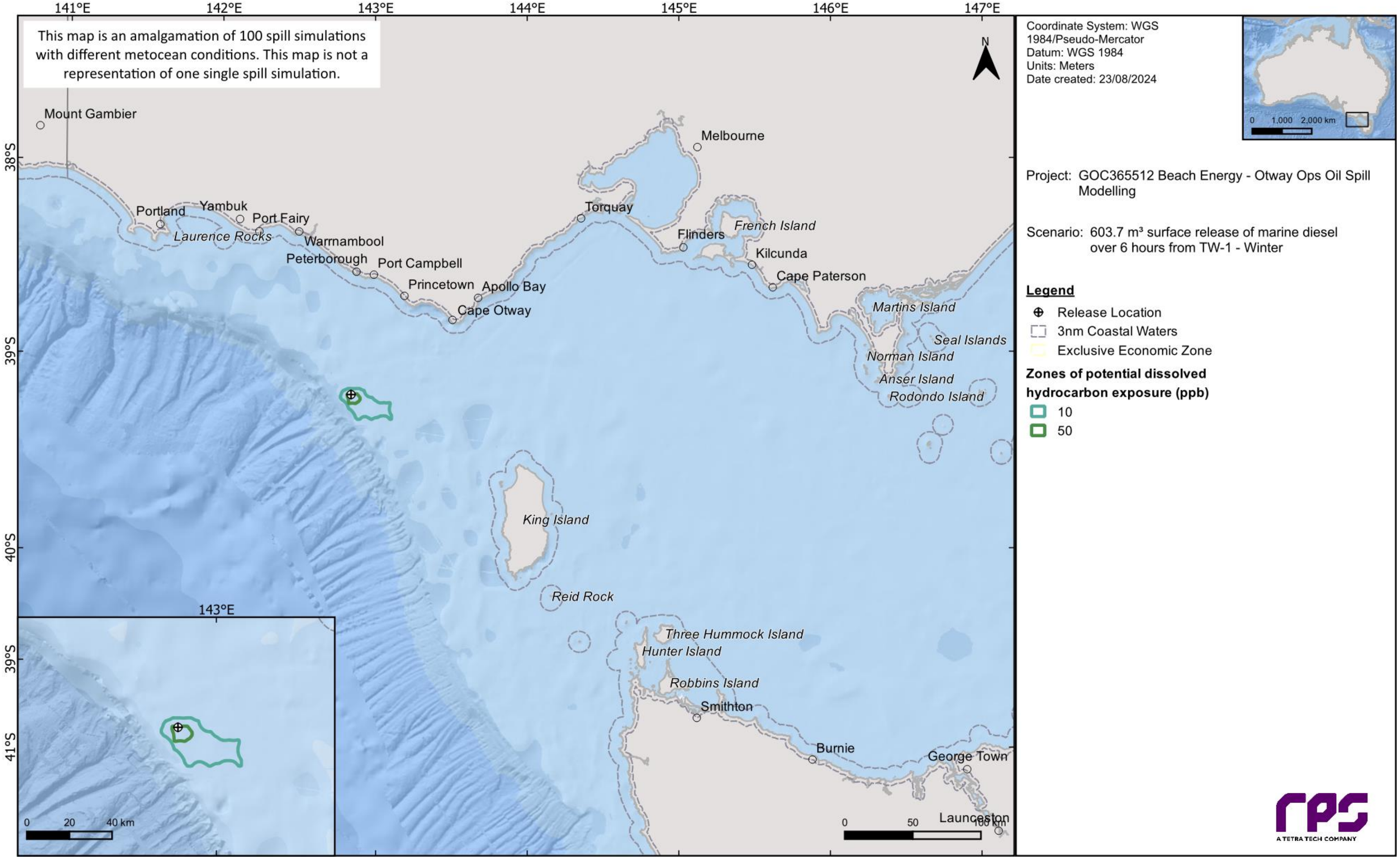


Figure 16-12 Zones of potential dissolved hydrocarbon exposure at 0-10 m below the sea in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during winter conditions.

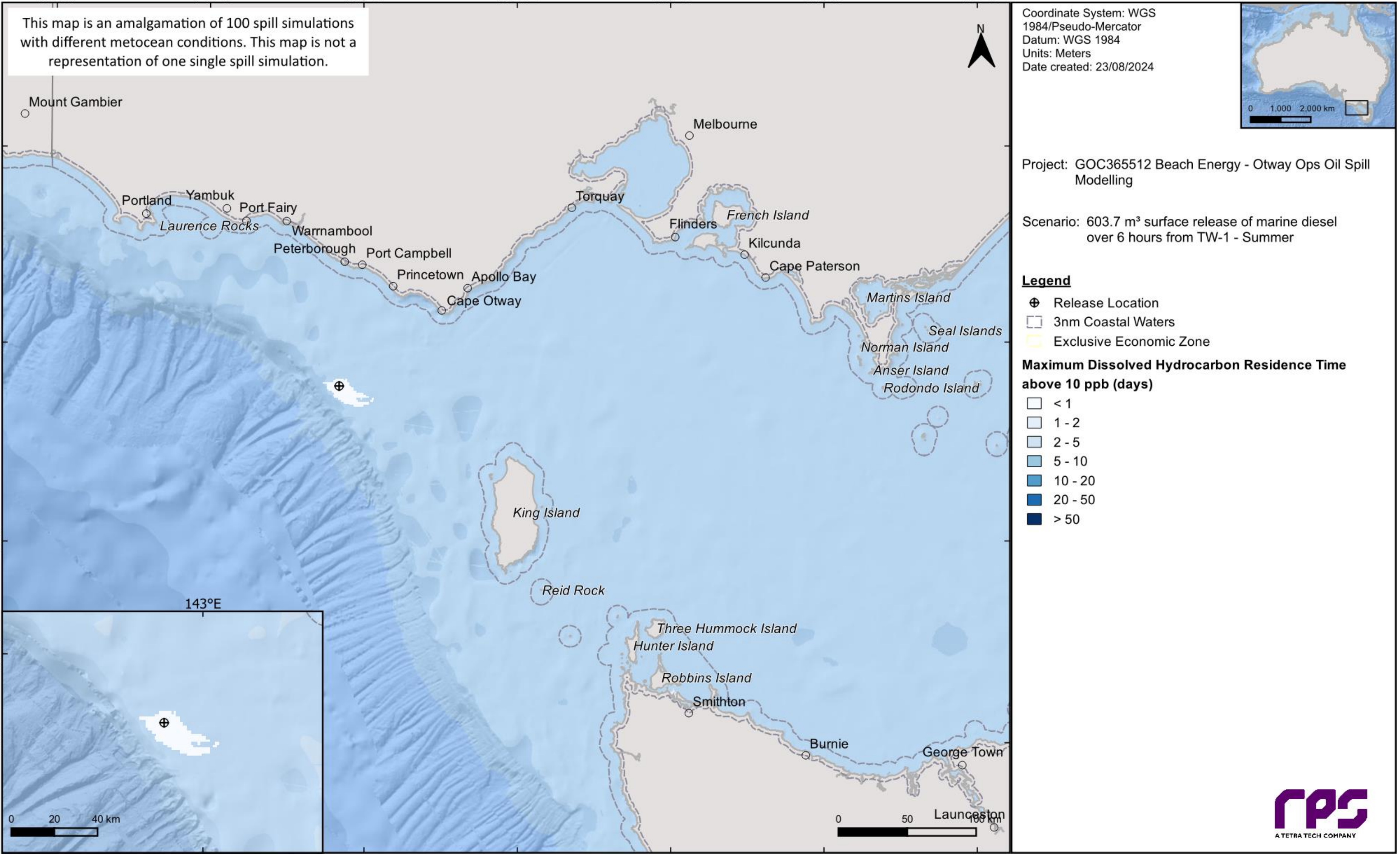


Figure 16-13 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during summer conditions.

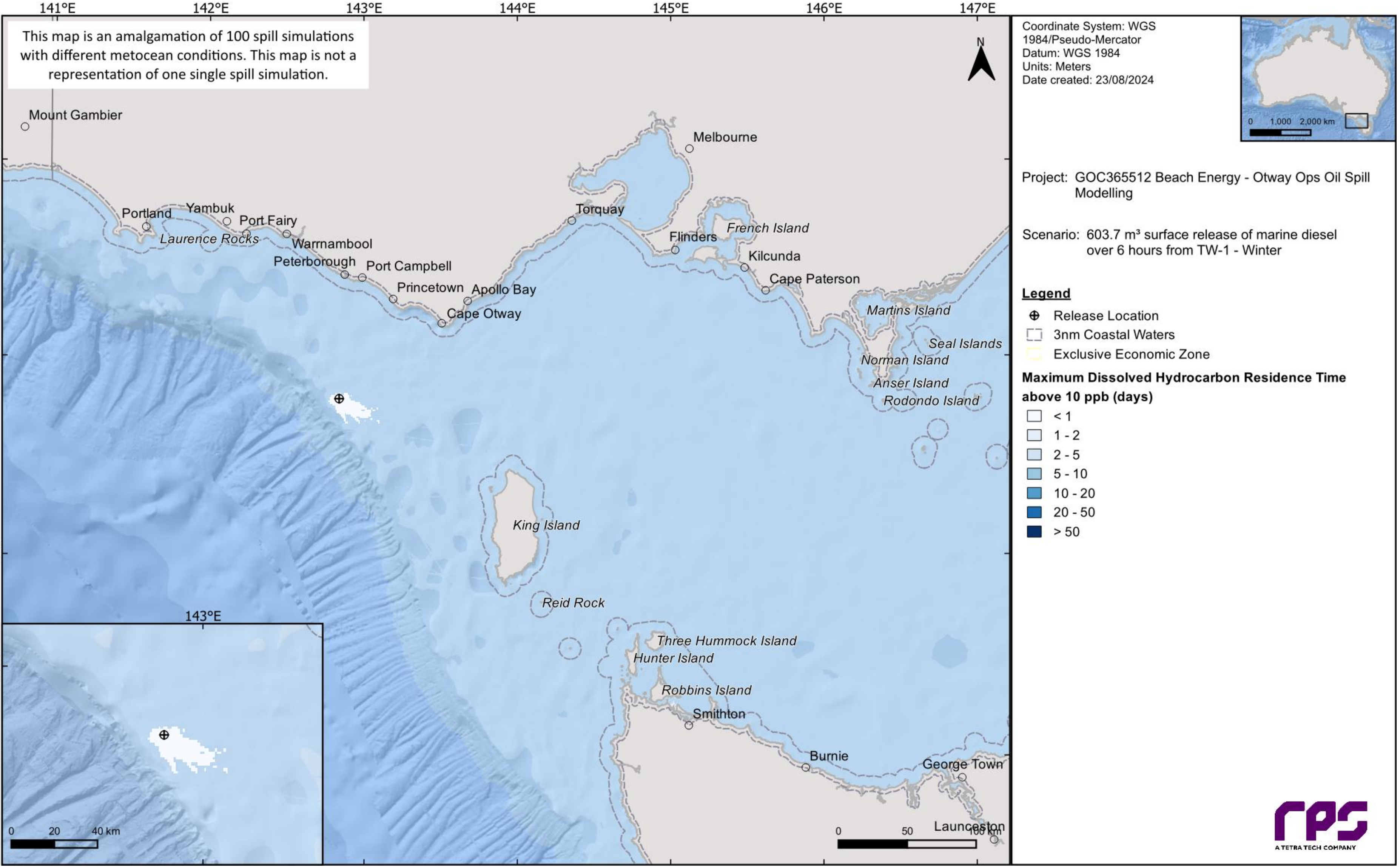


Figure 16-14 Maximum residence time for dissolved hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during winter conditions.

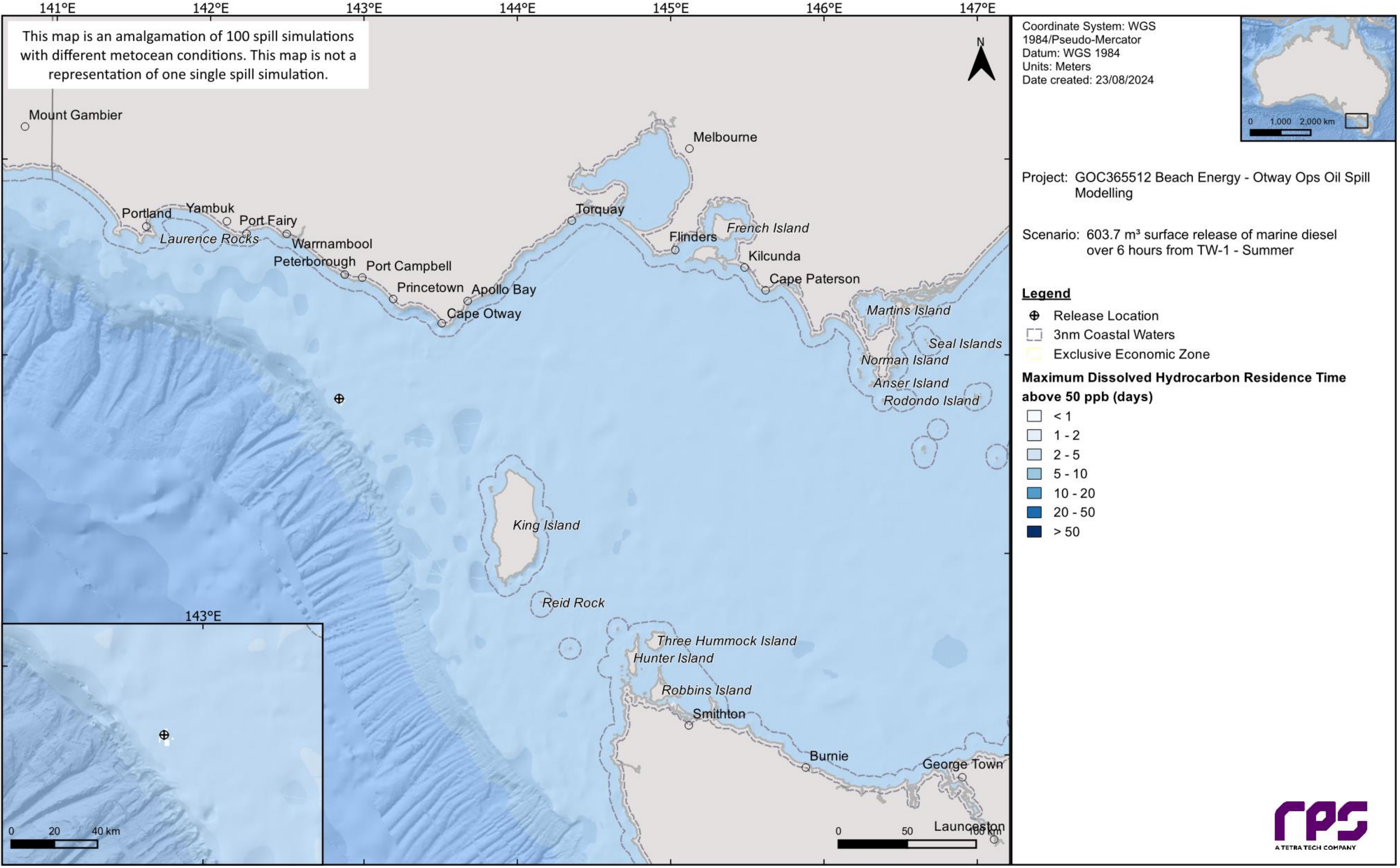


Figure 16-15 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during summer conditions.

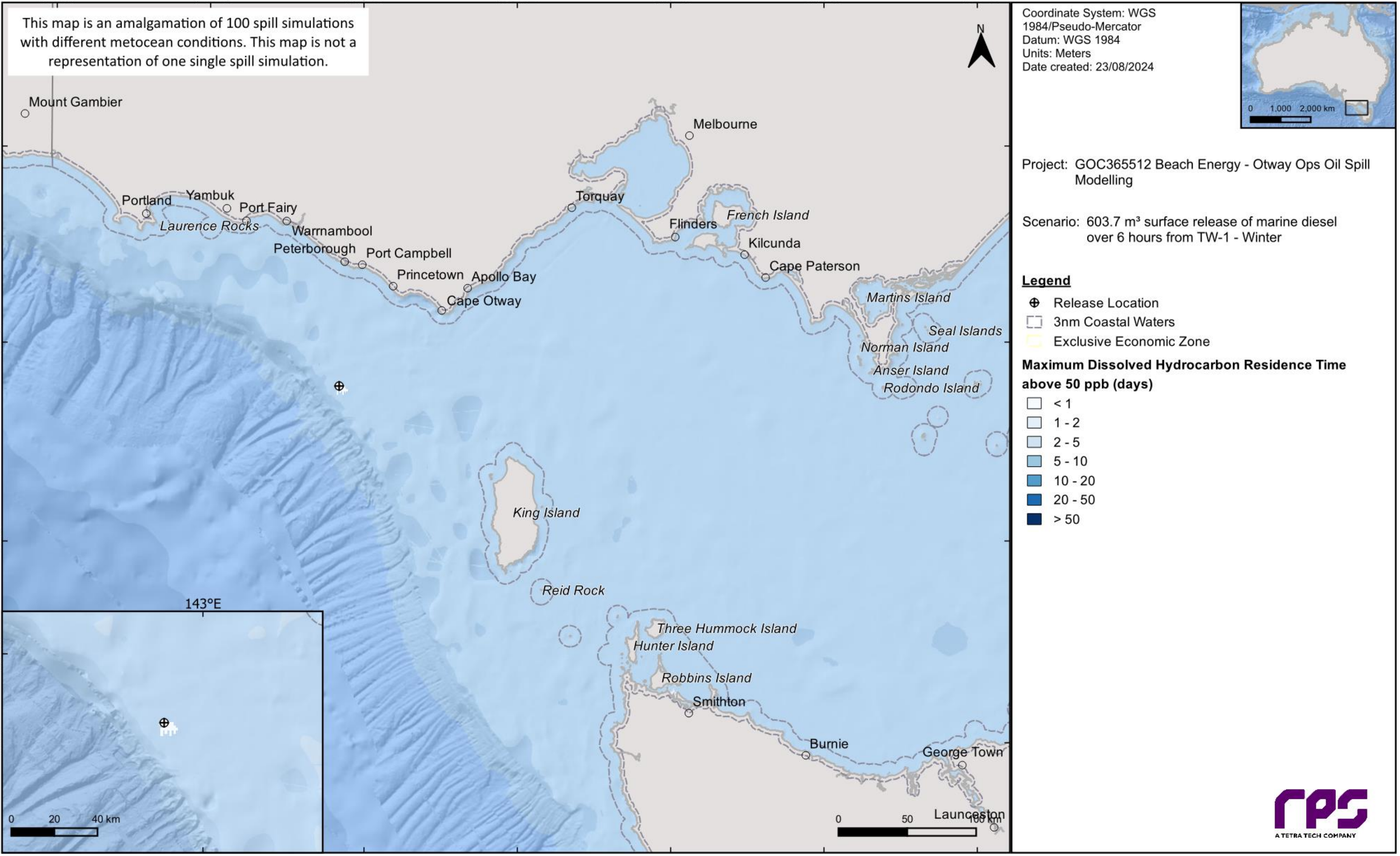


Figure 16-16 Maximum residence time for dissolved hydrocarbon exposure above 50 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during winter conditions.

16.1.4.2 Entrained Hydrocarbons

Table 16-8 presents the probability of exposure to individual receptors from entrained hydrocarbons in the 0-10 m depth layer for the summer and winter conditions.

Outside of the receptors that the Northern Release Location resides within (refer to Table 12-1), the highest concentration of entrained hydrocarbon was predicted for Short-tailed Shearwater - Foraging BIA (summer – 6,692.22 ppb, winter – 6,075.03 ppb).

Table 16-9 presents the predicted minimum time to entrained hydrocarbon exposure and maximum residence time for entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer, for all seasonal conditions and all thresholds assessed.

Figure 16-17 and Figure 16-18 present the zones of potential entrained hydrocarbon exposure for the 0-10 m depth layer, for each threshold assessed under summer and winter conditions, respectively.

Figure 16-19 to Figure 16-24 present the maximum residence time of entrained hydrocarbon exposure for the NOPSEMA thresholds in summer and winter.

Table 16-8 **Probability of entrained hydrocarbons exposure to marine based receptors in the 0–10 m depth layer. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations per season.**

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	99.54	19	-	-	143.28	49	3	-
	Zeehan	44.47	49	-	-	123.66	39	1	-
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	7,505.14	100	100	93	7,419.26	100	100	93
	Australasian Gannet - Foraging (Buffer around Black Pyramid)	-	-	-	-	40.9	3	-	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	7,505.14	100	100	93	7,419.26	100	100	93
	Black-faced Cormorant - Breeding (Christmas Island)	21.63	1	-	-	22.68	4	-	-
	Black-faced Cormorant - Foraging (Buffer around Christmas Island Tasmania)	21.63	1	-	-	68.58	23	-	-
	Black-faced Cormorant - Foraging (Buffer around Councillor Island)	-	-	-	-	25.05	3	-	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	7,505.14	100	100	93	7,419.26	100	100	93
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	7,505.14	100	100	93	7,419.26	100	100	93
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	7,505.14	100	100	93	7,419.26	100	100	93
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	7,505.14	100	100	93	7,419.26	100	100	93
	Little Penguin - Breeding (Christmas Island)	21.63	1	-	-	22.68	4	-	-
	Little Penguin - Foraging (Buffer around Christmas Island Tasmania)	21.63	1	-	-	53.12	19	-	-
	Little Penguin - Foraging (Buffer around Councillor Island)	-	-	-	-	25.05	3	-	-

Receptor	Summer (November through to March)				Winter (April to October)			
	Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
		Low	Moderate	High		Low	Moderate	High
Pygmy Blue Whale - Distribution (None)**	7,505.14	100	100	93	7,419.26	100	100	93
Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	872.28	94	71	-	1,613.53	98	87	4
Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	7,505.14	100	100	93	7,419.26	100	100	93
Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)	44.47	49	-	-	224.64	81	5	-
Short-tailed Shearwater - Breeding (Cape Wickham)	-	-	-	-	12.38	2	-	-
Short-tailed Shearwater - Breeding (Christmas Island)	21.63	1	-	-	22.68	4	-	-
Short-tailed Shearwater - Breeding (New Year Island)	-	-	-	-	17.79	4	-	-
Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)**	6,692.22	100	100	91	6,075.03	100	100	90
Shy Albatross - Foraging likely (The whole South-east Marine Region)**	7,505.14	100	100	93	7,419.26	100	100	93
Southern Right Whale - Connecting habitat (King Island area)	39.42	4	-	-	224.64	21	3	-
Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	7,505.14	100	100	93	7,419.26	100	100	93
Wandering Albatross - Foraging (The whole South-east Marine Region)**	7,505.14	100	100	93	7,419.26	100	100	93
Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	7,505.14	100	100	93	7,419.26	100	100	93

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
	White Shark - Distribution (Between the 120 - 1,000m depth contour)	2,776.45	87	67	11	1,760.94	68	54	6
	White Shark - Distribution (Between the 60-120m depth contour)**	7,505.14	100	100	91	7,419.26	100	100	93
	White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	7,505.14	100	100	93	7,419.26	100	100	93
	White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region)	15.22	3	-	-	87.28	14	-	-
	White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	7,505.14	100	100	93	7,419.26	100	100	93
	White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)	34.47	4	-	-	79.81	24	-	-
	White-faced Storm-petrel - Foraging (Buffer around the northern side of Tasmania into Bass Strait)	39.42	17	-	-	224.64	34	3	-
CA	Red Hut Point	-	-	-	-	22.58	2	-	-
GR	New Year Island	-	-	-	-	17.79	4	-	-
IBRA	King	21.63	1	-	-	22.68	9	-	-
IMCRA-MESO	Central Bass Strait	38.74	7	-	-	110.79	53	1	-
	Central Victoria	12	1	-	-	24.83	3	-	-
	Franklin	-	-	-	-	12.3	2	-	-
	Otway**	7,505.14	100	100	93	7,419.26	100	100	93
IMCRA-PROV	Bass Strait Shelf Province	38.74	7	-	-	110.79	53	1	-
	Tasmanian Shelf Province	-	-	-	-	12.3	2	-	-
	West Tasmania Transition	496.96	59	20	-	372.52	30	7	-
	Western Bass Strait Shelf Transition**	7,505.14	100	100	93	7,419.26	100	100	93
KEF	West Tasmania Canyons	458.66	57	14	-	393.31	30	6	-
MR	South-east (Marine)**	7,505.14	100	100	93	7,419.26	100	100	93

Receptor		Summer (November through to March)				Winter (April to October)			
		Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure			Maximum entrained hydrocarbon exposure	Probability of entrained hydrocarbon exposure		
			Low	Moderate	High		Low	Moderate	High
NR	Christmas Island	21.63	1	-	-	22.68	4	-	-
NRMR	North NRM Region (TAS)	-	-	-	-	54.95	5	-	-
	North West NRM Region (TAS)	39.42	6	-	-	224.64	28	3	-
SHORE-LGA	King Island Council (TAS)	39.42	3	-	-	224.64	18	3	-
SR	Cape Wickham	-	-	-	-	12.38	2	-	-
State Waters	Tasmania	39.42	6	-	-	224.64	33	3	-

*The release location resides within the receptor boundaries.

Table 16-9 **Predicted minimum time to entrained hydrocarbon exposure and maximum residence time for entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill trajectories per season.**

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)			Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
AMP	Apollo	2.5	-	-	95.5	-	-	1.89	2.18	-	140.75	9	-
	Zeehan	3.8	-	-	119.25	-	-	2.21	3.96	-	146.25	7.25	-
BIA	Antipodean Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	65.75	13.75
	Australasian Gannet - Foraging (Buffer around Black Pyramid)	-	-	-	-	-	-	14.97	-	-	42.5	-	-
	Black-browed Albatross - Foraging (The whole South-east Marine Region)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
	Black-faced Cormorant - Breeding (Christmas Island)	22.03	-	-	59.5	-	-	18	-	-	62.25	-	-
	Black-faced Cormorant - Foraging (Buffer around Christmas Island Tasmania)	10.72	-	-	67.25	-	-	4.72	-	-	455.75	-	-
	Black-faced Cormorant - Foraging (Buffer around Councillor Island)	-	-	-	-	-	-	13.8	-	-	66.25	-	-
	Bullers Albatross - Foraging (Most of the South-east Marine Region)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
	Campbell Albatross - Foraging (The whole South-east Marine Region including Macquaire Island)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
	Common Diving-petrel - Foraging (Buffer around Tasmania and Victoria)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
	Indian Yellow-nosed Albatross - Foraging (Most of the South-east Marine Region)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
	Little Penguin - Breeding (Christmas Island)	22.03	-	-	59.5	-	-	18	-	-	62.25	-	-
	Little Penguin - Foraging (Buffer around Christmas Island Tasmania)	11.96	-	-	67.25	-	-	4.97	-	-	455.75	-	-
	Little Penguin - Foraging (Buffer around Councillor Island)	-	-	-	-	-	-	13.82	-	-	66.25	-	-
	Pygmy Blue Whale - Distribution (None)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
	Pygmy Blue Whale - Foraging (The majority of Bass Strait and the coastal waters of Tasmania)	0.19	0.21	-	207.5	30.25	-	0.2	0.22	0.6	505.75	152.5	1.75
	Pygmy Blue Whale - Foraging (annual high use area) (Between Cape Otway and Robe. The Bonney Upwelling is a well described pygmy blue whale feeding area)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	320.75	65.75	13.75

Receptor	Summer (November through to March)						Winter (April to October)					
	Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)			Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)		
	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Pygmy Blue Whale - Known Foraging Area (The north-west part of Bass Strait, from Cape Otway to Port Phillip Heads and to the south of King Island)	4.17	-	-	148.5	-	-	2.4	3	-	505.75	152.5	-
Short-tailed Shearwater - Breeding (Cape Wickham)	-	-	-	-	-	-	8.72	-	-	19.5	-	-
Short-tailed Shearwater - Breeding (Christmas Island)	22.03	-	-	59.5	-	-	18	-	-	62.25	-	-
Short-tailed Shearwater - Breeding (New Year Island)	-	-	-	-	-	-	7.33	-	-	9.25	-	-
Short-tailed Shearwater - Foraging (Buffer around Tasmania including Bass Strait)**	0.01	0.01	0.02	207.5	71	12.75	0.01	0.01	0.01	505.75	152.5	13.75
Shy Albatross - Foraging likely (The whole South-east Marine Region)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
Southern Right Whale - Connecting habitat (King Island area)	13.6	-	-	148.5	-	-	6.11	12.57	-	482.75	152.5	-
Southern Right Whale - Known core range (Southern Right Whales occur in coastal waters anywhere between Sydney and Perth, including off Tasmania)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
Wandering Albatross - Foraging (The whole South-east Marine Region)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
Wedge-tailed Shearwater - Foraging (Breeding area / sites buffer- Muttonbird Island (VIC))**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	455.75	65.75	13.75
White Shark - Distribution (Between the 120 - 1,000m depth contour)	0.09	0.11	0.19	188.25	56	6.5	0.09	0.11	0.21	138.5	46	6
White Shark - Distribution (Between the 60-120m depth contour)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	318.5	65.75	13.75
White Shark - Distribution (low density) (Australian waters from Barrow Island/Montebello Islands, WA to Yeppoon/Swains Reef, Qld)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
White Shark - Foraging (Waters off pinniped colonies throughout the South-east Marine Region)	13.47	-	-	12.5	-	-	10.04	-	-	94	-	-
White Shark - Known distribution (Coastal/Shelf/Upper Slope waters out to 1000m depth contour)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
White-faced Storm-petrel - Foraging (Buffer around Melbourne and Port Phillip Bay)	5.72	-	-	119.25	-	-	3.07	-	-	98.25	-	-
White-faced Storm-petrel - Foraging (Buffer around the northern side of Tasmania into Bass Strait)	8.31	-	-	148.5	-	-	5.23	12.57	-	505.75	152.5	-

Receptor		Summer (November through to March)						Winter (April to October)					
		Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)			Minimum time before entrained hydrocarbon exposure (days)			Maximum residence time for entrained hydrocarbon exposure (hours)		
		Low	Moderate	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
CA	Red Hut Point	-	-	-	-	-	-	11.22	-	-	75.25	-	-
GR	New Year Island	-	-	-	-	-	-	7.33	-	-	9.25	-	-
IBRA	King	22.03	-	-	59.5	-	-	7.33	-	-	75.25	-	-
IMCRA-MESO	Central Bass Strait	4.04	-	-	119.25	-	-	2.35	2.79	-	140.75	4.25	-
	Central Victoria	16.86	-	-	10.5	-	-	6.48	-	-	45.75	-	-
	Franklin	-	-	-	-	-	-	17.74	-	-	3.5	-	-
	Otway**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
IMCRA-PROV	Bass Strait Shelf Province	4.04	-	-	119.25	-	-	2.35	2.79	-	140.75	4.25	-
	Tasmanian Shelf Province	-	-	-	-	-	-	17.74	-	-	3.5	-	-
	West Tasmania Transition	0.32	0.78	-	188	32.25	-	0.61	0.73	-	102.75	30	-
	Western Bass Strait Shelf Transition**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
KEF	West Tasmania Canyons	0.72	0.75	-	146.5	21	-	0.58	0.67	-	95.25	9	-
MR	South-east (Marine)**	0.01	0.01	0.02	242.5	71	16.75	0.01	0.01	0.01	505.75	152.5	13.75
NR	Christmas Island	22.03	-	-	59.5	-	-	18	-	-	62.25	-	-
NRMR	North NRM Region (TAS)	-	-	-	-	-	-	19.35	-	-	55.75	-	-
	North West NRM Region (TAS)	12.89	-	-	148.5	-	-	5.47	12.57	-	505.75	152.5	-
SHORE-LGA	King Island Council (TAS)	15.33	-	-	122.75	-	-	6.86	12.57	-	479	152.5	-
SR	Cape Wickham	-	-	-	-	-	-	8.72	-	-	19.5	-	-
State Waters	Tasmania	12.89	-	-	148.5	-	-	5.47	12.57	-	505.75	152.5	-

*The release location resides within the receptor boundaries.

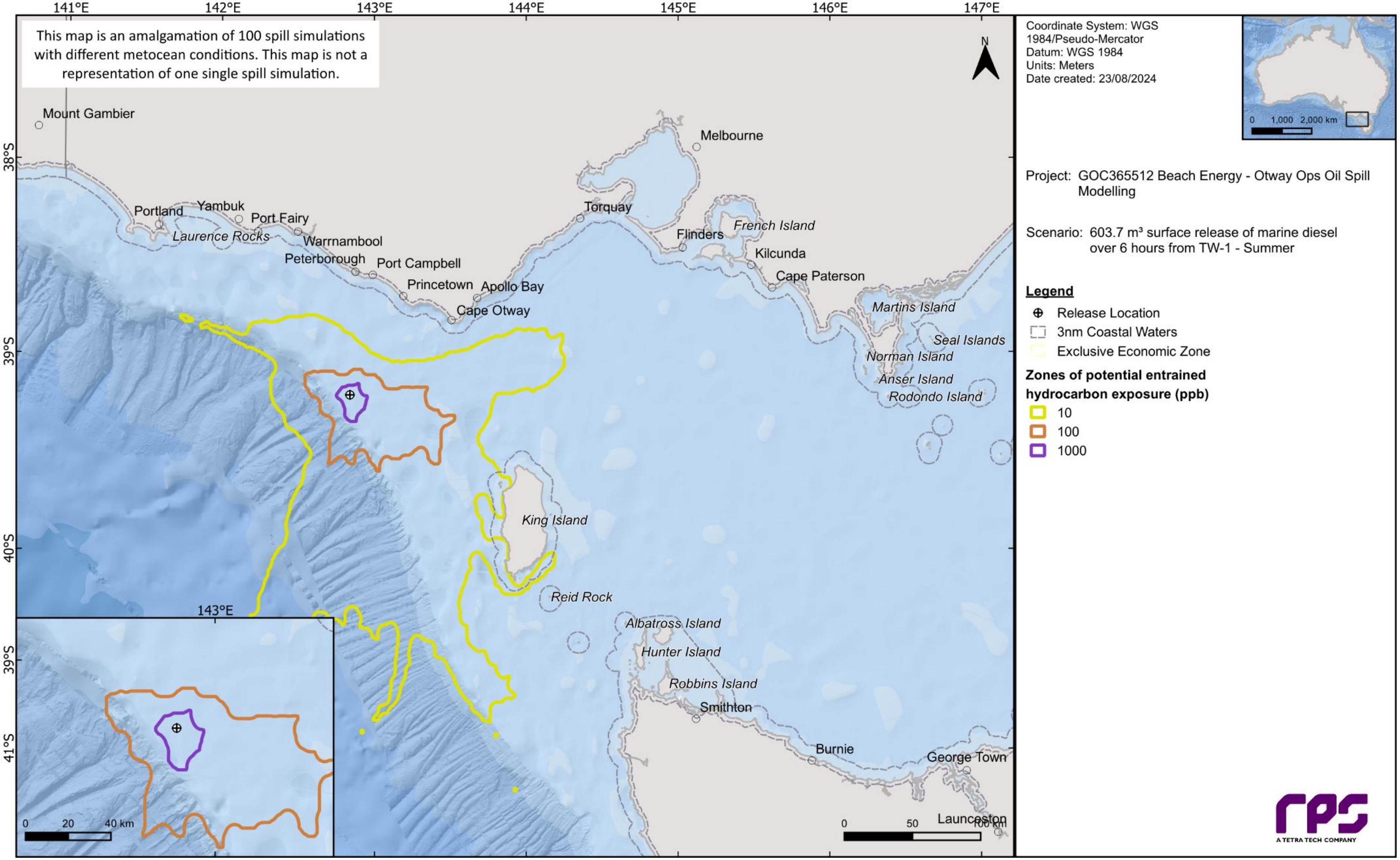


Figure 16-17 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during summer conditions.

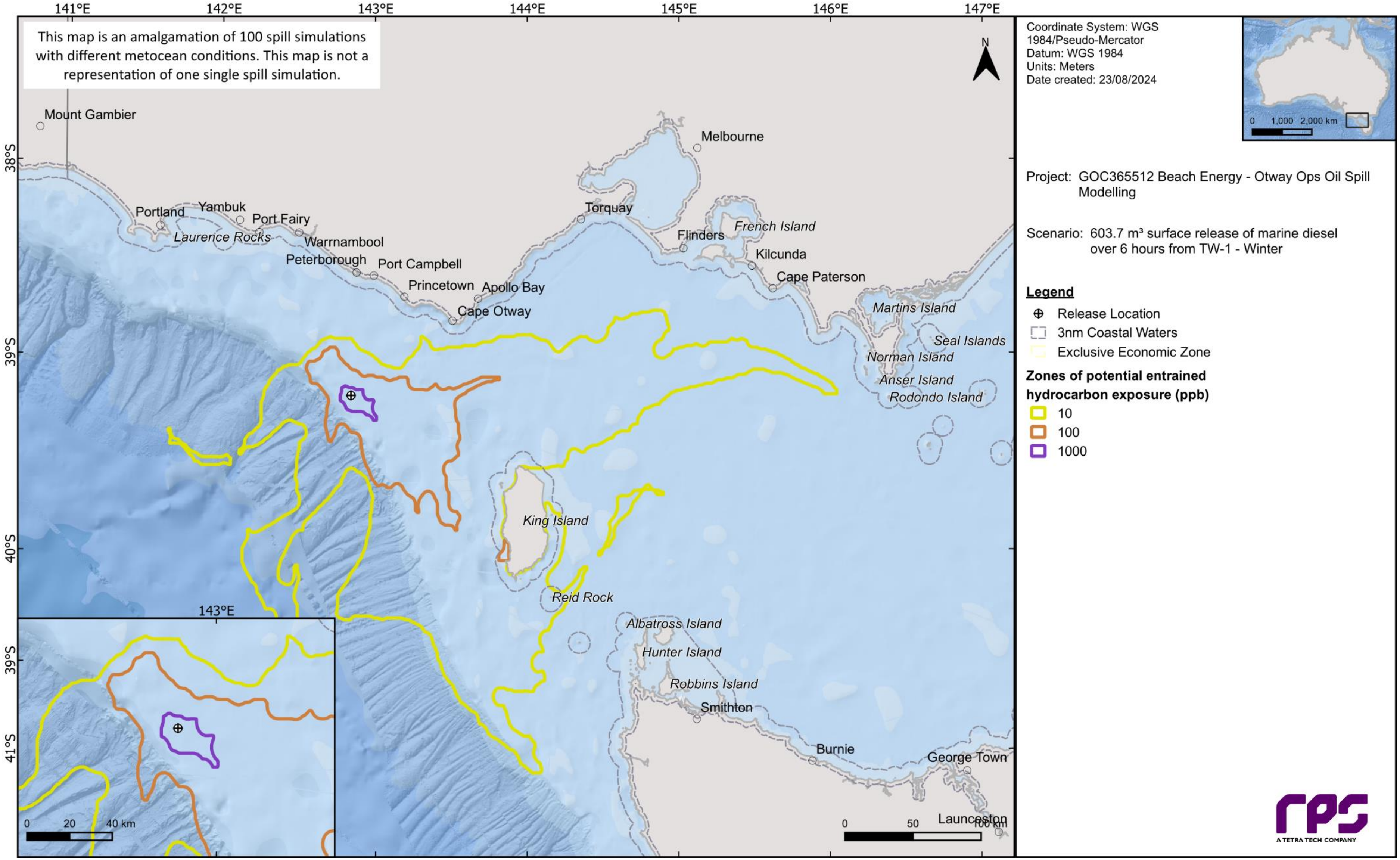


Figure 16-18 Zones of potential entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during winter conditions.

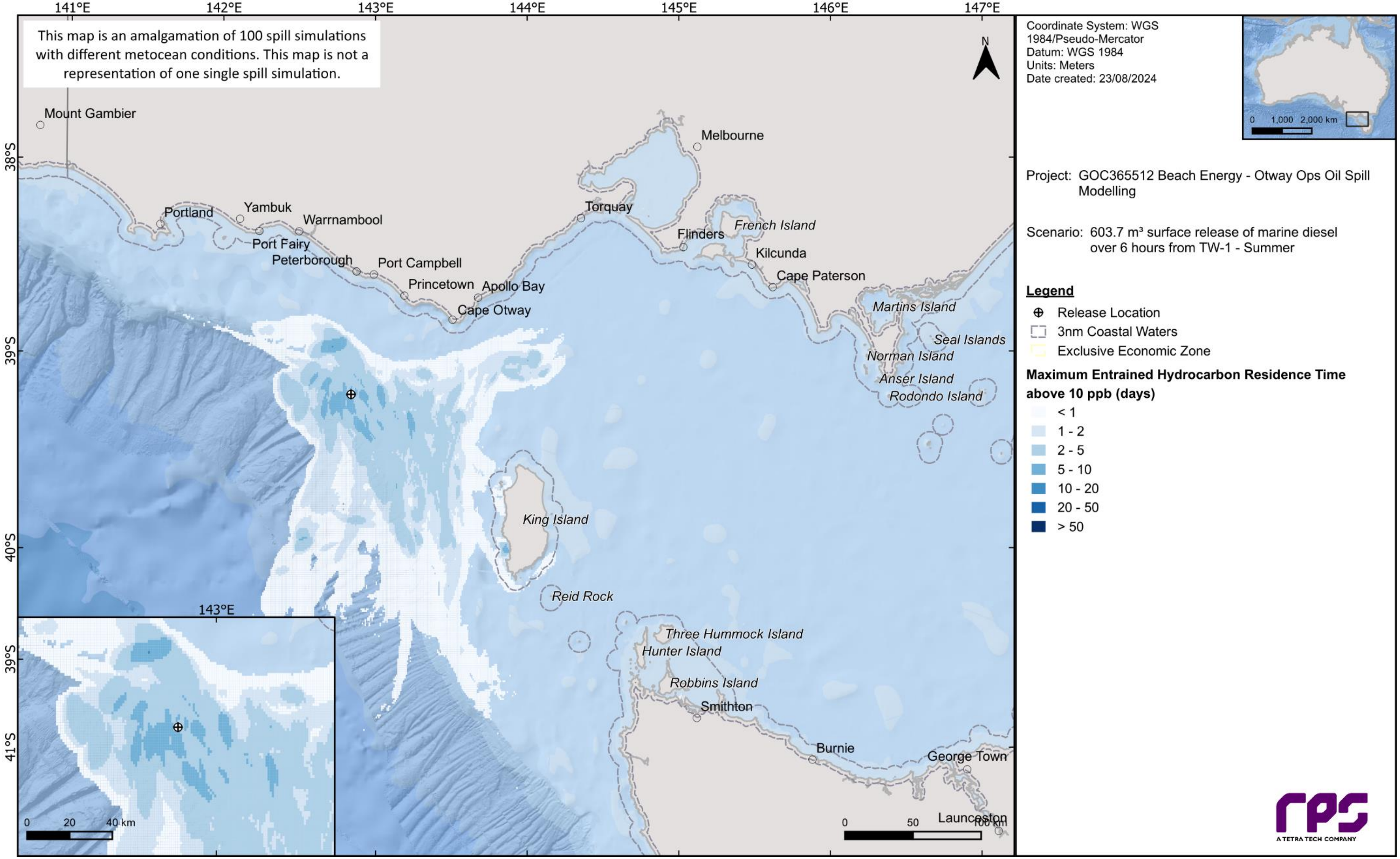


Figure 16-19 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during summer conditions.

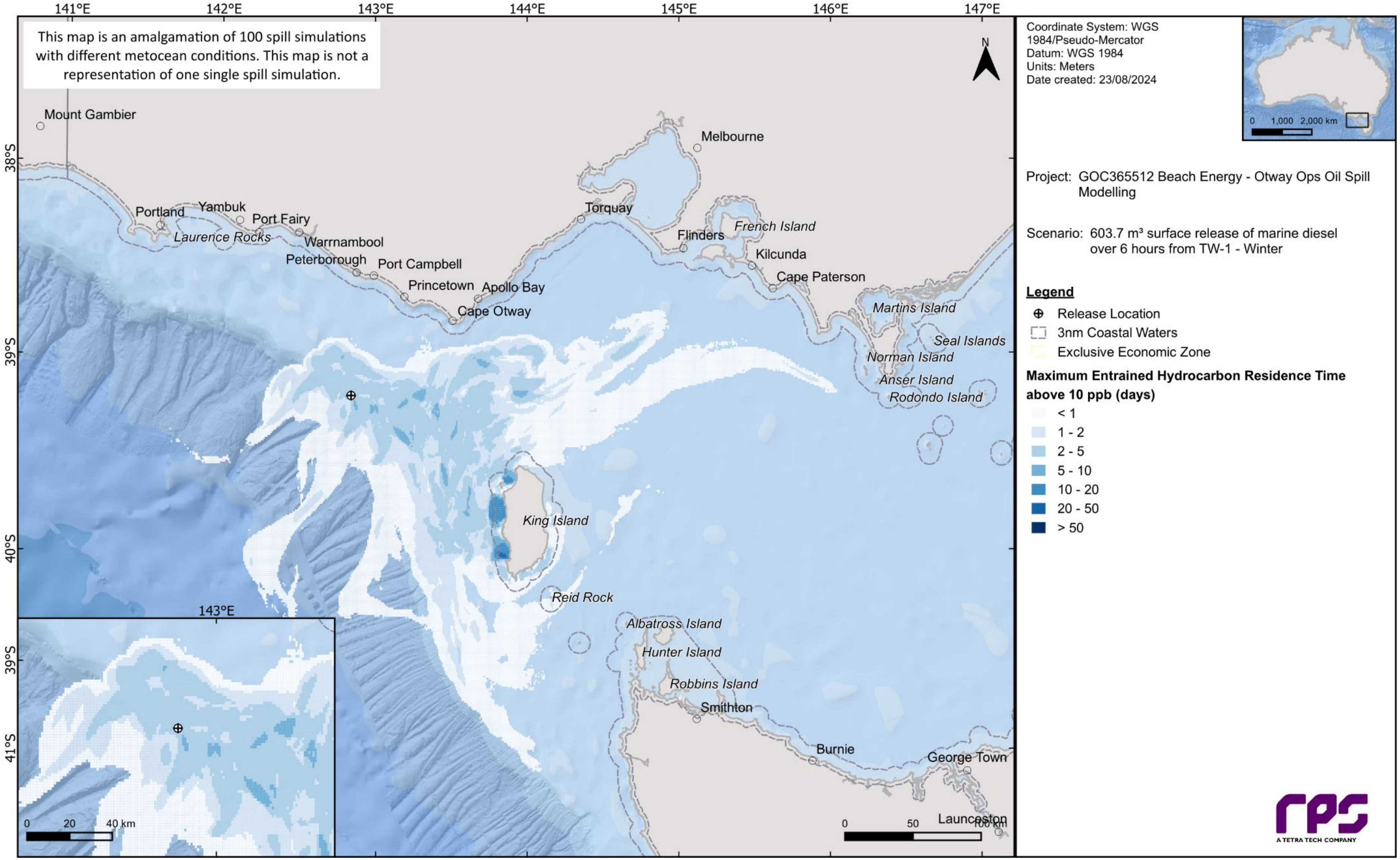


Figure 16-20 Maximum residence time for entrained hydrocarbon exposure above 10 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during winter conditions.

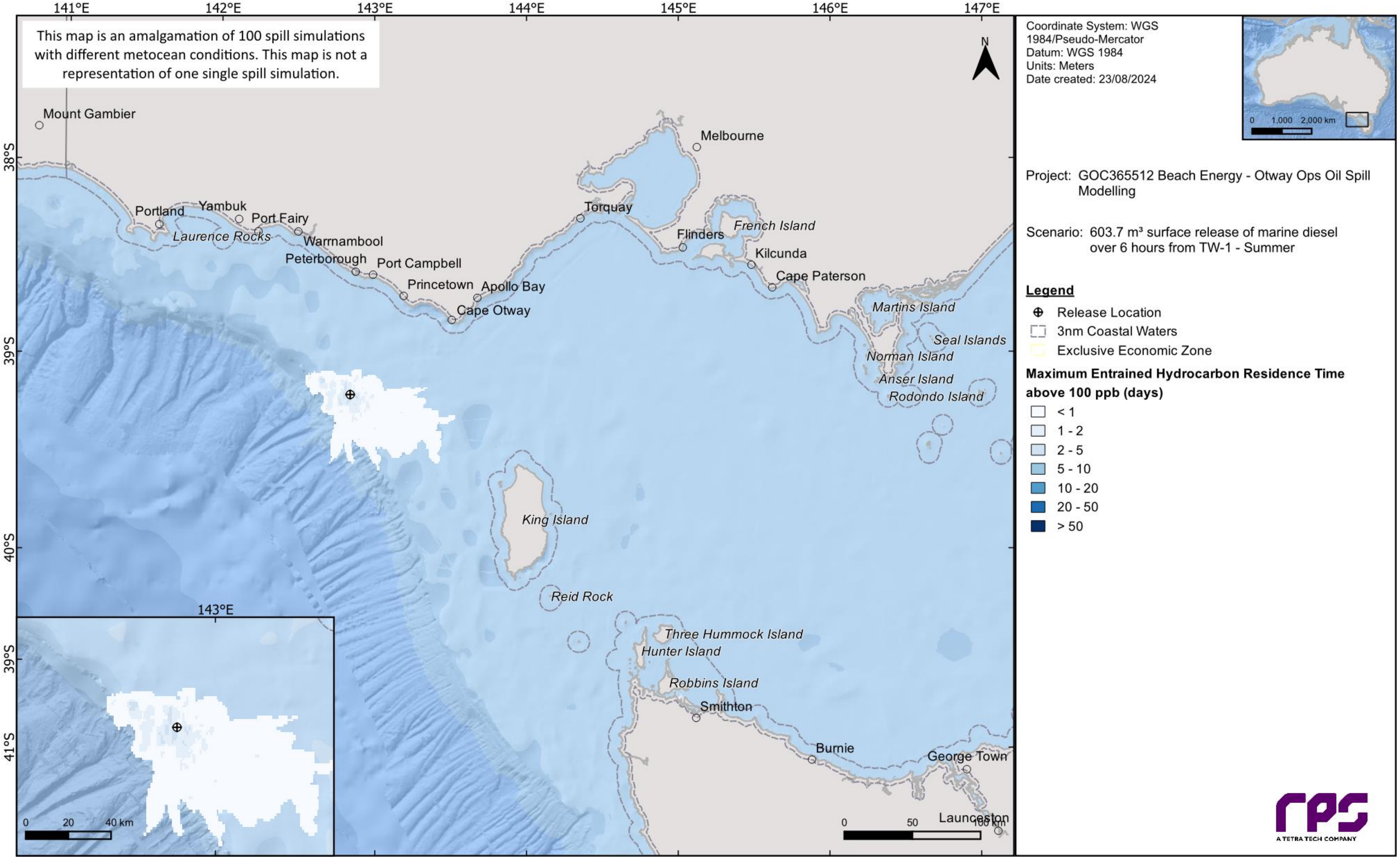


Figure 16-21 **Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during summer conditions.**

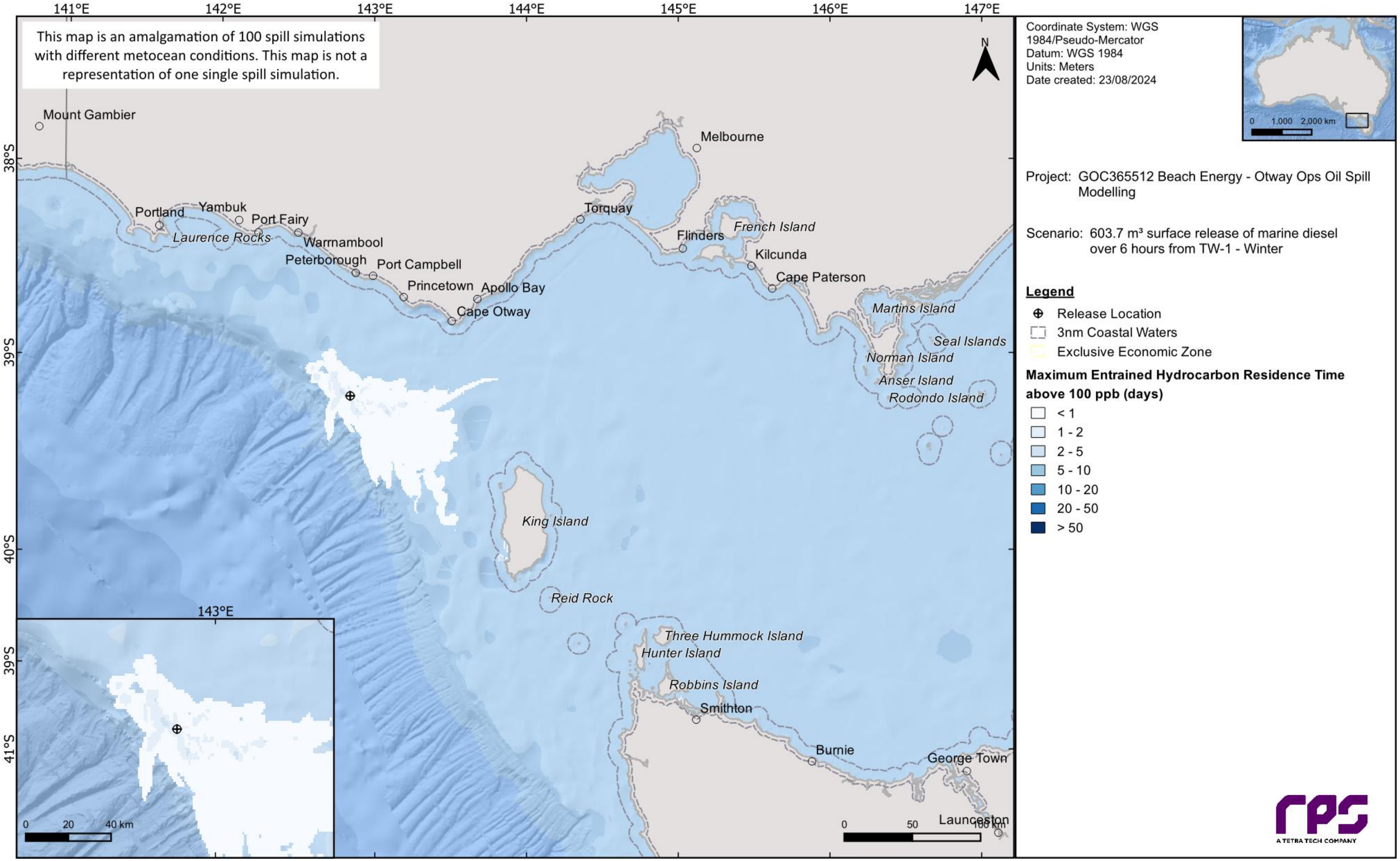


Figure 16-22 Maximum residence time for entrained hydrocarbon exposure above 100 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during winter conditions.

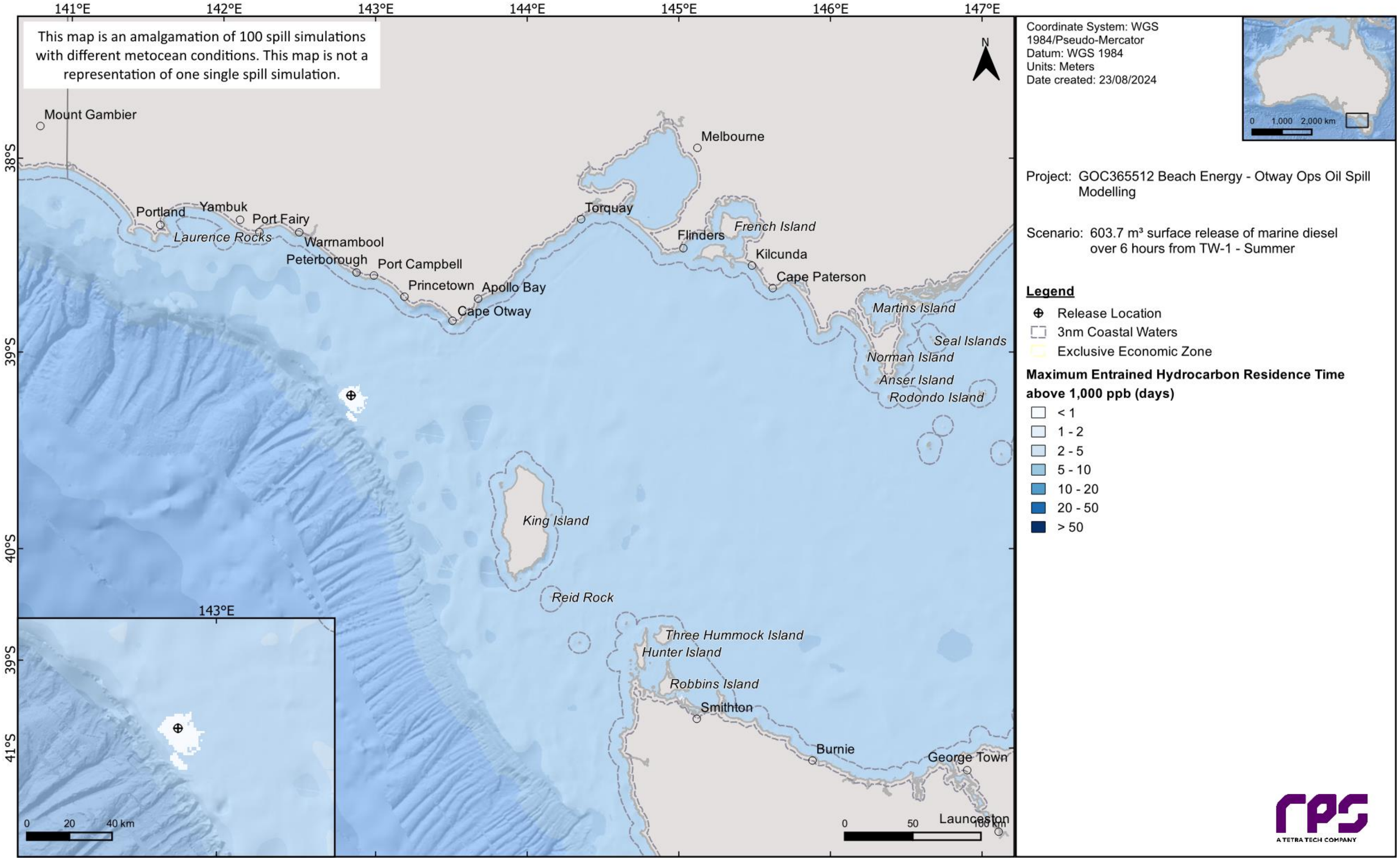


Figure 16-23 Maximum residence time for entrained hydrocarbon exposure above 1,000 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during summer conditions.

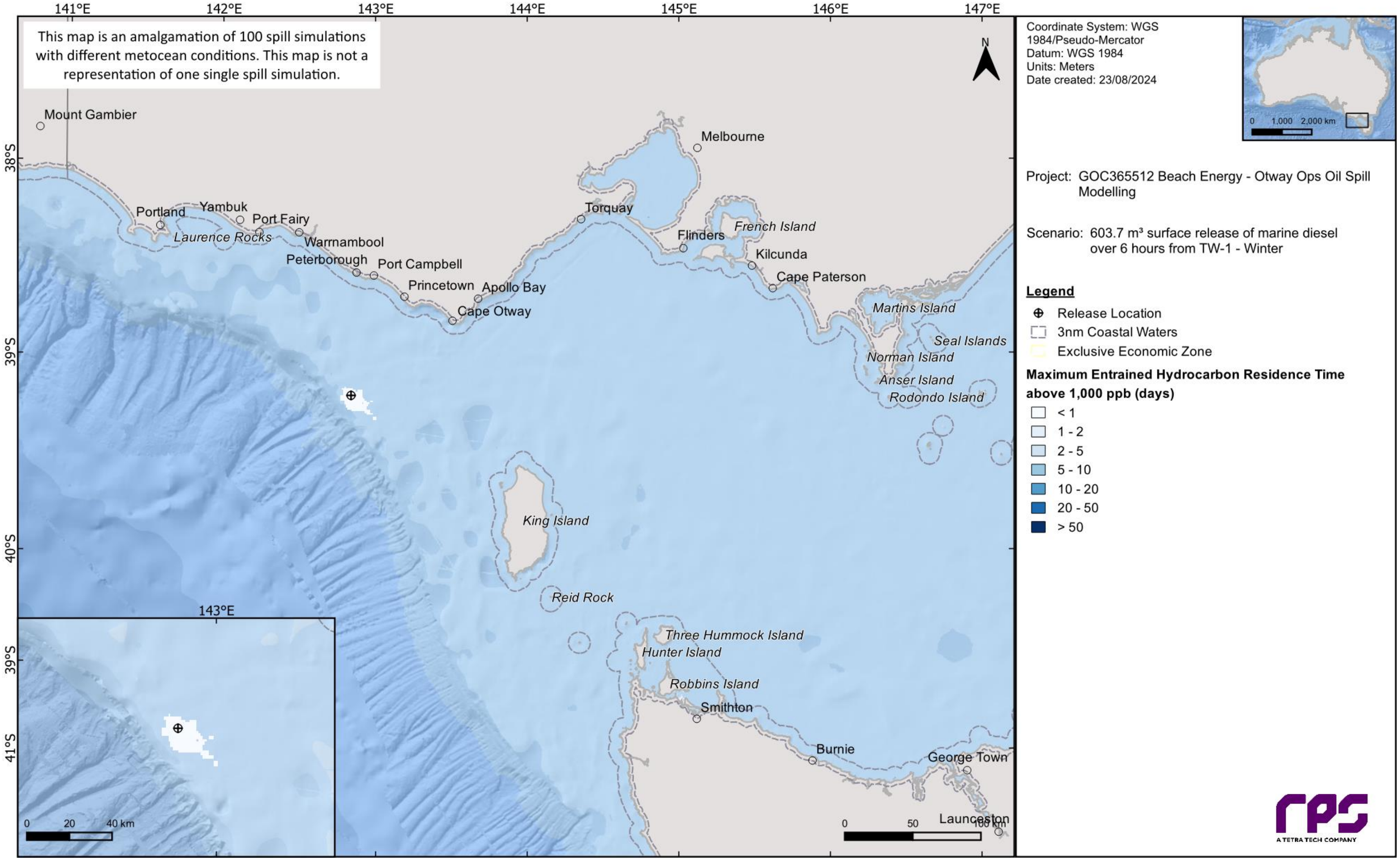


Figure 16-24 Maximum residence time for entrained hydrocarbon exposure above 1,000 ppb, at 0-10 m below the sea surface in the event of a 603.7 m^3 surface release of marine diesel for a loss of containment from vessel collision at TW1. The results were calculated from 100 spill simulations during winter conditions.

17 REFERENCES

American Society for Testing and Materials (ASTM) 2013, ‘F2067-13 Standard Practice for Development and Use of Oil-Spill Trajectory Models’, ASTM International, West Conshohocken (PA).

Andersen, OB 1995, ‘Global ocean tides from ERS 1 and TOPEX/POSEIDON altimetry’, Journal of Geophysical Research: Oceans, vol. 100, no. C12, pp. 25249–25259.

Anderson JW, Neff JM, Cox BA, Tatem HE & Hightower GM 1974, ‘Characteristics of dispersions and water-soluble extracts of crude and refined oils and their toxicity to estuarine crustaceans and fish’, Marine Biology, vol. 27, no. 1, pp. 75–88.

Anderson JW, Riley R, Kiesser S & Gurtisen J 1987, ‘Toxicity of dispersed and undispersed Prudhoe Bay crude oil fractions to shrimp and fish’, Proceedings of the 1987 International Oil Spill Conference, American Petroleum Institute, pp. 235–240.

Applied Science Associates (ASA) 2011, OILMAP-DEEP: Blowout Plume Model Technical Manual, Applied Science Associates Inc, South Kingstown, USA.

Asia-Pacific ASA 2010, ‘Montara well release monitoring study S7.2 Oil fate and effects assessment: modelling of chemical dispersant operation’, Prepared for PTTEP Australasia.

Australian Maritime Safety Authority (AMSA) 2014, ‘Identification of oil on water: Aerial observations and identification guide’, viewed 4 June 2020, https://www.amsa.gov.au/sites/default/files/2014-01-mp-amsa22-identification-oil-on-water.pdf

Australian Maritime Safety Authority (AMSA) 2015, ‘Australian Maritime Safety Authority Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities Australian Maritime Safety Authority’, viewed 20 June 2017, https://www.amsa.gov.au/forms-and-publications/Publications/AMSA413_Contingency_Planning_Guidelines.pdf

Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000, ‘Australian and New Zealand guidelines for fresh and marine water quality Volume 1, The guidelines (National water quality management strategy; no.4)’, Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand. Brandvik, PJ, Johansen, O, Leirvik, F, Farooq, U & Daling PS 2013, ‘Droplet Breakup in subsurface oil releases – Part 1: Experimental study of droplet breakup and effectiveness of dispersant injection’, Marine Pollution Bulletin, vol. 73, no. 1, pp 319–326.

Becker, JJ, Sandwell, DT, Smith, WHF, Braud, J, Binder, B, Depner, J, Fabre, D, Factor, J, Ingalls, S, Kim, S-H, Ladner, R, Marks, K, Nelson, S, Pharaoh, A, Trimmer, R, Von Rosenberg, J, Wallace, G & Weatherall, P 2009, ‘Global bathymetry and evaluation data at 30 arc seconds resolution: SRTM30_PLUS’, Marine Geodesy, vol. 32, no. 4, pp. 355–371.

Belore, UC 2014, ‘Subsea chemical dispersant research’, Proceedings of the 37th AMOP Technical Seminar on Environmental Contamination and Response, Environmental Canada, Canmore, Alberta, Canada pp. 618–650.

Blum DJ & Speece RE 1990, ’Determining chemical toxicity to aquatic species’, Environmental Science & Technology, vol. 24, no. 3, pp. 284–293.

Bonn Agreement 2009, ‘Bonn Agreement aerial operations handbook, 2009 - Publication of the Bonn Agreement’, viewed 13 January 2015, http://www.bonnagreement.org/site/assets/files/3947/ba-aoh_revision_2_april_2012.pdf

Brandvik, PJ, Johansen, O, Farooq, U, Angell, G & Leirvik F 2014, ‘Sub-surface oil releases – Experimental study of droplet distributions and different dispersant injection techniques- version 2’, A scaled experimental approach using the SINTEF Tower basin. SINTEF report no: A25122. Trondheim Norway 2014. ISBN: 9788214057393

Carls, MG, Holland, L, Larsen, M, Collier, TK, Scholz, NL & Incardona, JP 2008, ‘Fish embryos are damaged by dissolved PAHs, not oil particles’, Aquatic Toxicology vol. 88, no. 2, pp.121–127.

Chassignet, EP, Hurlburt, HE, Smedstad, OM, Halliwell, GR, Hogan, PJ, Wallcraft, AJ, Baraille, R & Bleck, R 2007, ‘The HYCOM (hybrid coordinate ocean model) data assimilative system’, Journal of Marine Systems, vol. 65, no. 1, pp. 60–83.

Chassignet, E, Hurlburt, H, Metzger, E, Smedstad, O, Cummings, J & Halliwell, G 2009, ‘U.S. GODAE: Global Ocean Prediction with the HYbrid Coordinate Ocean Model (HYCOM)’, Oceanography, vol. 22, no. 2, pp. 64–75.

Davies, AM 1977a, ‘The numerical solutions of the three-dimensional hydrodynamic equations using a B-spline representation of the vertical current profile’, in JC Nihoul (ed), Bottom Turbulence: Proceedings of the 8th Liège Colloquium on Ocean Hydrodynamics, Elsevier Scientific, Amsterdam, pp. 1–25.

Davies, AM 1977b, ‘Three-dimensional model with depth-varying eddy viscosity’, in JC Nihoul (ed), Bottom Turbulence: Proceedings of the 8th Liège Colloquium on Ocean Hydrodynamics, Elsevier Scientific, Amsterdam, pp. 27–48.

French, D, Reed, M, Jayko, K, Feng, S, Rines, H, Pavignano, S, Isaji, T, Puckett, S, Keller, A, French III, FW, Gifford, D, McCue, J, Brown, G, MacDonald, E, Quirk, J, Natzke, S, Bishop, R, Welsh, M, Phillips, M & Ingram, BS 1996, ‘The CERCLA Type A natural resource damage assessment model for coastal and marine environments (NRDAM/CME), Technical Documentation, Volume I - Model Description, Final Report,’ Office of Environmental Policy and Compliance, U.S. Department of the Interior, Washington DC.

French, D, Schuttenberg, H & Isaji, T 1999, ‘Probabilities of oil exceeding thresholds of concern: examples from an evaluation for Florida Power and Light’, Proceedings of the 22nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Alberta, pp. 243–270.

French-McCay, DP 2002, ‘Development and application of an oil toxicity and exposure model, OilToxEx’, Environmental Toxicology and Chemistry, vol. 21, no. 10, pp. 2080–2094.

French-McCay, DP 2003, ‘Development and application of damage assessment modelling: example assessment for the North Cape oil spill’, Marine Pollution Bulletin, vol. 47, no. 9, pp. 9–12.

French-McCay, DP 2004, ‘Spill impact modelling: development and validation’, Environmental Toxicology and Chemistry, vol. 23, no.10, pp. 2441–2456.

French-McCay, DP 2009, ‘State-of-the-art and research needs for oil spill impact assessment modelling’, Proceedings of the 32nd Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa, pp. 601–653.

French-McCay, D, Rowe, JJ, Whittier, N, Sankaranarayanan, S, & Etkin, DS 2004, ‘Estimate of potential impacts and natural resource damages of oil’, Journal of Hazardous Materials, vol. 107, no. 1, pp. 11–25.

French-McCay, D, Whittier, N, Dalton, C, Rowe, J, Sankaranarayanan, S & Aurand, D 2005a, ‘Modeling the fates of hypothetical oil spills in Delaware, Florida, Texas, California, and Alaska waters, varying response options including use of dispersants’, Proceedings of the International Oil Spill Conference 2005, American Petroleum Institute, Washington DC, paper 399.

French-McCay, D, Whittier, N, Rowe, J, Sankaranarayanan, S, Kim, H-S & Aurand, D 2005b, ‘Use of probabilistic trajectory and impact modeling to assess consequences of oil spills with various response strategies,’ Proceedings of the 28th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa, pp. 253–271.

French-McCay, D, Reich, D, Rowe, J, Schroeder, M & Graham, E 2011, ‘Oil spill modeling input to the offshore environmental cost model (OECM) for US-BOEMRE's spill risk and costs evaluations’, Proceedings of the 34th Arctic and Marine Oil Spill Program (AMOP) Technical Siminar, Environment Canada, Ottawa.

French-McCay, D, Reich, D, Michel, J, Etkin, DS, Symons, L, Helton, D, & Wagner J 2012, ‘Oil spill consequence analysis of potentially-polluting shipwrecks’, Proceedings of the 35th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Environment Canada, Ottawa.

French-McCay, D, Jayko, K, Li, Z, Horn, M, Kim, Y, Isaji, T, Crowley, D, Spaulding, M, Decker, L, Turner, C, Zamorski, S, Fontenault, J, Schmmkler, R & Rowe, J 2015, ’Technical Reports for Deepwater Horizon Water Column Injury Assessment: WC_TR.14: Modeling Oil Fate and Exposure Concentrations in the Deepwater Plume and Rising Oil Resulting from the Deepwater Horizon Oil Spill’ RPS ASA, South Kingston, Rhode Island.

French-McCay, DP 2023, Entrained oil effects threshold applicable to oil spill modelling results – Presentation to the Australian Energy Producers (AEP) Oil Spill Preparedness and Response Working

Group, 2nd November 2023, by Dr. French McCay – Director, Research and Model Development, RPS Ocean Science, South Kingstown, RI USA.

Gordon, R 1982, ‘Wind driven circulation in Narragansett Bay’ PhD thesis, Department of Ocean Engineering, University of Rhode Island.

Grant, DL, Clarke, PJ & Allaway, WG 1993, ‘The response of grey mangrove (*Avicennia marina* (Forsk.) Vierh) seedlings to spills of crude oil,’ The Journal of Experimental Marine Biological Ecology, vol. 171, no. 2, pp. 273–295.

International Tankers Owners Pollution Federation (ITOPF) 2020, ‘Handbook 2020/21’, International Tankers Owners Pollution Federation Ltd, UK.

Isaji, T & Spaulding, M 1984, ‘A model of the tidally induced residual circulation in the Gulf of Maine and Georges Bank’, Journal of Physical Oceanography, vol. 14, no. 6, pp. 1119–1126.

Isaji, T, Howlett, E, Dalton C, & Anderson, E 2001, ‘Stepwise-continuous-variable-rectangular grid hydrodynamics model’, Proceedings of the 24th Arctic and Marine Oil spill Program (AMOP) Technical Seminar (including 18th TSOCS and 3rd PHYTO), Environment Canada, Edmonton, pp. 597–610.

Jones, ISF 1980, ‘Tidal and wind driven currents in Bass Strait’, Australian Journal of Marine and Freshwater Research vol. 31, no. 2, pp. 109–117.

Koops, W, Jak, RG & van der Veen, DPC 2004, ‘Use of dispersants in oil spill response to minimise environmental damage to birds and aquatic organisms’, Proceedings of the Interspill 2004: Conference and Exhibition on Oil Spill Technology, Trondheim, presentation 429.

Kostianoy, AG, Ginzburg, AI, Lebedev, SA, Frankignoulle, M & Delille, B 2003, ‘Fronts and mesoscale variability in the southern Indian Ocean as inferred from the TOPEX/POSEIDON and ERS-2 Altimetry data’, Oceanology, vol. 43, no. 5, pp. 632–642.

Levitus, S, Antonov, JI, Baranova, OK, Boyer, TP, Coleman, CL, Garcia, HE, Grodsky, AI, Johnson, DR, Locarnini, RA, Mishonov, AV, Reagan, JR, Sazama, CL, Seidov, D, Smolyar, I, Yarosh, ES & Zweng, MM 2013, ‘The World Ocean Database’, Data Science Journal, vol.12, no. 0, pp. WDS229–WDS234.

Li, Z, Spaulding, M, French-McCay, D, Crowley, D & Payne JR 2017, ‘Development of a unified oil droplet size distribution model with application to surface breaking waves and subsea blowout releases considering dispersant effects’, Marine Pollution Bulletin, vol. 114, no. 1, pp 247–257.

Lin, Q & Mendelssohn, IA 1996, ‘A comparative investigation of the effects of south Louisiana crude oil on the vegetation of fresh, brackish and Salt Marshes’, Marine Pollution Bulletin, vol. 32, no. 2, pp. 202–209.

Ludicone, D, Santoleri, R, Marullo, S & Gerosa, P 1998, ‘Sea level variability and surface eddy statistics in the Mediterranean Sea from TOPEX/POSEIDON data’, Journal of Geophysical Research, vol. 103, no. C2, pp. 2995–3011.

Malins DC & Hodgins HO 1981, ‘Petroleum and marine fishes: a review of uptake, disposition, and effects’, Environmental Science & Technology, vol. 15, no. 11, pp.1272–1280.

Matsumoto, K, Takanezawa, T & Ooe, M 2000, ‘Ocean tide models developed by assimilating TOPEX/POSEIDON altimeter data into hydrodynamical model: A global model and a regional model around Japan’, Journal of Oceanography, vol. 56, no.5, pp. 567–581.

McAuliffe CD 1987, ‘Organism exposure to volatile/soluble hydrocarbons from crude oil spills – a field and laboratory comparison’, Proceedings of the 1987 International Oil Spill Conference, American Petroleum Institute, pp. 275–288.

McCarty LS 1986, ‘The relationship between aquatic toxicity QSARs and bioconcentration for some organic chemicals’, Environmental Toxicology and Chemistry, vol. 5, no. 12, pp. 1071–1080.

McCarty LS, Dixon DG, MacKay D, Smith AD & Ozburn GW 1992a, ‘Residue-based interpretation of toxicity and bioconcentration QSARs from aquatic bioassays: Neutral narcotic organics’, Environmental Toxicology and Chemistry, vol. 11, no. 7, pp.917–930.

McCarty LP, Flannagan DC, Randall SA & Johnson KA 1992b, ‘Acute toxicity in rats of chlorinated hydrocarbons given via the intratracheal route’, Human & Experimental Toxicology, vol. 11, no. 3, pp.173–117.

McCarty LS & Mackay D 1993, ‘Enhancing ecotoxicological modelling and assessment. Body residues and modes of toxic action’, Environmental Science & Technology, vol. 27, no. 9, pp. 1718–1728.

McGrath JA, & Di Toro DM 2009, ‘Validation of the target lipid model for toxicity assessment of residual petroleum constituents: monocyclic and polycyclic aromatic hydrocarbons’, Environmental Toxicology and Chemistry, vol. 28, no. 6, pp. 1130–1148.

Middleton, JF & Bye AT 2007, ‘A review of shelf-slope circulation along Australia’s southern shelves: Cape Leeuwin to Portland’, Progress in Oceanography vol. 75, pp. 1–41.

National Centers for Environmental Information (NCEI) 2021, ‘World Ocean Atlas’ viewed 20 July 2021, https://www.ncei.noaa.gov/products/world-ocean-atlas

National Oceanic and Atmospheric Administration (NOAA) 2013, Screening level risk assessment package Gulf state, Office of National Marine Sanctuaries & Office of Response and Restoration, Washington DC.

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) 2018, ‘At a glance: Oil spill modelling’, viewed 15 November 2018, https://www.nopsema.gov.au/assets/Publications/A626200.pdf

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) 2019, ‘Environment bulletin: Oil spill modelling’, viewed 4 February 2020, https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf

National Research Council (NRC) 2003, ‘Oil in the sea III: Inputs, fates and effects’, National Research Council, The National Academic Press, Washington DC.

National Research Council (NRC) 2005, ‘Oil Spill Dispersants Efficacy and Effects. Committee on Oil Spill Dispersants: Efficacy and Effects’, National Research Council, The National Academies Press, Washington DC.

Neff JM & Anderson JW 1981, ‘Response of marine animals to petroleum and specific petroleum hydrocarbons’ United States Department of Energy, United States.

Nirmalakhandan N & Speece RE 1988, ‘Quantitative techniques for predicting the behaviour of chemicals in the ecosystem’, Environmental Science & Technology, vol. 22, no. 6, pp. 606–615.

Nordtug, T., Olsen, A.J., Altin, D., Overrein, I., Storøy, W., Hansen, B.H. and De Laender, F., 2011. Oil droplets do not affect assimilation and survival probability of first feeding larvae of North-East Arctic cod. Science of the Total Environment, 412, pp.148–153.

Oil Spill Solutions 2015, ‘Evaluation - The Theory of Oil Slick Appearances’, viewed 6 January 2015, http://www.oilspillsolutions.org/evaluation.htm

Okubo, A, 1971 ‘Oceanic diffusion diagrams’, *Deep Sea Research and Oceanographic Abstracts*, vol. 18, no. 8, pp. 789–802.

Owen, A 1980, ‘A three-dimensional model of the Bristol Channel’, Journal of Physical Oceanography, vol. 10, pp. 1290–1302.

Qiu, B & Chen, S 2010, ‘Eddy-mean flow interaction in the decadally modulating Kuroshio Extension system’, Deep-Sea Research II, vol. 57, no. 13, pp. 1098–1110.

Redman AD 2015, ‘Role of entrained droplet oil on the bioavailability of petroleum substances in aqueous exposures’, Marine Pollution Bulletin, vol. 97, no. 1–2, pp. 342–348.

Saha, S, Moorthi, S, Pan, H-L, Wu, X, Wang, J & Nadiga, S 2010, ‘The NCEP Climate Forecast System Reanalysis’, Bulletin of the American Meteorological Society, vol. 91, no. 8, pp. 1015–1057.

Sandery, P & Kämpf, J 2007, ‘Transport timescales for identifying seasonal variation in Bass Strait, south-eastern Australia’, Estuarine, Coastal and Shelf Science, vol. 74, no. 4, pp. 684-696.

Scholten, MCTh, Kaag, NHBM, Dokkum, HP van, Jak, R.G., Schobben, HPM & Slob, W 1996, Toxische effecten van olie in het aquatische milieu, TNO report TNO-MEP – R96/230, Den Helder.

Spaulding, ML, Kolluru, VS, Anderson, E & Howlett, E 1994, ‘Application of three-dimensional oil spill model (WOSM/OILMAP) to hindcast the Braer Spill’, Spill Science and Technology Bulletin, vol. 1, no. 1, pp. 23–35.

Spaulding, ML, Bishnoi, PR, Anderson, E & Isaji, T 2000, 'An integrated model for prediction of oil transport from a deep water blowout', Proceedings of the 23rd Arctic and Marine Oilspill Program (AMOP) Technical Seminar, Environment Canada, Vancouver, BC, pp. 2611–2635.

Spaulding, ML, Mendelsohn, D, Crowley, D, Li, Z, and Bird A, 2015. Technical Reports for Deepwater Horizon Water Column Injury Assessment- WC_TR.13: Application of OILMAP DEEP to the Deepwater Horizon Blowout. RPS APASA, 55 Village Square Drive, South Kingstown, RE 02879.

Suprayogi, B & Murray, F 1999, 'A field experiment of the physical and chemical effects of two oils on mangroves', Environmental and Experimental Botany, vol. 42, no. 3, pp. 221–229.

Swartz RC, Schults DW, Ozretich RJ, Lamberson JO, Cole FA, Ferraro SP, Dewitt TH & Redmond MS 1995, 'ΣPAH: A Model to predict the toxicity of polynuclear aromatic hydrocarbon mixtures in field-collected sediments', Environmental Toxicology and Chemistry, vol. 14, no. 11, pp. 1977–1187.

Verhaar, HJ, Van Leeuwen, CJ & Hermens, JL 1992, 'Classifying environmental pollutants', Chemosphere, vol. 25, no. 4, pp. 471-491.

Verhaar, HJ, de Wolf, W, Dyer, S, Legierse, KC, Seinen, W & Hermens, JL 1999, 'An LC_{50} vs time model for the aquatic toxicity of reactive and receptor-mediated compounds. Consequences for bioconcentration kinetics and risk assessment', Environmental Science & Technology, vol. 33, no. 5, pp.758–763.

Willmott, CJ 1981, 'On the validation of models', Physical Geography, vol. 2, no. 2, pp.184–194.

Willmott, CJ 1982, 'Some comments on the evaluation of model performance', Bulletin of the American Meteorological Society, vol. 63, no. 11, pp.1309–1313.

Willmott CJ, Ackleson SG, Davis RE, Feddema JJ, Klink, KM, Legates, DR, O'Donnell, J & Rowe, CM 1985, 'Statistics for the evaluation of model performance', Journal of Geophysical Research, vol. I 90, no. C5, pp. 8995–9005.

Willmott, CJ & Matsuura, K 2005, 'Advantages of the mean absolute error (MAE) over the root mean square error (RMSE) in assessing average model performance', Journal of Climate Research, vol. 30, no. 1, pp. 79–82.

Yaremchuk, M & Tangdong, Q 2004, 'Seasonal variability of the large-scale currents near the coast of the Philippines', Journal of Physical Oceanography, vol. 34, no., 4, pp. 844–855.

Zigic, S, Zapata, M, Isaji, T, King, B, & Lemckert, C 2003, 'Modelling of Moreton Bay using an ocean/coastal circulation model', Proceedings of the 16th Australasian Coastal and Ocean Engineering Conference, the 9th Australasian Port and Harbour Conference and the Annual New Zealand Coastal Society Conference, Institution of Engineers Australia, Auckland, paper 170.

Appendix N Stakeholder Consultation Information Sheets

Offshore Gas Victoria Project

Drilling Program EP

Drilling activities | 16 September 2024

Project overview

Through production at the Otway Gas Plant near Port Campbell and the Lang Lang Gas Plant, 80 kms south-east of Melbourne CBD, Beach Energy (**Beach**) supplies natural gas to the east coast market, which delivers energy to Victorian homes, business and industry.

Beach safely drilled one exploration well and six production wells in its Otway Basin offshore Commonwealth permits from February 2021 to July 2022. Four production wells from that project have been connected and are now producing gas for the east coast market, with two remaining wells planned for connection in late 2024.

Beach is continuing its commitment to supply natural gas to the east coast gas market and, in June 2023, commenced consultation on Offshore Gas Victoria (**OGV**) Project activities in the course of preparing Environment Plans and an Offshore Project Proposal. OGV consists of a number of activities that would occur in several phases subject to approvals.

Following seabed assessments, the next phase of activities is the drilling phase (including the planned plugging and abandonment (**P&A**) of legacy suspended wells and the drilling of exploration or appraisal wells). The project phases are summarised in the diagram below.

Seabed assessments

- Assessment of suitable location for drilling rig and new seabed infrastructure to connect wells.
- Activities planned for no earlier than November 2024.

Removing wells (P&A)

- **Removal of five legacy suspended wells through a formal procedure (P&A).**
- **Activities planned for no earlier than March 2025.**

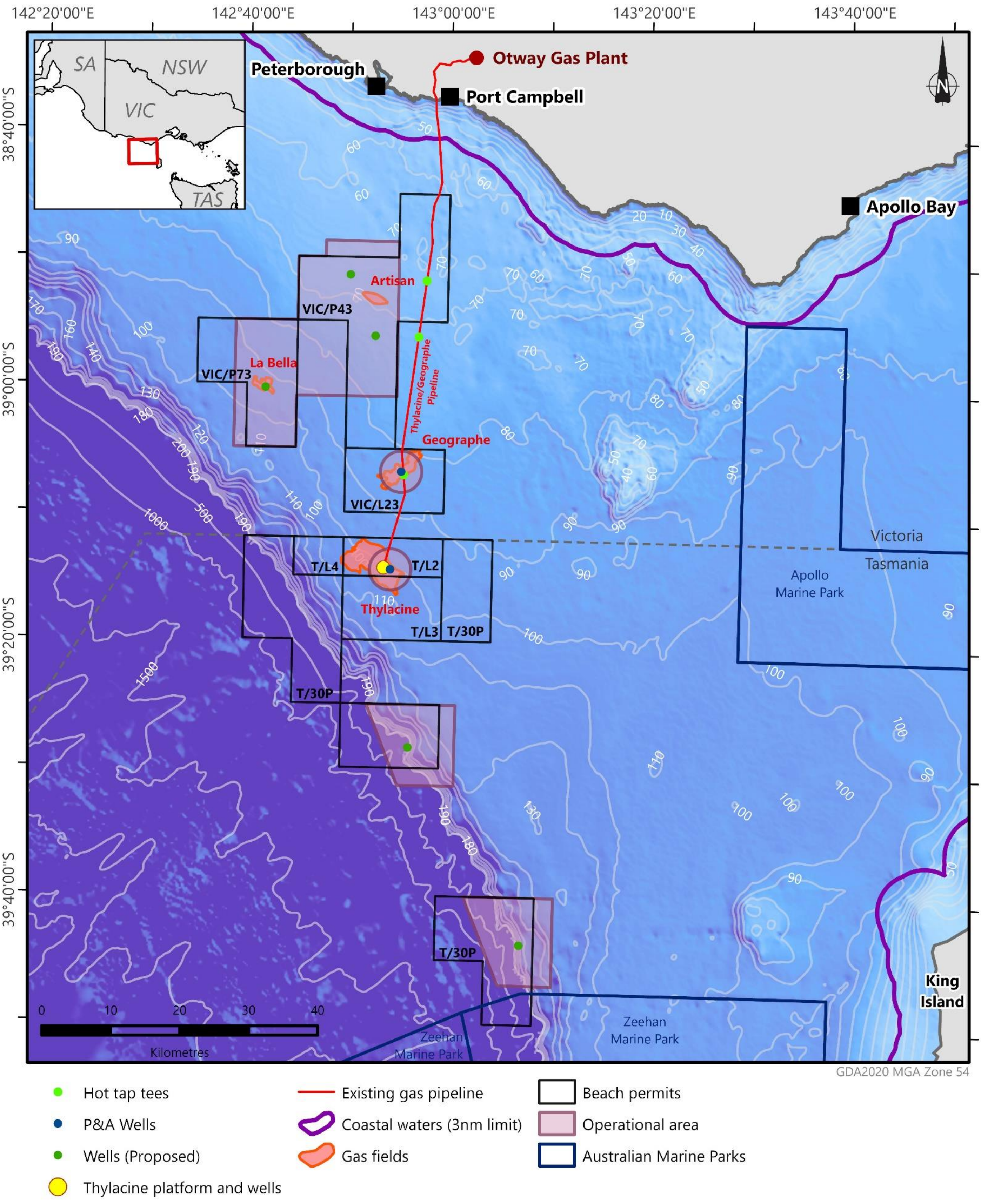
Drilling wells

- **Up to five exploration, appraisal or production wells.**
- **Activities planned for no earlier than March 2025.**

Completing wells

- Completing up to four successful wells.
- Contingent P&A of one suspended well
- Activities planned for no earlier than early 2026.

Otway Basin activity location map



11/09/2024

This map is provided as a general reference only and is not intended to be used for any other purpose.
No warranty is provided in relation to the accuracy of the information contained in this map.

OT24-0028_R3

Project timing

Preliminary activities would start from November 2024 with seabed assessments to determine suitable drilling and infrastructure locations. Subject to internal and external approvals, P&A of suspended legacy wells and drilling of new wells would commence from March 2025 and may continue up to January 2026.

Each well would take between 30 to 40 days to drill depending on whether the well is viable and will be developed for production. Each P&A well would take approximately 15 to 20 days.

The timing of activities will be subject to final approvals, the availability of the drilling rig after it completes programs of works for other companies and weather conditions. Beach will provide a detailed activity schedule prior to commencement.

Project locations

The OGV Project includes both the Otway and Bass offshore basins. In the Otway Basin two legacy wells would be P&A and up to five wells would be drilled. In the Bass Basin three legacy wells would be P&A. At this stage (and for purpose of the Environment Plan) no exploration or appraisal drilling is planned in the Bass Basin. All new wells will be within existing permits and the indicative well locations are shown in the map on page 2.

Environment protection regulations

The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), regulates activities in accordance with *the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations (2023)* (Environment Regulations). The OGV Project will require Environment Plans (EPs) to be accepted by NOPSEMA before commencement of activities. EPs will be prepared for different activity phases, including one EP covering drilling and P&A activities.

EPs must include a description of the existing environment, the proposed activities, an evaluation of the impacts and risks, environmental performance outcomes and controls, implementation strategy, and reporting requirements. They must also demonstrate that consultations with relevant persons whose functions, interests or activities may be affected by the activities in the EP ('relevant persons'), have been carried out in accordance with the regulations.

For successful gas wells that would be developed for production, an Offshore Project Proposal (OPP) will be required and will undergo a public consultation phase. Once an OPP is accepted, further EPs will be required for construction activities and commissioning the new wells.

Environment description

EPs will include a detailed description of the existing environment in the immediate operational area and in the broader emergency planning area where there is a variety of marine fauna, including the presence of:

- Blue, humpback and fin whales, particularly during the summer months.
- Southern right and minke whales, particularly during the winter months.
- Common dolphins and shark species throughout the year.
- New Zealand and Australian fur seals throughout the year.
- Migratory birds.

There will be no drilling within marine parks. However, within the broader emergency planning area, there are National Marine Parks and State Marine Protected areas (see map).

Socio-economic and cultural values and sensitivities within the activity and emergency planning areas include:

- Commonwealth managed fisheries, including southern and eastern scalefish and shark, and southern squid jig fishery.
- Victorian managed fisheries, including rock lobster and giant crab.
- Commercial shipping activity.
- Sea Country cultural values and sensitivities held by First Nation peoples.
- Shipwrecks, primarily in close shoreline proximity.
- Recreational fishing.
- Recreational diving focussed on shipwrecks and reefs close to the shoreline.
- Signficant tourism features and activities associated with the Great Ocean Road, Twelve Apostles and Bay of Islands Coastal Park.

Impacts, performance outcomes and controls

Beach recognises the environmental, cultural, heritage, social and economic values in our activity and planning areas.

We have a proud track record for safety and environmental performance, adhering to performance measures set out in EPs and Safety Cases accepted by regulators.

EPs will detail potential impacts on the environment, and provide performance outcomes and standards, and control measures to reduce and manage environmental impacts and potential risks to ALARP and acceptable levels, and follows the principles of ecologically sustainable development. ALARP stands for 'As Low As Reasonably Practicable'. It is an assessment principle commonly used in the oil and gas industry to assess and reduce potential impacts and risks that cannot be eliminated. For information on how NOPSEMA assesses ALARP see: ALARP Guidance Note (nopsema.gov.au).

A summary of the key impacts, mitigations and management plans can be found here.

Marine mammal protection

EPs will set out detailed control measures that are consistent with marine mammal management plans that have been produced by the Federal Government under the *Environment Protection and Biodiversity Conservation (EPBC) Regulations (2000)*.

These control measures are based on the avoidance of collision or entanglement of marine mammals, reducing vessel speeds, and minimising any anchor lines. The control measures also focus on the reduction of marine noise from vessel and drilling rig activities, so any noise produced does not impact the behaviour of a protected marine mammal.

Dedicated Marine Mammal Observers will be deployed on vessels to advise vessel captains and the drilling rig of protected marine mammals near our activities.

All whale sightings will be recorded along with the actions taken to avoid potential impacts.

Commercial fishing control measures

The project activities would occur among commercial Commonwealth and State fisheries, which cover vast areas. The drilling activities require access to relatively small areas for short periods of time as described in the Project Timing section. EPs will set out detailed assessment of fisheries and fishing activity that may overlap the project activities.

Beach will consult with commercial fishers on arrangements to ensure each other's operational plans are understood, helping to minimise any impacts to fishing activities and to the OGV Project.

Beach will provide regular updates on its operations to fishing associations throughout the duration of the activities.

Beach has a *Fair Ocean Access* procedure, which sets out Beach's commitment to consultation, minimising impacts of its activities, the circumstances in which a fisher may claim compensation, the evidence required and the claim process.

Recognising cultural values and sensitivities

The project operations would occur in the Sea Country adjacent to coastal First Nations groups including: Eastern Maar Aboriginal Corporation; Gunditj Mirring Traditional Owner Corporation; Wadawurrung Traditional Owners Corporation; Bunurong Land Council Aboriginal Corporation; Gunaikurnai Aboriginal Land Council Tasmania; Flinders Island Aboriginal Association; and Tasmanian Aboriginal Centre.

Beach is consulting with these groups to identify cultural values of Sea Country so that they can be assessed for any potential impacts and control measures that may be required in the preparation of the drilling EP (and other EPs).

In addition to cultural values identified through consultation, Beach has engaged a suitably qualified maritime archaeologist who will assess data gathered in the seabed assessment surveys. For any identified cultural landscape values and sensitivities within the activity area an underwater cultural landscape management plan will be developed.

Operating safely

At Beach, safety takes precedence in everything we do. The drilling rig would have a dedicated Safety Case that requires approval from NOPSEMA. Marine vessels and the drilling rig contracted by Beach will operate in accordance with Australian Maritime Standards, regulated by the Australian Maritime Safety Authority (AMSA). This includes adherence to the following protocols at sea:

- Notifications to the Australian Hydrographic Office before mobilising to the operational area, moving to different drilling locations, and when demobilising.
- Communication with other vessels and marine users will occur using standard maritime protocols.
- Safe operating distances will be maintained around all vessels and the drilling rig at all times.
- Compliance to Navigational Safety requirements, including lighting and Automatic Identification System.

Exclusion zones

When the drilling rig is on a well location, all vessels are required to be abide by a 3 km radius cautionary zone around the drilling rig. The cautionary zone is to allow for anchors, mooring chains, and wire to be placed within the operational area during the drilling program. Exact locations of mooring chains and anchors would be made available before the start of drilling each well.

There will also be a Petroleum Safety Zone (PSZ) of 500 m around the drilling rig during operations and for each well before and after drilling. Beach will communicate new PSZs created for wells and equipment to marine users as part of its ongoing consultation. PSZs are administered by NOPSEMA under Section 616 of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act). PSZs extend for a radius of up to 500 m and are gazetted around wells, structures, and equipment.

Entry into PSZs is prohibited to all except those vessels authorised to do so by NOPSEMA (as detailed in the gazetted notice) or exempt under Section 615 of the OPGGS Act. PSZs are shown as a 'Restricted Area' on navigation charts.

Emergency planning

When conducting any offshore activity, there is an extremely unlikely risk of release of hydrocarbon (which is primarily gas) from a well during drilling or from marine vessel fuel in the event of an accident.

Beach standard operating procedures include emergency response plans, which are included in EPs. Preparing emergency response plans involves modelling of all possible hydrocarbon releases in the local area using a worst-case scenario, assuming no control measures are in place. The modelling calculates the transport, spreading, entrainment and evaporation over time, using data on the prevailing metocean conditions (wind, wave, and climate), the volume released, and the physical and chemical properties of the hydrocarbons.

The modelling determines the full extent of the ‘Environment that may be affected’ known as the EMBA. EPs must describe the EMBA (see map) and include an assessment of the likelihood and consequences of any hydrocarbon release, which must be reduced to ALARP through a range of control measures and include detailed response plans.

An emergency response plan describes the arrangements that must be in place for responding to and monitoring any release of hydrocarbon and include:

- 24/7 on-call team for rapid response clean-up actions, including mobilisation of personnel and equipment.
- 24/7 on-call team for modelling and monitoring of a hydrocarbon release to inform response activities, and monitoring of effectiveness of response activities.
- Control measures necessary for ensuring rapid response and maintenance of capabilities (personnel and equipment).

These arrangements are based on the worst-case event associated with the proposed activities to ensure that Beach has the appropriate level of response arrangements and capability.

Beach maintains a current contract with Australian Marine Oil Spill Centre (AMOSC) based in Geelong for access to spill response resources and personnel. In Victoria, the Department of Transport is the control agency for marine pollution emergencies. Beach also conducts exercises to test the emergency response plans and identify any issues and improvements before, and during, operations.

For more information on hydrocarbon release modelling and why it is required for the preparation of EPs, click here to watch a video on the NOPSEMA website.


Transocean Equinox Semi-submersible drill rig

Offshore drilling approach

Depending on the size and geological structure of hydrocarbon reservoirs, the sequence of drilling often involves:

1. an exploration well into a prospective hydrocarbon reservoir identified in a previous seismic survey.
2. an appraisal well to establish the size of the reservoir.

then completing a well to become a production well that would be tied back to a platform and/or pipeline.

Beach’s program of work would be optimised in well design and equipment so that exploration and appraisal wells would be drilled to the same specifications as a production well. By taking this approach, if the wells are assessed as viable for production, at the end of drilling they would be completed ready for connection. If they are assessed as unviable, they would immediately undergo the formal P&A process.

This approach will reduce the number of drilling activities and the time taken to explore, appraise and convert a well through to production, thereby also reducing environmental impacts from the activities.

Key steps in the drilling program

The approach to drilling is summarised in the following key steps *(see diagram over page)*.

- Using an approved shipping route specialist anchor handling vessels (AHSVs) will manoeuvre the drilling rig into place.
- Mooring equipment will be pre-laid by the AHSVs and the rig will be connected at sites determined as suitable by the seabed assessments.
- Conductor and surface hole sections will be drilled and cased, then a marine riser and Blow-out Preventer (BOP) installed.
- The well would then be drilled to reach the gas reservoir beneath the seabed.
- The rig would be moved from one well to the next, repeating the anchoring and drilling process.

Drilling methodology

Beach would use the Transocean Equinox, which is a modern semi-submersible drilling rig designed for harsh weather and sea conditions. It can operate in waters up to 500 m deep, drill for gas at up to 8,500 m deep and accommodate 130 crew.

This type of drilling rig is commonly used for operations on the Norwegian Continental Shelf. Its design incorporates the latest technologies that mechanise hazardous operations enhancing the safety of personnel, improves fuel efficiency and utilises emissions reduction and monitoring systems.

The rig is equipped with a marine riser and Blow Out Preventer (BOP) which is a highly specialised valve unit weighing approximately 244 tonnes and measuring 14 m high. A BOP is used in all drilling operations however the offshore rig BOP is more robust with 100% duplication of functionality.

The BOP is used to shut-in and seal off a well in the event of an unplanned pressure build up or ‘kick’. Beach engineers use a rigorous process for the design of construction and operation of wells which, when combined with the rig contractor procedures and BOP equipment, ensures:

- well integrity throughout the drilling process and, in the case of production wells throughout the well lifecycle.
- ongoing personnel safety.
- prevention of any environmental incidents.

The drilling process would run over several stages starting with a top-hole section of approximately 91 centimetres in diameter, then reducing in diameter to consecutively smaller sizes until the well reaches the final target depth. For each section, a casing (steel pipe) would be placed in the hole and cemented in place, then a smaller drill bit would be run through the casing to drill a smaller hole to the next target depth and the process repeated to reach the final depth. This is usually several kilometres below the seabed.

Drilling muds

Beach OGV Project drilling operations would use only water-based fluids called ‘muds’ to lubricate and stabilise the wellbores in each section and remove drilling cuttings. Drill cuttings are rock chips from the sedimentary layers that emerge from the drilling process and would range from very fine to coarse in size.

Water based muds are recycled as much as possible during the drilling process. The cuttings would be processed on the drilling rig before they are discharged overboard, where they will settle rapidly on the seafloor around the well site. This is standard industry practice in Australia.

Marine mammals and fish may transit through these areas but will usually avoid the temporary disturbance. Any exposure to suspended sediment before it settles on the seabed will be highly localised and temporary due to high dilution and fast dispersal in the water column.

Production well connections

When the production wells have been completed, they would be connected to seabed infrastructure and the existing offshore to onshore pipeline.

Some seabed infrastructure for tying in the new wells is already in place and connected to the existing pipelines.

Additional infrastructure for any new production wells would also be installed to tie-in to the existing pipeline.

New infrastructure would typically include:

- Diving Integration Skid, which is a module that is installed on the seabed by divers from a dive support vessel and connected to an existing pipeline connection (hot tap) or offshore platform, ready for later connection of flowlines from the wells.
- Flowlines and various subsea connection modules to connect the production wells to the existing platform and pipeline.
- Electrical and hydraulic controls within cables that enable remote monitoring and control of the production wells.
- Concrete mattresses will be installed over the flowlines and/or umbilicals for stabilisation and protection as required.

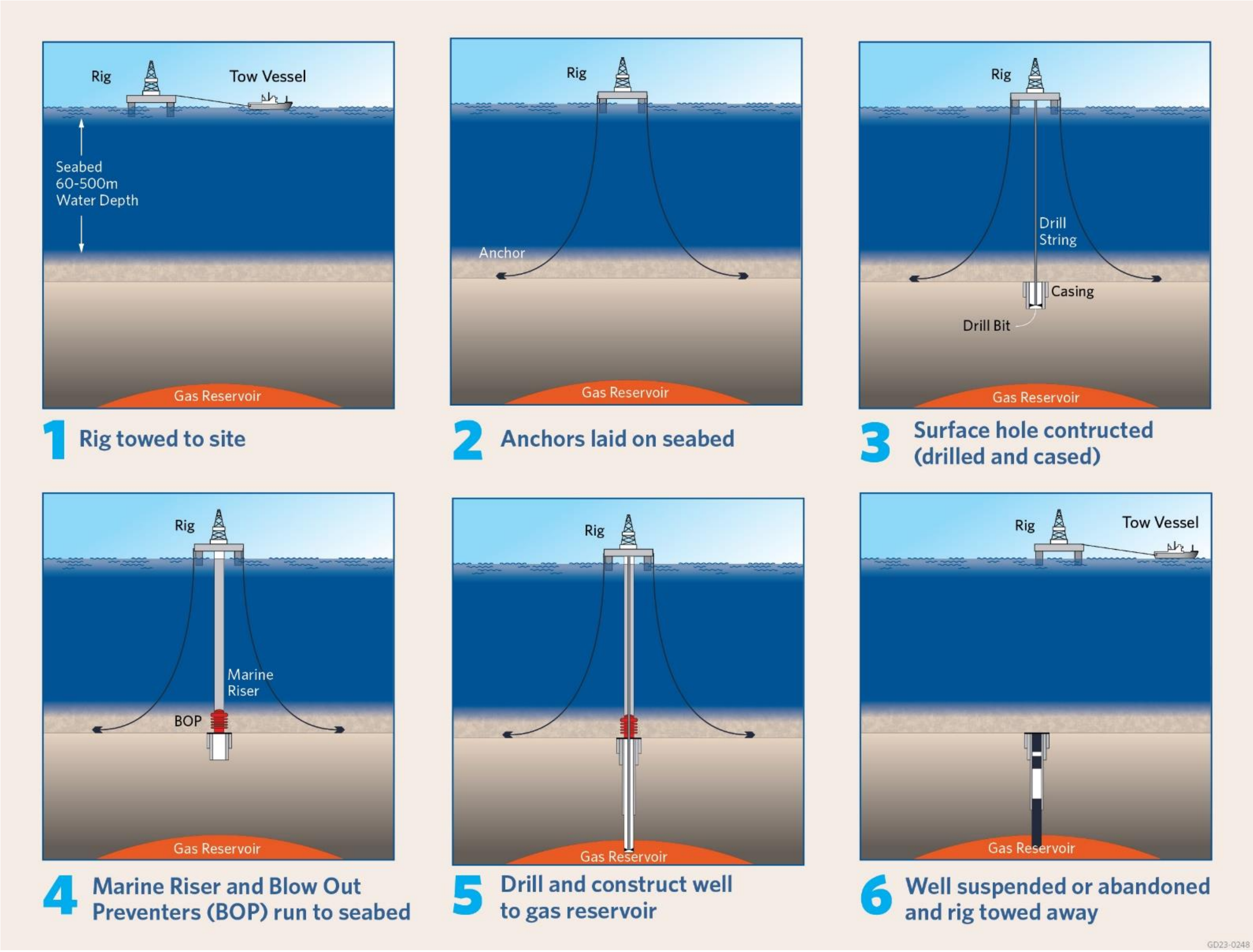
A construction support vessel using an ROV would install the equipment and commission the production wells after they are connected.

Plug and abandonment process

If a well is commercially unviable, and for the removal of existing suspended wells, a formal plug and abandonment process would be carried out. Beach engineers design the well abandonment in compliance with the Norwegian Norsok and Oil and Gas UK standards industry best practice and guidelines, for example the Oil and Energy UK (OEUK) guidelines; standards that are recognised by NOPSEMA as current industry best.

Multiple cement plugs would be installed within the well to permanently seal the well and isolate any productive or water bearing formations reservoirs or hydrocarbon bearing zones.

An additional cement plug would be installed at the seabed and all casings will be cut and recovered from at least 2 m below the mudline to ensure that the seabed is returned to the same condition as it was prior to drilling operations commencing.



1 Rig towed to site

2 Anchors laid on seabed

3 Surface hole contructed (drilled and cased)

4 Marine Riser and Blow Out Preventers (BOP) run to seabed

5 Drill and construct well to gas reservoir

6 Well suspended or abandoned and rig towed away

Consultation with Relevant Persons

Purpose of consultation

Consultation with Relevant Persons is an important part of developing EPs as its purpose is to ensure that potential impacts have been identified and appropriate measures adopted because of the consultations.

Beach Energy is providing - and will continue to provide - a range of consultation methods and opportunities including an online consultation hub (Engage Beach) where you can ask questions, as well as information sessions, online webinars, phone calls, emails and meetings. Please contact us if you would like to discuss your preferred approach to consultation.

Relevant Persons

A 'Relevant Person' is defined in the Regulations as including a person or organisation whose functions, interests or activities may be affected by the activities to be carried out under an EP.

Please contact us if you would like to discuss your functions, interest or activities in relation to the activities proposed under the Well Completions & Interventions EP.

If you know of any person or organisation who you believe may be a Relevant Person, please pass on our contact details to them.

Sufficient information

The Regulations also require that Relevant Persons must be provided sufficient information to allow them to make an informed assessment of the possible consequences of the EP activity on their functions, interests or activities.

At the online engagement hub Engage Beach you will find information prepared in a variety of styles including short summaries; long descriptions; diagrams; maps; questions and answer formats; and detailed information on a range of topics related to the activities.

Please contact us if you would like to discuss information you are seeking in relation to EP activities.

Reasonable period

The Regulations also require that titleholders allow Relevant Persons a reasonable period of time for consultation. What is a reasonable period for consultation will depend on the nature of an activity, the potential impacts and risks on a relevant person's functions, interest or activities, and is considered on a case-by-case basis.

Sensitive information

In accordance with regulations, each EP must include a report on all consultations and a copy of the full text of any response by a Relevant Person.

Relevant Persons may request that the information they provide not be published, and it will be identified as sensitive information and not published in the Environment Plans.

NOPSEMA consultation brochure

For further information regarding consultation, please see NOSPEMA's Brochure titled 'Consultation on offshore petroleum environment plans', found here.

Contact us

Please contact us if you would like further information, have any questions, or feedback, or wish to consult with us about how the activities in the Drilling Program EP may impact your functions, interests or activities.

Beach will take into consideration all feedback, including any concerns or objections and will explore measures to reduce any impacts and risks.

Online: www.engage.beachenergy.com.au

Phone: 1800 797 011

Email: community@beachenergy.com.au

Offshore Gas Victoria Project

Well Completions, Well Interventions and Plugging and Abandonment EP

Information Sheet | 16 September 2024

On 16 September 2024, Beach commenced consultation in the course of preparing the Well Completions, Well Interventions and Plugging and Abandonment Activities Environment Plan (**Well Completions and Interventions EP**). This information sheet has been prepared to provide information on the proposed activities under the Well Completions and Interventions EP for the purpose of consultation with relevant persons, in accordance with the regulatory regime.

Project overview

Through production at the Otway Gas Plant near Port Campbell and the Lang Lang Gas Plant, 80 kms south-east of Melbourne CBD, Beach Energy (**Beach**) supplies natural gas to the east coast market, which delivers energy to Victorian homes, business and industry.

Beach safely drilled one exploration well and six production wells in its Otway Basin offshore Commonwealth permits from February 2021 to July 2022. Four production wells from that project have been connected and are now producing gas for the east coast market, with two remaining wells planned for connection in late 2024.

Beach is continuing its commitment to supply natural gas to the east coast gas market and, in June 2023, commenced consultation on Offshore Gas Victoria (**OGV**) Project activities in the course of preparing Environment Plans and an Offshore Project Proposal. OGV consists of a number of activities that would occur in several phases (below) subject to approvals.

Following seabed assessments and drilling phases (including the planned plugging and abandonment (**P&A**) of legacy suspended wells and the drilling of exploration or appraisal wells) the next phase* of activities would include well completions, well interventions, and one potential additional P&A activity. These are summarised in the diagram below.

Seabed assessments

- Assessment of suitable location for drilling rig and new seabed infrastructure to connect wells.
- Activities planned for no earlier than November 2024.

Removing wells (P&A)

- Removal of five legacy suspended wells through a formal procedure (P&A).
- Activities planned for no earlier than March 2025.

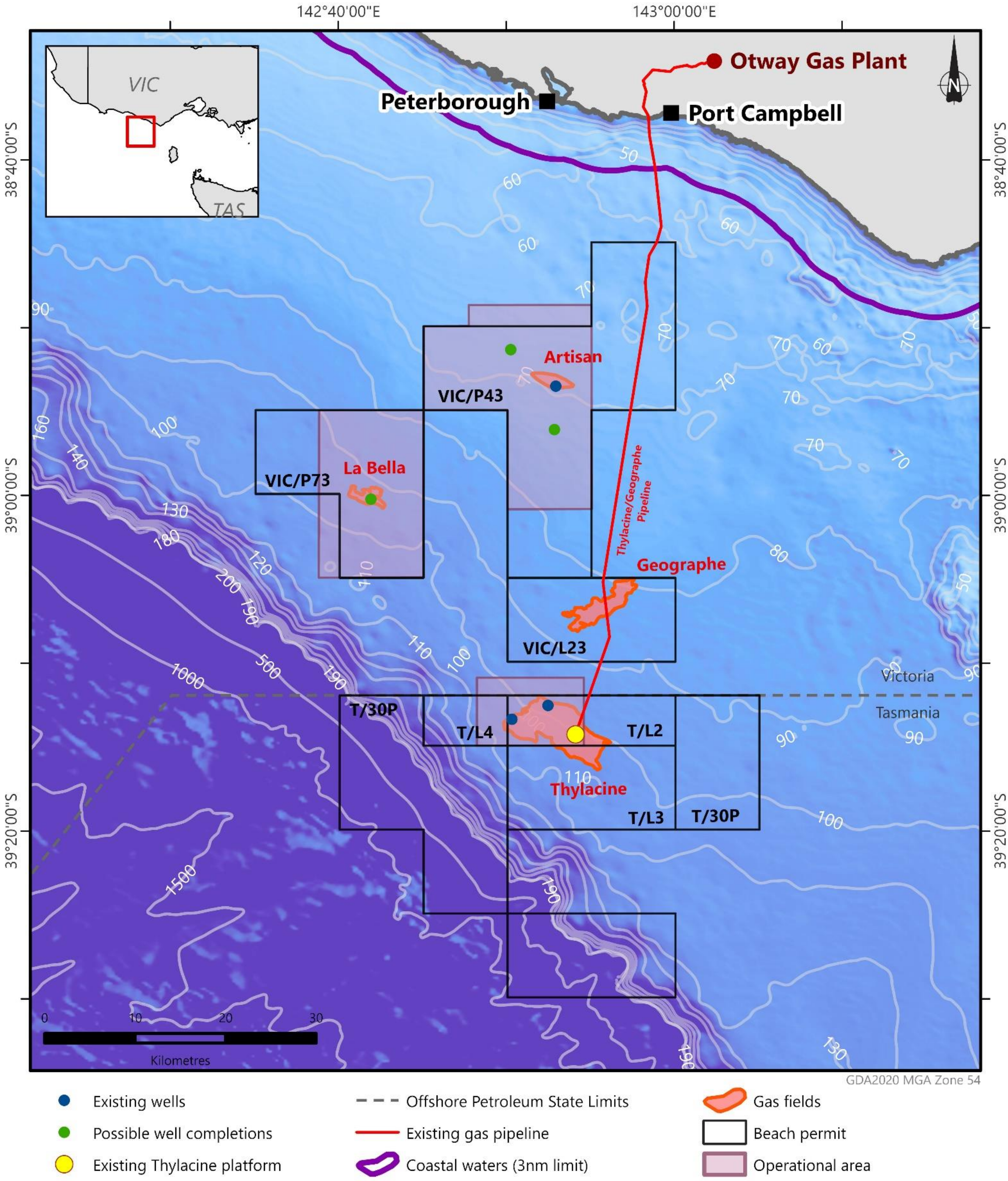
Drilling wells

- Up to five exploration, appraisal or production wells.
- Activities planned for no earlier than March 2025.

***Completing wells**

- **Completing up to four successful wells.**
- **Contingent P&A of one suspended well**
- **Activities planned for no earlier than early 2026.**

Location map



12/09/2024

This map is provided as a general reference only and is not intended to be used for any other purpose.
No warranty is provided in relation to the accuracy of the information contained in this map.

OT24-0028A_R3

Activity timings

The Well Completions and Interventions EP activities are expected to be undertaken between 1 January and 31 December 2026, and would take approximately 145 days to complete, including:

- 25 days per well for the installation of subsea equipment and well completions activities
- 15 days per well for intervention activities
- 15 days for contingency P&A activities at one location.

All timings are approximate and will be subject to final approvals, the availability of the drilling rig after it completes programs of works for other companies, weather conditions and prior drilling results.

Beach will provide a detailed schedule of times, locations and activities prior to the commencement of the relevant activities.

Activity locations

The activities would be carried out in the Otway Basin in offshore Commonwealth waters, approximately 20 km south of Victoria's mainland and 90 km north-west of Tasmania (King Island) at its closest points, in water depths ranging from 65 m to 190 m. All activities would be within existing Beach permits, the locations of which are shown in the maps on page two of this information sheet.

Seabed assessment activities will occur prior to drilling wells to ensure precise locations for the operation of the drill rig and, ultimately, the wells that will be drilled. Should the location of wells be modified after the seabed assessment activities have been completed (see details here), Beach will advise all Relevant Persons and provide an updated map.

Well completions activities

Well completion is the process of preparing a well for production after it has been successfully drilled. It involves installing production and flow control equipment within the wellbore on the seabed and completing the final construction of the well. Each well will have a wellhead that supports the production well casing. Completions operations are conducted with well control equipment called a blow-out preventer (**BOP**) and a subsea production tree (**subsea tree**) placed on the seabed at or near the site of the well.

The BOP is a highly specialised series of valves used in all offshore drilling, weighing approximately 244 tonnes and measuring 14 m high. The BOP is used to shut-in and seal off a well for planned operations such as pressure testing and in the event of a pressure build up. It ensures well integrity throughout the drilling and completion process, ongoing safety of personnel and prevention of any environmental incidents.

Well completion activities may be undertaken for up to four wells and (for each well) includes:

- installing the subsea tree
- preparing the wellbore for lower and upper completion installation
- installing the completion equipment
- perforating the production casing
- flowing the well back to surface facilities for clean-up.

The subsea tree is a set of valves and fittings installed directly on top of the wellhead that:

- controls the flow of fluids from the well to subsea production facilities and flowlines
- controls chemical injections
- monitors production
- regulates flow rates with hydraulic valves and chokes.

Well flowback and clean-up will be performed on each well that is to be completed. The flowback fluid is expected to consist of (in order of arrival at the rig-based well test package):

- low density fluid
- completion brine
- drilling fluid filtrate
- reservoir fluids (including hydrocarbon gas, condensate, formation and condensed water)

Depending on the hydrocarbon reservoir and well construction process, there could also be minimal levels of solids such as sand/rock/debris remaining from the drilling process.

Reservoir fluids recovered during well clean-up will be directed to a rig-based well test package where the fluids will be separated, measured and either flared (hydrocarbons) or treated for overboard discharge (non-hydrocarbons) or disposal onshore.

Well intervention activities

Well interventions are carried out to improve the performance of a well that has not been operating to its potential or requires modification or maintenance. Intervention activities would be carried out to:

- allow additional sub-seabed surface geological zones to produce
- close off zones that are no longer required
- repair or replace downhole completion equipment.

Intervention activities will occur at up to two existing well locations located in petroleum title T/L2 (see location map on page two). The activities would include:

- positioning the drilling rig over the existing well and connecting to pre-laid mooring lines and anchors
- installing the BOP
- installing intervention pressure control equipment and de-suspending the well
- accessing a zone of interest and isolating (and potentially reopening) the applicable production zone
- re-suspending the well
- recovering the BOP
- (at the conclusion of the well intervention activities described above) releasing the drilling rig from the mooring spread and leaving the location.

Plugging & abandonment activities

The P&A process is used to:

- close exploration wells that are assessed as unsuccessful immediate after drilling
- decommission operational wells that are no longer commercially viable, or
- remove suspended wells.

Under the Well Completions and Interventions EP, P&A activities might be undertaken at one suspended well that was drilled and suspended in a previous project. This decision has not yet been made by Beach. If undertaken, P&A activities would include installation of multiple cement plugs within the well to permanently seal the well. An additional cement plug would be installed at the seabed and all well casings would be cut and recovered from at least 2 m below the seabed/mudline.

Environment protection regulations

NOPSEMA regulates activities in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023* (**Regulations**)[1]. The OGV Project requires Environment Plans (**EPs**) to be accepted by NOPSEMA before beginning activities. EPs will typically be prepared for different activity phases; in the present case, Beach is preparing one single EP covering the well completions, well interventions, and P&A activities described in this information sheet.

EPs must include:

- a description of the existing environment
- the proposed activities
- an evaluation of the impacts and risks, environmental performance outcomes and controls, implementation strategy, and reporting requirements.

EPs must also demonstrate that consultations with relevant persons whose functions, interests or activities may be affected by the activities in the EP (**relevant**

---

[1] Under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth).

persons), have been carried out in accordance with the Regulations.

For successfully drilled gas wells within the OGV Project that will be developed for production, an Offshore Project Proposal (**OPP**) is required. Beach has developed an OPP for the OGV Project, completed the Public Comment Period for the OPP and it is currently under assessment by NOPSEMA.

Environment description

EPs include a detailed description of the Environment that May Be Affected (**EMBA**) by the activities described in the EP. The EMBA is the largest geographic area where operational activities could potentially have a direct or indirect environmental impact under worst-case scenarios.

The EMBA includes both the **operational area** for activities and a **planning area** where emergency response plans must be ready for activation in the unlikely event of an accident. The EMBA map can be found on page seven.

EMBAs are also used to define the broadest area where environmental values and sensitivities are defined, the potential impacts assessed, and control measures to mitigate these impacts are developed.

The defined EMBA for the Well Completions and Interventions EP include the following marine fauna which may be present in the area at various times during the activities described in the EP:

- Blue, humpback and fin whales, particularly during the summer months
- Southern right and minke whales, particularly during the winter months
- Common dolphins and shark species throughout the year
- New Zealand and Australian fur seals throughout the year
- Migratory birds.

Importantly, Beach will not be conducting regulatory activities within marine parks. However, within the broader planning area for emergencies, there are National Marine Parks and State Marine Protected areas (see map).

Socio-economic and cultural values and sensitivities within the EMBA include:

- Commonwealth managed fisheries, including southern and eastern scalefish and shark, Bass Strait zone scallop fishery and southern squid jig fishery
- Victorian, South Australian and Tasmanian managed fisheries, including rock lobster and giant crab
- Commercial shipping activity
- Offshore Wind Industry
- Subsea cables
- Sea Country cultural values and sensitivities held by First Nation peoples
- Shipwrecks, primarily in close shoreline proximity
- Recreational fishing
- Recreational diving focussed on shipwrecks and reefs close to the shoreline
- Significant tourism features and activities associated with the Great Ocean Road, Twelve Apostles and Bay of Islands Coastal Park.

Impacts, performance outcomes and controls

Beach recognises the environmental, cultural, heritage, social and economic values in our operational areas and planning areas.

Beach has a proud track record of successful safety and environmental performance, adhering to performance measures set out in EPs and Safety Cases accepted by regulators.

The Well Completions and Interventions EP will detail potential impacts on the environment, and provide performance outcomes and standards, and control measures to reduce and manage environmental impacts and potential risks to ‘As Low As Reasonably Practicable,’ known as ALARP, and acceptable levels. They follow the principles of ecologically sustainable development. ALARP is an assessment principle commonly used in the oil and gas industry to assess and reduce potential impacts and risks that cannot be eliminated. For information on how NOPSEMA assesses ALARP see: ALARP Guidance Note.

A summary of the key impacts, mitigations and management plans can be found here.

Marine mammal protection

The Well Completions and Interventions EP will set out detailed control measures that are consistent with marine mammal management plans that have been produced by the Federal Government under the *Environment Protection and Biodiversity Conservation Regulations 2000* (Cth)[2].

These control measures are based on the avoidance of collision or entanglement of marine mammals, reducing vessel speeds, and minimising length and number of anchor lines. The control measures also focus on the reduction of marine noise from vessel and drilling rig activities, so that any noise produced is managed such that biologically important behaviours can continue while the activity is being undertaken.

Dedicated Marine Mammal Observers will be deployed on vessels to advise vessel captains and the drilling rig operator of protected marine mammals near Beach's activities. All whale sightings will be recorded along with the actions taken to avoid potential impacts.

Commercial fishing control measures

The Well Completions and Interventions EP activities will occur among commercial Commonwealth and State fisheries zones that cover vast areas. Beach's activities will require access to relatively small areas within these fishing zones, and then only for short periods of time. The Well Completions and Interventions EP will set out detailed assessment of fisheries and fishing activity that may overlap with the project activities.

Beach will consult with commercial fishers on arrangements to ensure each other's operational plans are understood, helping to minimise any impacts to fishing activities and to the EP activities.

Beach will provide regular updates on its operations to fishing associations throughout the duration of the activities.

Beach has a *Fair Ocean Access* procedure that sets out Beach's commitment to consultation, minimising impacts of its activities, the circumstances when a fisher may claim compensation, the evidence required and the claim process.

Exclusion zones

When the drilling rig is on a well location, all vessels are required to be abide by a 3 km radius cautionary zone around the rig. The cautionary zone is to allow for anchors, mooring chains, and wires to be placed within the operational area during the well completions, well interventions and P&A program. Exact locations of mooring chains and anchors will be made available before the start of activities at each well.

There will also be a Petroleum Safety Zone (**PSZ**) of 500 m around the drilling rig during operations and for each well before and after activities. Beach will communicate new PSZs created for wells and equipment to marine users as part of its ongoing consultation. PSZs are administered by NOPSEMA under Section 616 of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth) (**OPGGS Act**). PSZs extend for a radius of up to 500m and are gazetted around wells, structures, and equipment.

Entry into PSZs is prohibited to all except vessels authorised to do so by NOPSEMA (as detailed in the gazetted notice) or exempt under Section 615 of the OPGGS Act. PSZs are shown as a 'Restricted Area' on navigation charts.

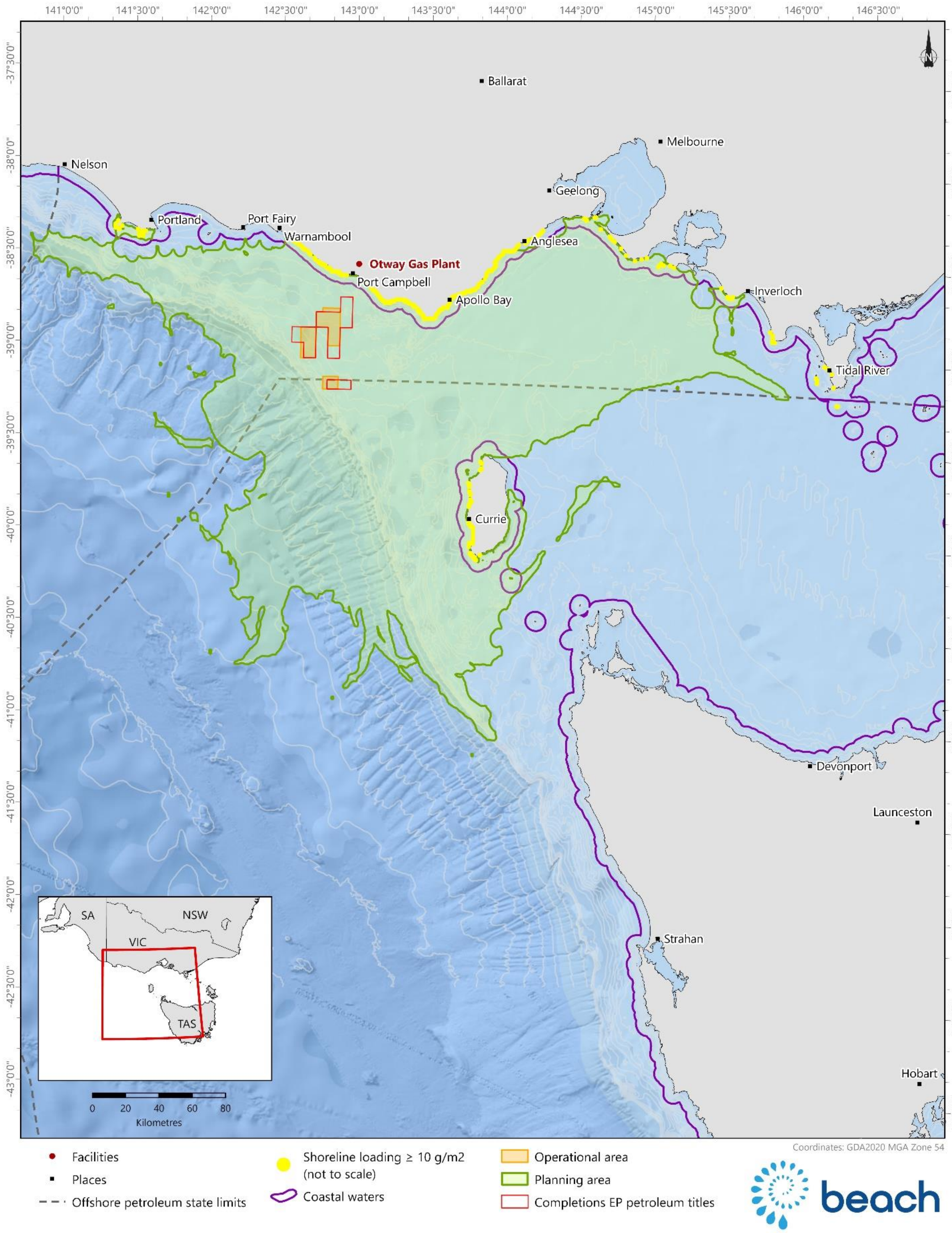
Recognising cultural values and sensitivities

Beach has identified and will consult with relevant First Nations groups to identify cultural values of Sea Country so that they can be assessed for any potential impacts and control measures that may be required in the preparation of the Well Completions and Interventions EP.

---

[2] Under the *Environment Conservation and Biodiversity Protection Act 1999* (Cth)

EMBA map



Operational area: the area within which well completions, well intervention, and plug & abandonment activities are planned to occur (subject to final approvals).

Planning area: the broadest extent of the defined 'environment that may be affected' (EMBA). Note: The EMBA is the largest geographic area where operational activities could potentially have a direct or indirect environmental impact.

Shoreline loading: where hydrocarbons may reach the shoreline in the event of an accident. The maps show the modelling of over 200 scenarios in different weather conditions and times of the year. It does not represent what would occur in the event of a single accident.

This map is provided as a general reference only and is not intended to be used for any other purpose. No warranty is provided in relation to the accuracy of the information contained in this map.

16/09/2024 | OT24-0033A

Operating safely

Safety takes precedence in every activity undertaken by Beach. The drilling rig contracted by Beach will have a dedicated Safety Case that must be accepted by NOPSEMA. Marine vessels and the drilling rig will operate in accordance with Australian Maritime Standards, regulated by the Australian Maritime Safety Authority. This includes adherence to the following protocols at sea:

- notifications to the Australian Hydrographic Office before mobilising to the operational area, moving to different well locations, and when demobilising
- communication with other vessels and marine users will occur using standard maritime protocols
- safe operating distances will always be maintained around vessels and the drilling rig
- compliance with Navigational Safety requirements, including lighting and Automatic Identification System.

Emergency planning

When conducting any offshore activity, there is an extremely unlikely risk of a hydrocarbons release from a well (which is primarily gas) during well completions, well interventions or P&A activities or from marine vessel fuel in the event of an accident.

Beach's standard operating procedures include emergency response plans, which are included in all EPs. Preparing emergency response plans involves modelling of all possible hydrocarbon releases in the local area using a worst-case scenario, assuming no control measures are in place. The modelling calculates the transport, spreading, entrainment and evaporation over time, using data on the prevailing metocean conditions (wind, wave, and climate), the volume released and the physical and chemical properties of the hydrocarbons.

The modelling determines the full extent of the EMBA. The Well Completions and Interventions EP will describe the EMBA and include an assessment of the likelihood and consequences of any hydrocarbon release, which must be reduced to ALARP through a range of control measures and include detailed response plans.

An emergency response plan describes the arrangements that must be in place for responding to and monitoring any release of hydrocarbon and include:

- 24/7 on-call team for rapid response clean-up actions, including mobilisation of personnel and equipment
- 24/7 on-call team for modelling and monitoring of a hydrocarbon release to inform response activities, and monitoring of effectiveness of response activities
- control measures necessary for ensuring rapid response and maintenance of capabilities (personnel and equipment).

These arrangements are based on the worst-case event associated with the proposed activities to ensure that Beach has the appropriate level of response arrangements and capability.

Beach maintains a current contract with Australian Marine Oil Spill Centre based in Geelong for access to spill response resources and personnel. The Victorian Department of Transport is the control agency for marine pollution emergencies. Beach also conducts exercises to test the emergency response plans and identify any issues and improvements before, and during operations.

For more information on hydrocarbon release modelling and why it is required for the preparation of EPs, click here to watch a video on the NOPSEMA website.

Consultation with Relevant Persons

Purpose of consultation

Consultation with Relevant Persons is an important part of developing EPs as its purpose is to ensure that potential impacts have been identified and appropriate measures adopted because of the consultations.

Beach Energy is providing - and will continue to provide - a range of consultation methods and opportunities including an online consultation hub (Engage Beach) where you can ask questions, as well as information sessions, online webinars, phone calls, emails and meetings. Please contact us if you would like to discuss your preferred approach to consultation.

Relevant Persons

A 'Relevant Person' is defined in the Regulations as including a person or organisation whose functions, interests or activities may be affected by the activities to be carried out under an EP.

Please contact us if you would like to discuss your functions, interest or activities in relation to the activities proposed under the Well Completions & Interventions EP.

If you know of any person or organisation who you believe may be a Relevant Person, please pass on our contact details to them.

Sufficient information

The Regulations also require that Relevant Persons must be provided sufficient information to allow them to make an informed assessment of the possible consequences of the EP activity on their functions, interests or activities.

At the online engagement hub Engage Beach you will find information prepared in a variety of styles including: short summaries; long descriptions; diagrams; maps; questions and answer formats; and detailed information on a range of topics related to the activities.

Please contact us if you would like to discuss information you are seeking in relation to EP activities.

Reasonable period

The Regulations also require that titleholders allow Relevant Persons a reasonable period of time for consultation. What is a reasonable period for consultation will depend on the nature of an activity, the potential impacts and risks on a relevant person's functions, interest or activities, and is considered on a case-by-case basis.

Sensitive information

In accordance with regulations, each EP must include a report on all consultations and a copy of the full text of any response by a Relevant Person.

Relevant Persons may request that the information they provide not be published, and it will be identified as sensitive information and not published in the Environment Plans.

NOPSEMA consultation brochure

For further information regarding consultation, please see NOSPEMA's Brochure titled 'Consultation on offshore petroleum environment plans', found here.

Contact us

Please contact us if you would like further information, have any questions, or feedback, or wish to consult with us about how the activities in the **Well Completions & Interventions EP** may impact your functions, interests or activities.

Beach will take into consideration all feedback, including any concerns or objections and will explore measures to reduce any impacts and risks.

Online: www.engage.beachenergy.com.au

Phone: 1800 797 011

Email: community@beachenergy.com.au

Appendix O Project Light Modelling Report

Beach Energy Limited

Otway Offshore Gas Victoria Project

Light Emissions Study for Otway Basin Drilling Campaign

ASSIGNMENT P100465-S00
DOCUMENT P-100465-S00-A-REPT-001

XODUS

Perth

Level 1
1 William Street . Perth
WA 6000 . Australia

T +61 (0)86555 5600

www.xodusgroup.com

REVISIONS & APPROVALS

This document has been prepared by Xodus Group exclusively for the benefit and use of Beach Energy Limited. Xodus Group expressly disclaims any and all liability to third parties (parties or persons other than Beach Energy Limited) which may be based on this document.

The information contained in this document is strictly confidential and intended only for the use of Beach Energy Limited. This document shall not be reproduced, distributed, quoted or made available – in whole or in part – to any third party other than for the purpose for which it was originally produced without the prior written consent of Xodus Group.

The authenticity, completeness and accuracy of any information provided to Xodus Group in relation to this document has not been independently verified. No representation or warranty express or implied, is or will be made in relation to, and no responsibility or liability will be accepted by Xodus Group as to or in relation to, the accuracy or completeness of this document. Xodus Group expressly disclaims any and all liability which may be based on such information, errors therein or omissions therefrom.

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
R03	03/09/2024	Issued for Review	FC, BW	AC	AC	TF
R02	13/05/2024	Issued for Use	BW	AC	AC	TF
R01	24/04/2024	Issued for Review	FC	MH	AC	GN

CONTENTS

EXECUTIVE SUMMARY

This technical report presents the results of the visible line of sight and illuminance assessments for the initial drilling campaign in the Offshore Gas Victoria Project ('the Drilling Campaign') operated by Beach Energy's ('Beach'). The light modelling study was conducted for the Drilling Campaign within Beach's exploration permits – VIC/P43 and VIC/P73 located in the offshore Otway Basin. The Project Area of the Drilling Campaign is located approximately 20 km south of the Victorian mainland and 85 km north-west of Tasmania (King Island) at its closest points.

The sources of light emissions considered were the navigation lights on the derrick and the working lights on the main deck of the mobile offshore drilling unit (MODU). The light resulting from flaring from the MODU during well testing and completion was also included. A peak flare rate of 65 MMscfd was used with flaring occurring from a horizontal boom. The heights of the MODU infrastructure were assumed to be 84 m derrick height, 49 m flare location (32 m helideck height plus 17 m horizontal boom) and 21 m deck height above sea-level.

The threshold for the spatial extent of visible light (the Visible Light Exposure Area) that is predicted to occur from the Drilling Campaign was defined as whether any part of the facility is visible as a dot on the horizon (via visible line of sight assessment). The threshold for the spatial extent of a measurable change in ambient light that is predicted to occur from the Drilling Campaign (the Potential Impact Area) was defined as an illuminance equivalent to ambient light on a moonless clear night sky/new moon (<0.001 lux). The area within these thresholds is considered relevant to the impact assessment for planned light emissions from the Drilling Campaign.

The results of the visible line-of-sight assessment conclude that the MODU lights and flare will be visible from a distance of 38 km from receptors at sea level while, due to elevations on the mainland, the MODU will be visible from the Victorian mainland adjacent to the Project Area.

Illuminance assessment indicates that during flaring, a measurable change will occur up to 63 km from the expected position of the MODU and reduces to 10 km from the MODU when not flaring. At the selected receptor locations of Port Campbell National Park (19 km), Cape Otway Light Station Lookout (37 km), Warrnambool (53 km), and Currie (King Island, 102 km), the illuminance levels when flaring have been estimated to be approximately 0.0111, 0.0029, 0.0014, and 0.0004 lux respectively. These illuminance levels are comparable to the ambient light levels between a quarter moon and a new moon, except for Port Campbell National Park with a slightly higher illuminance level due to closer proximity to the Project Area of the Drilling Campaign, and Currie which is farthest away with an ambient light level between the new moon and moonless overcast night sky. When not flaring, the illuminance levels of all selected receptor locations are less than 0.001 lux, comparable to the ambient light levels less than a moonless clear night sky (new moon).

1 INTRODUCTION

1.1 Project Overview

The Offshore Gas Victoria Project ('the Project') operated by Beach Energy Limited ('Beach') focuses on exploration, appraisal and development of existing and future gas discoveries in Beach's exploration permits – VIC/P43 and VIC/P73 located in the offshore Otway Basin. The Project covers an area that is located approximately 20 km south of the Victorian mainland and 85 km north-west of Tasmania (King Island) at its closest points (Figure 1-1). The Project is adjacent to Beach's current production operations at the Geographe and Thylacine gas fields in the offshore Otway Basin.

The development concept for the Project is the subsea development. The stages of the Project will include an initial drilling campaign ('the Drilling Campaign') operated by a semi-submersible mobile offshore drilling unit (MODU). Successful wells will be tied back to existing Otway Gas Production Pipeline (OGPP) and/or Thylacine A platform via installation of new subsea flowlines and facilities. Recovered gas will be transported through the OGPP to the onshore Otway Gas Plant (OGP) located onshore near Port Campbell, Victoria. The OGP supplies gas to the domestic market in south-east Australia.

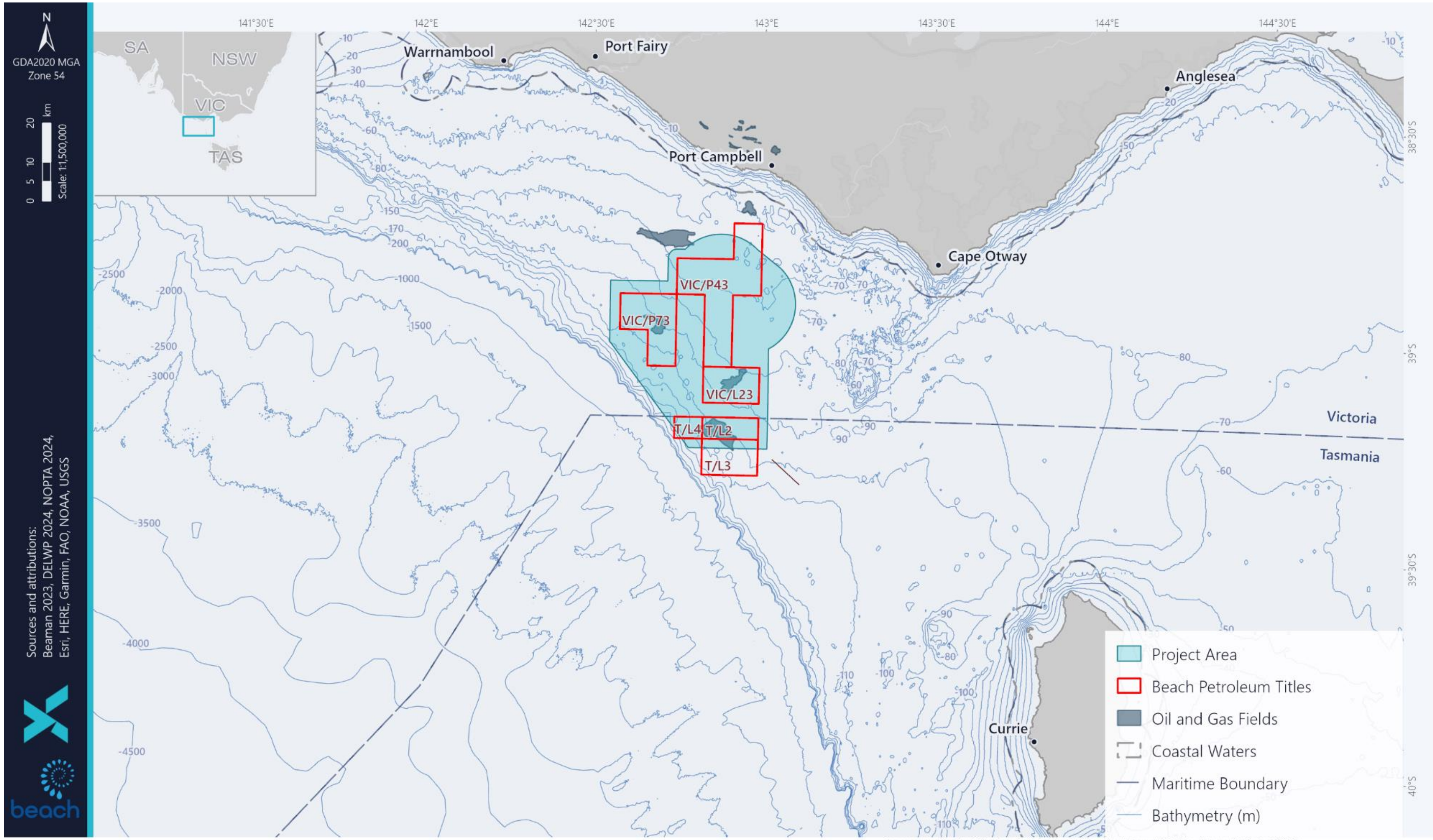


Figure 1-1: Project location.

1.2 Aim and Objectives

Beach has engaged Xodus to develop a Light Emissions study ('this study') for the Drilling Campaign to inform the Offshore Project Proposal (OPP), with the following objectives:

- Estimation of the visible line exposure area from the MODU.
- Estimation of the potential light impact area from the Drilling Campaign.
- Estimation of the illuminance level at the selected receptor locations.

1.3 Motivations and Constraint

Wildlife, particularly nocturnal species, are commonly sensitive to high-energy, short-wavelength ultraviolet (UV)/violet/blue light (Figure 1-2). There is mounting evidence that exposure to these wavelengths at night may affect human and wildlife physiological functions (DCCEEW, 2023).

Radiometric light measurements, which can detect and quantify all wavelengths from UV to infrared (IR), is a biologically relevant measure for understanding wildlife perception of light. The measurements include terms such as radiant flux, radiant intensity, irradiance and radiance. Photopic light measurements, on the other, is weighted to the sensitivity of the human eye. These measurements include terms such as illuminance and luminance. Table 1-1 shows the summary of the terms used for each measurement approach.

To date, light monitoring equipment has predominantly used photopic measurements. Although there are a few radiometric light measurement techniques available, most of them are still under experimental stage (DCCEEW, 2023). Therefore, in this study, photometric measures are used for the light emissions modelling to inform the potential impact of artificial light on wildlife. The limitation of this approach, however, should be acknowledged and considered as it may not accurately weight the blue and red wavelengths to which animals can be sensitive (DCCEEW, 2023).

Table 1-1: Typical radiometric and photometric terms.

RADIOMETRIC		PHOTOMETRIC	
Radiant power	W	**Luminous flux**	lm
Radiant intensity	W/sr	**Luminous intensity**	lm/sr (or cd)
Irradiance	W/m^2	**Illuminance**	lm/m^2 (or lux)
Radiance	W/m^{2}sr	**Luminance**	lm/m^{2}sr

W = watt; sr = steradian; lm = lumen; cd = candela

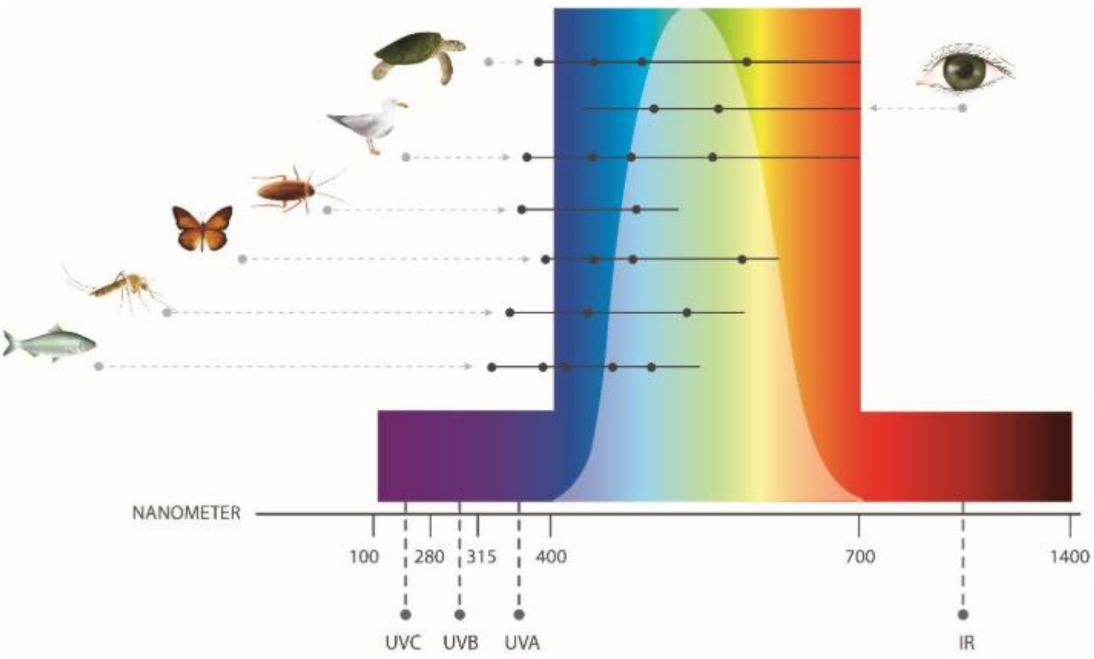


Figure 1-2: Comparative light perception among different species groups (Campos, 2017; DCCEEW, 2023).

2 SCOPE AND METHODOLOGIES

2.1 Scope

The light emissions sources considered in this study include:

- Flaring that will take place on the MODU at a maximum flare rate of 65 MMscfd/well and up to 24 hours/well.
- Facility lighting which includes navigation and working lights on the MODU.

Note that MODU was used as the basis for light modelling as it is the largest and tallest piece of infrastructure that will be infield for the Drilling Campaign. Other vessels were not included in the assessment due to their much smaller scale and/or temporary and transient nature.

Two sets of light modelling have been conducted – Line of Sight and Illuminance, to develop the Visible Light Exposure Area and the Potential Impact Area, respectively (Table 2-1).

Table 2-1: Indication of the predicted potential impact area and visible light exposure area.

ARTIFICIAL LIGHT ASSESSMENT AREAS	INIDICATION
Visible Light Exposure Area	The spatial extent of visible light that is predicted to occur from the Drilling Campaign. The threshold for this area is whether any part of the facility is visible as a dot on the horizon.
Potential Impact Area	The spatial extent of a measurable change in ambient light that is predicted to occur from the Drilling Campaign. The threshold for this area is an illuminance equivalent to ambient light on a moonless clear night sky/new moon (<0.001 lux). This is the area relevant to the impact assessment for planned light emissions from the Drilling Campaign.

2.2 Visible Light Exposure Area

2.2.1 Threshold

The Visible Light Exposure Area, as defined in Table 2-1, refers to the spatial extent of visible light that is predicted to occur from the Drilling Campaign. The threshold for this area is whether any part of the facility is visible as a dot on the horizon.

2.2.2 Basis

Equation

The Visible Light Exposure Area from the MODU was estimated based on the methodology in Stallings (2005) to determine the worst-case potential extent of visible light for the Drilling Campaign. Note that the visibility of an artificial light does not imply a measurable change in ambient light (and therefore a potential environmental impact), the potential environmental impact is estimated though change to illuminance as discussed in Section 2.2.

Line-of-sight modelling utilises the following equation to estimate the total line-of-sight ($\boldsymbol{d}$):

$$d = \left(2 \cdot \frac{4}{3} R h_1 + h_1^2\right)^{0.5} + \left(2 \cdot \frac{4}{3} R h_2 + h_2^2\right)^{0.5}$$

Where $\boldsymbol{d}$ = total line of sight; $\boldsymbol{h_1}$ = height of infrastructure; $\boldsymbol{h_2}$ = height of receptor; and $\boldsymbol{R}$ = radius of Earth.

Inputs and Assumptions

To estimate the Visible Light Exposure Area, the heights of the infrastructure on the MODU were assumed (Table 2-2), with final designs being confirmed during FEED. Varying elevations of the receptor at the mainland from 5 to 525 m were also modelled to determine the actual line-of-sight distances subject to elevations.

Table 2-2: Assumed heights of the MODU facility infrastructure utilised in the Drilling Campaign.

FACILITY INFRASTRUCTURE	HEIGHT ABOVE SEA LEVEL (m)
Derrick (Navigation Lights)	84
Deck Flare (Horizontal Boom)	49
Deck (Working Lights)	21

2.2.3 Calculations and Post-processing

The line-of-sight model was built in Microsoft Excel utilising Stallings equation (Section 2.2.2) by considering the height of the infrastructure and height (elevation) of the receptor. The Visible Light Exposure Areas for different infrastructure were then overlaid in geographic information system (GIS) to identify geospatial contours.

2.3 Potential Impact Area

2.3.1 Threshold

The Potential Impact Area, as defined in Table 2-1, refers to the spatial extent of a measurable change in ambient light that is predicted to occur from the Drilling Campaign.

Table 2-3 shows the typical light illuminance values from natural light sources and its corresponding moon phases are shown graphically in Figure 2-1. These light illuminance values are considered representative of ambient light levels in the vicinity of the Drilling Campaign.

As there are currently no published or accepted thresholds at which artificial light may impact fauna, the minimum threshold used to describe a change in ambient light conditions within this artificial light assessment is an illuminance equivalent to a new moon/moonless clear night sky (0.001 lux). It was assumed that beyond this threshold, there will be no impact to light sensitive faunas. This threshold (0.001 lux) was selected on the basis that fauna undertake nocturnal activities under the natural range of full moon (0.1 lux) to new moon (0.001 lux) without known adverse impacts.

Table 2-3: Summary of natural light illuminance (Environmental Resources Management, 2010).

NATURAL LIGHT SOURCE	LIGHT ILLUMINANCE (LUX)
Direct sunlight	100,00–130,000
Full daylight, indirect sunlight	10,000–20,000
Overcast day	1,000
Very dark day	100
Twilight	10
Deep twilight	1
Full moon	0.1
Quarter moon	0.01
Moonless clear night sky (new moon)[1]	0.001
Moonless overcast night sky	0.0001

---

[1] *Impact threshold utilised in this report is 0.001 lux, beyond this threshold no impact to light sensitive fauna is assumed.*

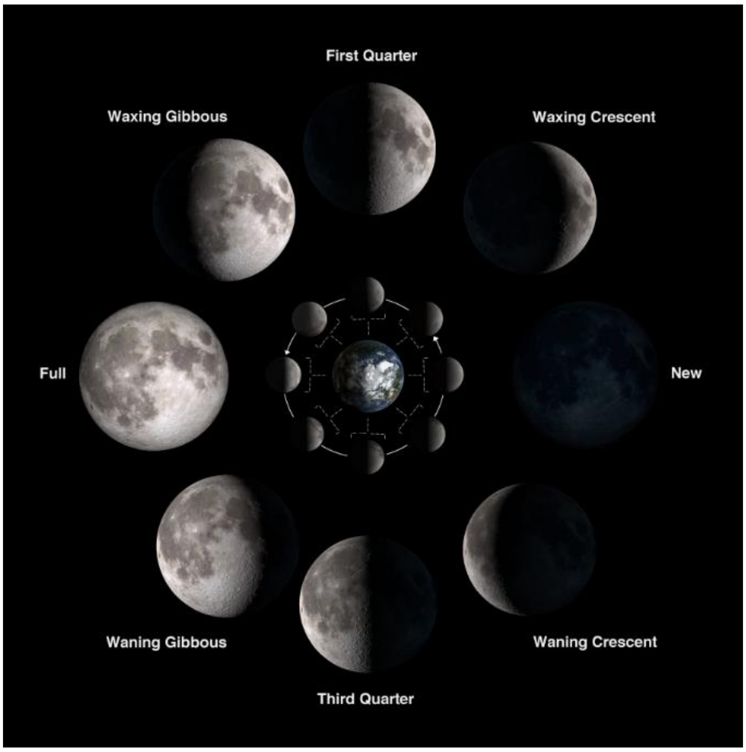


Figure 2-1: The moon phases. Credit: NASA/Bill Dunford (Johnston, 2020).

2.3.2 Basis

Equation

The illuminance modelling used the inverse square law of illuminance which states that *a doubling of distance results in a reduction in illuminance by four times*, i.e., as a surface that is illuminated by a light source moves away from the light source, the surface appears dimmer. Light emitted becomes dimmer in an inverse square relationship to distance as represented in and in the mathematical equation below:

$$E = \frac{I}{D^2}$$

where E = illuminance (in lux), I = luminous intensity (in candela), and D = the distance from the light source in meters.

Light sources

The luminous intensity (I) has included both flare light and facility lighting. It is noted at this preliminary stage that, the type of the light fitting, quantity, and exact location of light sources are not yet fixed. As such, to conduct the illuminance modelling, the use of analogues was adopted to determine the approximate luminous intensities of the flare light and facility lighting (Table 2-4). This is also considered a conservative approach as it does not include any best practice or additional mitigation measures that may be adopted by Beach during the front-end engineering design (FEED) of the Project.

Table 2-4: Analogues selected for the flare light and facility lighting used in the Drilling Campaign.

LIGHT SOURCE	ANALOGUE AND REFERENCE	DESCRIPTION
Flare light	Nigeria Obigbo Oil Production Facility, continuous flaring at 30 MMscfd (European Commission, 2014; Isichei & Sanford, 1976; Nwaobi, 2005)	Light illuminance levels at varying distances were measured, therefore reducing uncertainty in calculating luminous intensity from a flare
Facility lighting	The MODU facility lighting used in Woodside Torosa drilling campaign on Browse reef (Environmental Resources Management, 2010)	Light characteristics and modelling of light sources for the Torosa assessment were based on measured lighting data obtained

Obtaining the luminous intensity of a flare is not straightforward as flares are not designed to be luminous. To reduce the uncertainties, published potential analogue natural gas flares were compared (e.g., Tamarind operated FPSO oil facility, Chevron-operated onshore LNG facility, Proposed Santos-operated onshore gas production facility and Shell-operated Obigbo oil production facility in Nigeria). The Obigbo facility was finally selected as the appropriate analogue for the Drilling Campaign mainly due to the availability of a detailed light assessment study that provided measured lux levels at varying distances (European Commission, 2014; Isichei & Sanford, 1976; Nwaobi, 2005). This information allows for the characteristics of the Obigbo flare to be scaled and provides the basis for the illuminance modelling in this study.

For the facility lighting, it was assumed that the MODU for the Drilling campaign will have a similar lit surface area as the drill rig utilised for the Woodside Torosa drilling campaign on Browse reef for which published data is available (Environmental Resources Management, 2010). Therefore, the measured illuminance level was extracted for use in the illuminance modelling for the Drilling Campaign.

Inputs and Assumptions

To estimate the illuminance from the flare light, a peak flare rate of 65 MMscfd was modelled. The flare will be a horizontal boom extending out horizontally from the MODU deck. The resulting length of the flare flame was calculated to be approximately 14 m based on Gas Processors Suppliers Association (2004). The following assumptions were used in the illuminance modelling:

- The flare and its combustion were assumed to have similar characteristics as that used in the Nigeria Obigbo Oil Production Facility (Table 2-4).
- No allowance was made for atmospheric or topographic interactions including shadowing, absorption or scattering, as such the model is conservative and likely to overestimate illuminance at distance.
- Flare luminous intensity is calculated directly proportional to flare flow rate.

2.3.3 Calculations and Post-processing

The illuminance model was built in Microsoft Excel utilising the inverse law of illumination (Section 2.3.2) by considering the total luminous intensity resulted from the flare and facility lighting. Illuminance was calculated every 100 m from the light source in lux, and the illuminance levels including the Potential Impact Area (at 0.001 lux) were overlaid in geographic information system (GIS) to identify geospatial contours.

3 LIGHT ASSESSMENT RESULTS

3.1 Visible Light Exposure Area

The estimated line-of-sight distances for the infrastructure on the MODU are summarised in Table 3-1. The navigation lights of the MODU on the derrick are expected to be visible within 38 km at sea level; and the flare flame above the main deck level would be visible within approximately 29 km at sea level. The line-of-sight modelling also indicates that the MODU may be visible as a dot on the horizon from the adjacent mainland, extending inland up to 140 km for elevated receptor locations.

Note that this is a conservative estimation as the model has not considered the atmospheric interactions or obstacles. A zone of theoretical visibility analysis is recommended as it provides allowance for the luminance range of human vision, the curvature of the Earth, and atmospheric refraction.

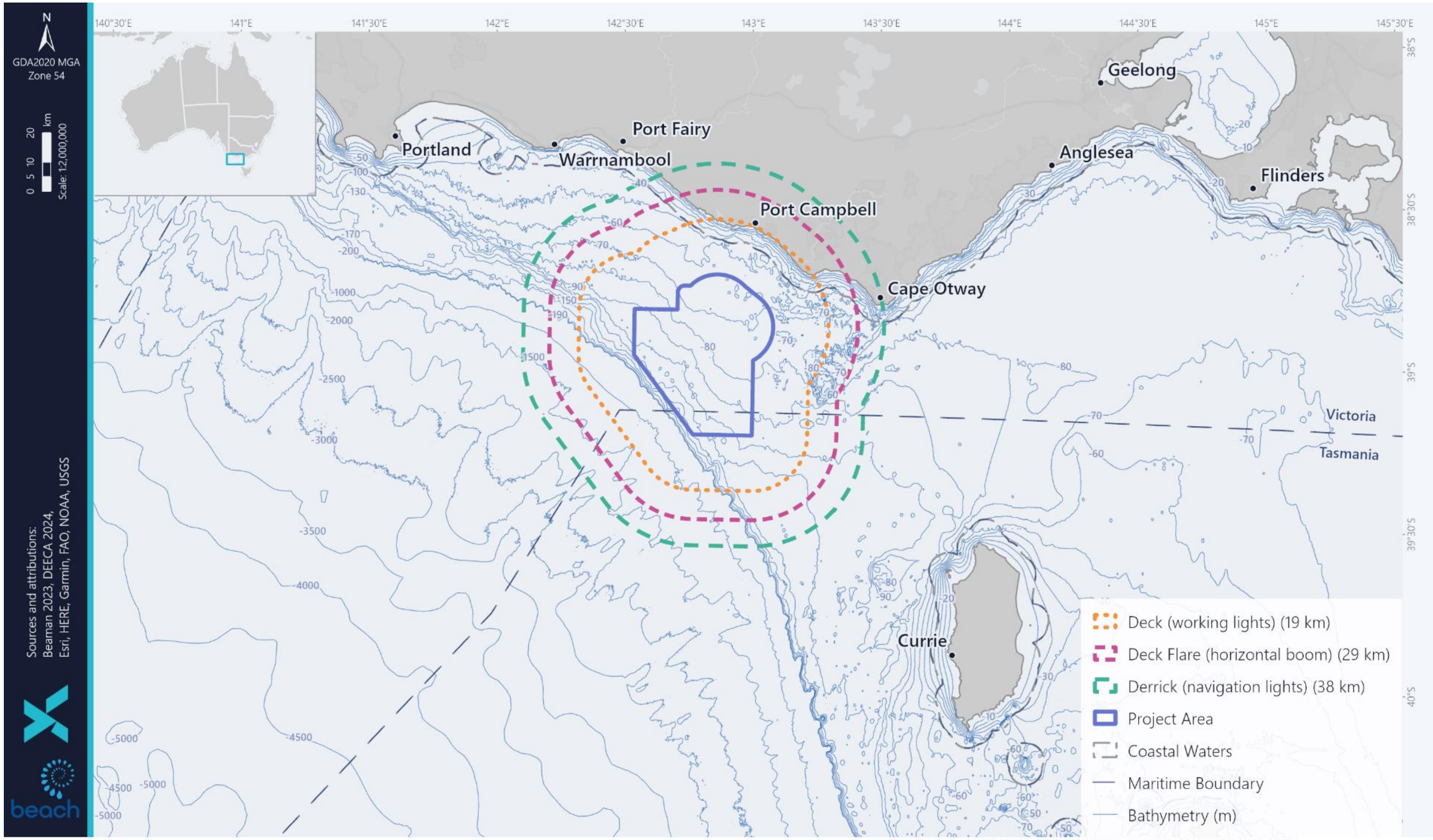
Figure 3-1 shows the Visible Light Exposure Areas for the MODU infrastructure – Deck, Deck flare and Derrick from the horizon. At higher elevation on the mainland, the MODU may be visible.

Matters protected by the EPBC Act 1999 within the Visible Light Exposure Areas are provided in Appendix A: A.2 (Deck Flare), A.3 (Derrick) and A.4 (Deck). Biologically important areas (BIAs) within these areas are presented in Appendix B.

Table 3-1: Visual line of sights for MODU infrastructure from sea level and from various receptor elevations.

VISIBILITY OF MODU INFRASTRUCTURE FROM SEA LEVEL			
MODU INFRASTRUCTURE	HEIGHT OF INFRASTRUCTURE (M)	RECEPTOR ELEVATION (M)	LINE OF SIGHT (KM)
Derrick (Navigation Lights)	84	0 (sea level)	38
Deck Flare (Horizontal Boom)	49	0 (sea level)	29
Deck (Working Lights)	21	0 (sea level)	19

VISIBILITY OF MODU DERRICK FROM VARIOUS RECEPTOR ELEVATIONS							
Highest Infrastructure	Height (m)	Line of Sight at Various Receptor Elevations (km)					
		5 m	10 m	50 m	100 m	300 m	525 m
Derrick (Navigation lights)	84	47	51	67	79	109	132



Sources and attributions: Beaman 2023, DEECA 2024, Esri, HERE, Garmin, FAO, NOAA, USGS

Document details: G:\CheckOuts\P100447\Output\02_Bass_OPP\P100447_00_Bass_OPP_Working.aprx, P100447_LightExposure_Otway, P-UWS-132, 28/08/2024

Figure 3-1: Predicted Visible Light Exposure Areas for the MODU infrastructure (19~38 km from the horizon).

3.2 Potential Impact Area

Table 3-2 shows the illuminance results including the analogue case. As presented in Table 3-2 and also graphically in Figure 3-2, the Potential Impact Area (with an illuminance level at/less than 0.001 lux) when flaring occurs is expected to be approximately 63 km and reduce to 10 km when there is no flaring.

Table 3-2: Illuminance modelling results for the Drilling Campaign.

SCENARIO	LUMINANCE INTENSITY (CD)	LIGHT ILLUMINANCE (LUX)							
		Distance from Facility (km)							
		0.5	1	5	10	20	30	60	70
Analogue Case									
Obigbo Oil Production Facility (with flaring)	~1,805,000	7.2	1.8	0.072	0.018	0.004	0.002	<0.002	<0.001
Modelled Cases									
Facility lighting from the MODU (no flaring)	~100,000	0.4	0.1	0.004	0.001	0.0002	<0.0001	<0.0001	0
Combined facility lighting and flaring from the MODU	~4,000,000	16.0	4.0	0.160	0.04	0.01	0.004	0.0011	<0.001

To further evaluate the light emissions impact, a list of selected receptor locations has been chosen to determine the illuminance (light intensity) levels. The results are presented in Table 3-3.

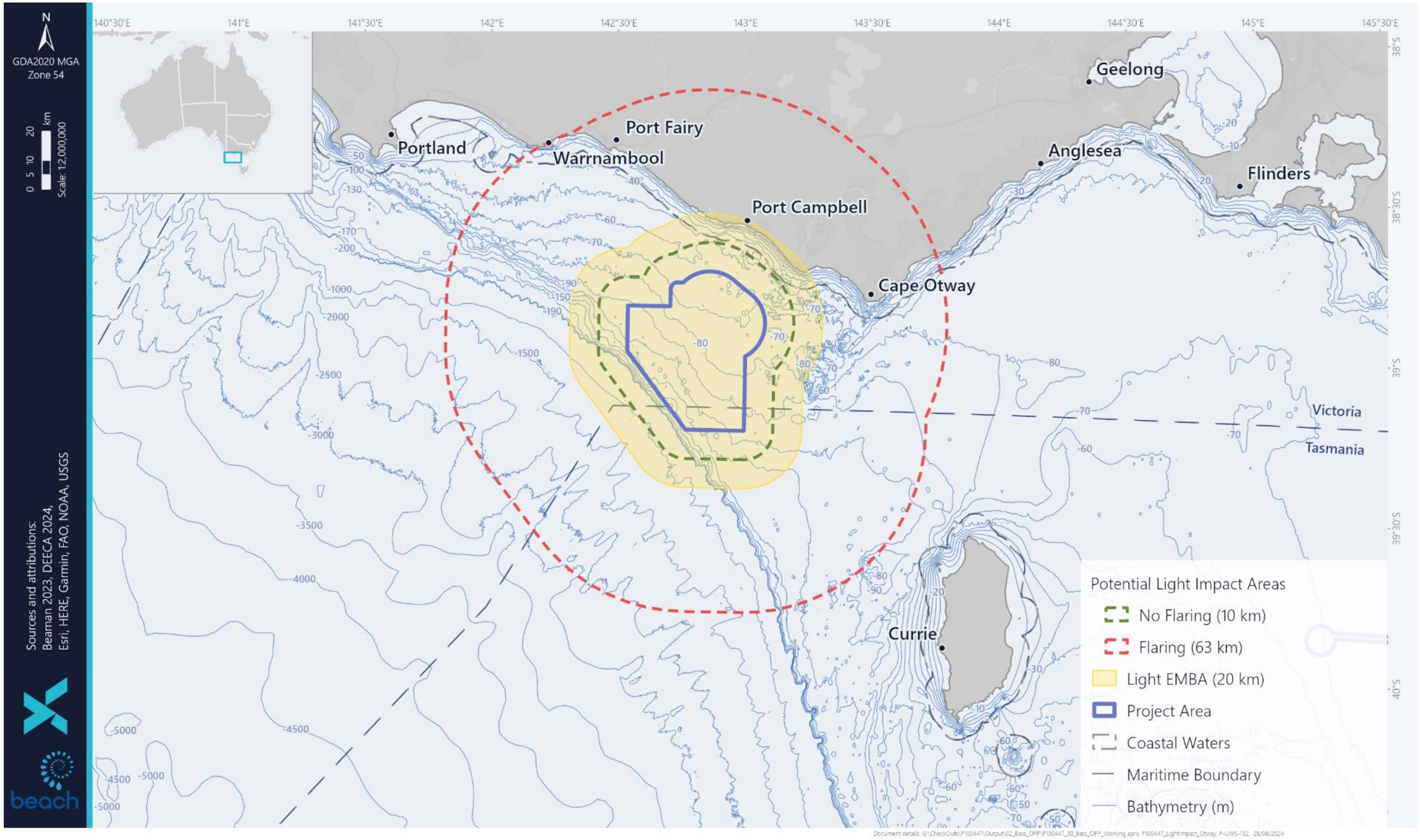
At the selected receptor locations of Port Campbell National Park (19 km), Cape Otway Light Station Lookout (37 km), Warrnambool (53 km), and Currie (King Island, 102 km), the illuminance levels when flaring have been estimated to be approximately 0.0111, 0.0029, 0.0014, and 0.0004 lux respectively. These illuminance levels are comparable to the ambient light levels between the quarter moon and the new moon phases in Figure 2-1, except for Port Campbell National Park with a slightly higher illuminance level due to closer proximity to the Project Area of the Drilling Campaign, and Currie which is farthest away with an ambient light level between the new moon and moonless overcast night sky.

When not flaring, the illuminance levels of all selected receptor locations are less than 0.001 lux, comparable to the ambient light levels less than a moonless clear night sky (new moon).

Matters protected by the EPBC Act 1999 within the Light EMBA and Potential Impact Areas are provided in Appendix A: A.1 (Light EMBA), A.5 (Flaring) and A.6 (No Flaring). Biologically important areas (BIAs) within these areas are presented in Appendix B.

Table 3-3: Selected receptor locations and their illuminance levels resulted from the Drilling Campaign.

RECEPTOR	COORDINATES	ELEVATION (m)	CLOSEST OA POINT	MIN. DISTANCE TO MODU POSITION [km]	ILLUMINANCE WHEN FLARING (LUX)	ILLUMINANCE WHEN NOT FLARING (LUX)
Port Campbell National Park	-38.6597, 143.1049	62	-38.7979, 142.9724	19	0.0111	0.0002
Cape Otway Light Station Lookout	-38.8504, 143.5143	99	-38.9133, 143.1013	37	0.0029	<0.0001
Warrnambool	-38.3818, 142.488	22	-38.8129, 142.7395	53	0.0014	<0.0001
Currie (King Island)	-39.9281, 143.8522	35	-39.2697, 143.0286	102	0.0004	~0



Document details: G:\CheckOuts\P100447\Output\02_Bass_OPP\P100447_00_Bass_OPP_Working.aprx, P100447_LightImpact_Otway, P-UWS-132, 28/08/2024

Figure 3-2: Predicted Potential Impact Areas for the MODU infrastructure when flaring (63 km), and when not flaring (10 km).

4 REFERENCES

Campos, S. (2017). *The impact of artificial lighting on nature*. 6th SENAC Meeting of Integrated Knowledge Senac Sorocaba.

DCCEEW. (2023). National Light Pollution Guidelines for Wildlife. *Department of Climate Change, Energy, the Environment and Water, Canberra, May. CC BY 4.0*. https://www.dcceew.gov.au/sites/default/files/documents/national-light-pollution-guidelines-wildlife.pdf

Environmental Resources Management. (2010). *Appendix F16—Browse Upstream LNG Development: Light Impact Assessment, Report produced for Woodside Energy Limited, pp.* https://www.woodside.com/docs/default-source/our-business---documents-and-files/burrup-hub---documents-and-files/browse---documents-and-files/index-of-previous-browse-studies/f16---erm-2010---browse-upstream-lng-development-light-impact-assessment_.pdf

European Commission. (2014). *EU Bulk Assessment Inputs Data Sheet – Communication and Information Resource Centre for Administrations, Businesses and Citizens*.

Gas Processors Suppliers Association, V. (2004). *Engineering Data Book: Vol. I&II* (12th ed). https://www.academia.edu/38372530/_GPSA_Engineering_Data_Book_Gas_Processing_12th_ed

Isichei, A. O., & Sanford, W. W. (1976). The Effects of Waste Gas Flares on the Surrounding Vegetation in South-Eastern Nigeria. *Journal of Applied Ecology*, *13*(1), 177–187. https://doi.org/10.2307/2401936

Johnston, B. G. (2020). *The Next Full Moon is the Strawberry Moon*. NASA Solar System Exploration. https://solarsystem.nasa.gov/news/1257/the-next-full-moon-is-the-strawberry-moon

Nwaobi, D. G. C. (2005). Oil Policy In Nigeria: A Critical Assessment (1958-1992). *Public Economics*, Article 0501001. https://ideas.repec.org/p/wpa/wuwppe/0501001.html

Stallings, W. (2005). *Wireless communications and networks* (2nd ed). Pearson Prentice Hall.

APPENDIX A PROTECTED MATTERS SEARCH TOOL REPORTS

A.1 Light EMBA (20 km)

Australian Government
Department of Climate Change, Energy,
the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 29-Aug-2024

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	85
Listed Migratory Species:	55

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	89
Whales and Other Cetaceans:	28
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	7
Regional Forest Agreements:	1
Nationally Important Wetlands:	1
EPBC Act Referrals:	47
Key Ecological Features (Marine):	1
Biologically Important Areas:	13
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places

[Resource Information]

Name	State	Legal Status
Historic		
Great Ocean Road and Scenic Environs	VIC	Listed place

Commonwealth Marine Area

[Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Ecological Communities

[Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	Endangered	Community likely to occur within area
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species

[Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Climacteris picumnus victoriae Brown Treecreeper (south-eastern) [67062]	Vulnerable	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area

Scientific Name	Threatened Category	Presence Text
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area
FISH		
Hoplostethus atlanticus Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Nannoperca obscura		
Yarra Pygmy Perch [26177]	Endangered	Species or species habitat may occur within area
Prototroctes maraena		
Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Seriolella brama		
Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
FROG		
Litoria raniformis		
Southern Bell Frog,, Growling Grass Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Antechinus minimus maritimus		
Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Endangered	Species or species habitat known to occur within area
Miniopterus orianae bassanii Southern Bent-wing Bat [87645]	Critically Endangered	Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat likely to occur within area
Potorous tridactylus trisulcatus Long-nosed Potoroo (southern mainland) [86367]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys fumeus Smoky Mouse, Konoom [88]	Endangered	Species or species habitat may occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
PLANT		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat may occur within area
Caladenia concolor Crimson Spider-orchid, Maroon Spider-orchid [5505]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Eucalyptus strzeleckii Strzelecki Gum [55400]	Vulnerable	Species or species habitat known to occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat likely to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat known to occur within area
Lepidium aschersonii Spiny Peppercress [10976]	Vulnerable	Species or species habitat may occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat may occur within area
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat known to occur within area
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat may occur within area
Pterostylis cucullata Leafy Greenhood [15459]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis tenuissima Swamp Greenhood, Dainty Swamp Orchid [13139]	Vulnerable	Species or species habitat known to occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat known to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Thelymitra orientalis Hoary Sun-orchid [88011]	Critically Endangered	Species or species habitat may occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Lissolepis coventryi Swamp Skink, Eastern Mourning Skink [84053]	Endangered	Species or species habitat known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Migration route known to occur within area
Centrophorus uyato Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Migration route known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris as Puffinus tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area overfly marine area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Stercorarius antarcticus as Catharacta skua Brown Skua [85039]		Species or species habitat may occur within area
Sterna striata White-fronted Tern [799]		Foraging, feeding or related behaviour likely to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei as Thalassarche sp. nov. Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus as Thinornis rubricollis Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area
Thinornis cucullatus cucullatus as Thinornis rubricollis rubricollis Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area overfly marine area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Current Scientific Name	Status	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves

[Resource Information]

Protected Area Name	Reserve Type	State
Bay of Islands Coastal Park	Conservation Park	VIC
Great Otway	National Park	VIC
Latrobe B.R.	Natural Features Reserve	VIC
Port Campbell	National Park	VIC
Princetown W.R	Natural Features Reserve	VIC
The Arches	Marine Sanctuary	VIC
Twelve Apostles	Marine National Park	VIC

Regional Forest Agreements

[Resource Information]

Note that all areas with completed RFAs have been included. Please see the associated resource information for specific caveats and use limitations associated with RFA boundary information.

RFA Name	State
West Victoria RFA	Victoria

Nationally Important Wetlands

[Resource Information]

Wetland Name	State
Princetown Wetlands	VIC

EPBC Act Referrals

[Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status

Title of referral	Reference	Referral Outcome	Assessment Status
Decommissioning of the Minerva Pipeline in Victorian state waters	2024/09879		Completed
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia East	2024/09795		Completed
Otway Astrolabe 3D Marine Seismic Survey, Otway Basin	2012/6421		Completed
Controlled action			
Alston-1 petroleum exploration well, permit VIC/P44	2003/1315	Controlled Action	Post-Approval
Casino Gas Field Development	2003/1295	Controlled Action	Post-Approval
Otway Development	2002/621	Controlled Action	Post-Approval
Schomberg 3D Marine Seismic Survey	2007/3754	Controlled Action	Completed
Strike Oil Gas Exploration Well, Otway Basin (VIC/P44)	2000/97	Controlled Action	Completed
Twelve Apostles Saddle Lookout	2019/8571	Controlled Action	Post-Approval
VICP61 2D Marine Seismic Survey	2008/4075	Controlled Action	Completed
Not controlled action			
Enterprise 1 Exploration Drilling Program, near Port Campbell, Vic	2019/8438	Not Controlled Action	Completed
Exploration drilling for liquid/gaseous hydrocarbons	2004/1681	Not Controlled Action	Completed
Gas Field Development	2006/2635	Not Controlled Action	Completed
Henry-1 Exploration Well, Petroleum Permit Area VIC/P44	2005/2147	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Minerva Cut Back Project, Vic	2017/8036	Not Controlled Action	Completed
Offshore exploration drilling within permit area VIC/P 37(v)	2004/1466	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Port Campbell Headland Walking Trail Realignment	2012/6676	Not Controlled Action	Completed
Track construction - Great Ocean Walk	2002/793	Not Controlled Action	Completed
VIC-P44 Stage 2 Gas Field Development	2007/3767	Not Controlled Action	Completed
Victorian Generator Project	2005/1984	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Moonlight Head' 3D seismic survey, VIC/P38(V), VIC/P43 and VIC/RL8	2005/2236	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2005/2295	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2003/1214	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey near King Island	2004/1461	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic program VIC/P38(v), VIC/P43 and VIC/RL8	2003/1137	Not Controlled Action (Particular Manner)	Post-Approval
Astrolabe 3D Marine Seismic Survey	2011/6048	Not Controlled Action (Particular Manner)	Post-Approval
BHPBilliton Otway 3D Seismic Survey	2007/3443	Not Controlled Action (Particular Manner)	Post-Approval
Deepwater Sorell Basin 2001 Non-Exclusive 2D Seismic Survey	2001/156	Not Controlled Action (Particular Manner)	Post-Approval
Drill and Profile Exploration Well Somerset 1, License Area T34P	2009/5037	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Enterprise Three-dimensional Transition Zone Seismic Survey, Victoria	2016/7800	Not Controlled Action (Particular Manner)	Post-Approval
Geographe-A gas exploration well	2000/82	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
La Bella 3D Marine Seismic Survey, Otway Basin, VIC	2012/6683	Not Controlled Action (Particular Manner)	Post-Approval
Otway Basin Exploration Drilling Campaign, Vic	2011/6125	Not Controlled Action (Particular Manner)	Post-Approval
Santos Otway 3d Seismic VIC/P44	2007/3367	Not Controlled Action (Particular Manner)	Post-Approval
Schomberg 3D Marine Seismic survey	2007/3868	Not Controlled Action (Particular Manner)	Post-Approval
Strike Oil NL Seismic Surveys	2000/107	Not Controlled Action (Particular Manner)	Post-Approval
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, Vic	2012/6565	Not Controlled Action (Particular Manner)	Post-Approval
Thylacine-A Exploration Well	2000/81	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5700	Not Controlled Action (Particular Manner)	Post-Approval
Vic/P37(v) and Vic/P44 3D marine seismic survey	2003/1102	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
VIC P44 Gas Exploration Wells	2002/662	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 2D seismic survey	2002/811	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, VIC	2012/6545	Referral Decision	Completed
VICP61 2D Marine Seismic Survey	2008/3975	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
West Tasmania Canyons	South-east

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Likely to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

A.2 Light Exposure Area - Deck Flare (Horizontal Boom) (29 km)

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 29-Aug-2024

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	87
Listed Migratory Species:	55

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	91
Whales and Other Cetaceans:	28
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	1
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	10
Regional Forest Agreements:	1
Nationally Important Wetlands:	1
EPBC Act Referrals:	57
Key Ecological Features (Marine):	1
Biologically Important Areas:	13
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places [Resource Information]

Name	State	Legal Status
Historic		
Great Ocean Road and Scenic Environs	VIC	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	Endangered	Community likely to occur within area
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		

Scientific Name	Threatened Category	Presence Text
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat may occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Climacteris picumnus victoriae Brown Treecreeper (south-eastern) [67062]	Vulnerable	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area
FISH		

Scientific Name	Threatened Category	Presence Text
Hoplostethus atlanticus Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area
Nannoperca obscura Yarra Pygmy Perch [26177]	Endangered	Species or species habitat likely to occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Seriolella brama Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
FROG		
Litoria raniformis Southern Bell Frog,, Growling Grass Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Antechinus minimus maritimus Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Endangered	Species or species habitat known to occur within area
Miniopterus orianae bassanii Southern Bent-wing Bat [87645]	Critically Endangered	Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Petauroides volans Greater Glider (southern and central) [254]	Endangered	Species or species habitat may occur within area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus trisulcatus Long-nosed Potoroo (southern mainland) [86367]	Vulnerable	Species or species habitat known to occur within area
Pseudomys fumeus Smoky Mouse, Konoom [88]	Endangered	Species or species habitat may occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
PLANT		

Scientific Name	Threatened Category	Presence Text
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat may occur within area
Caladenia concolor Crimson Spider-orchid, Maroon Spider-orchid [5505]	Vulnerable	Species or species habitat may occur within area
Eucalyptus strzeleckii Strzelecki Gum [55400]	Vulnerable	Species or species habitat known to occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat known to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat known to occur within area
Lepidium aschersonii Spiny Peppercress [10976]	Vulnerable	Species or species habitat may occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat may occur within area
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat known to occur within area
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat may occur within area
Pterostylis cucullata Leafy Greenhood [15459]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis tenuissima Swamp Greenhood, Dainty Swamp Orchid [13139]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat known to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area
Thelymitra matthewsii Spiral Sun-orchid [4168]	Vulnerable	Species or species habitat may occur within area
Thelymitra orientalis Hoary Sun-orchid [88011]	Critically Endangered	Species or species habitat may occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Lissolepis coventryi Swamp Skink, Eastern Mourning Skink [84053]	Endangered	Species or species habitat known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Migration route known to occur within area
Centrophorus uyato Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Migration route known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris as Puffinus tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area overfly marine area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pandion haliaetus		
Osprey [952]		Species or species habitat known to occur within area
Phalacrocorax fuscescens		
Black-faced Cormorant [59660]		Breeding known to occur within area
Phoebetria fusca		
Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis		
Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato)		
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Stercorarius antarcticus as Catharacta skua		
Brown Skua [85039]		Species or species habitat may occur within area
Sterna striata		
White-fronted Tern [799]		Foraging, feeding or related behaviour likely to occur within area
Sternula albifrons as Sterna albifrons		
Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri		
Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche bulleri platei as Thalassarche sp. nov.		
Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma		
Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini		
Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus as Thinornis rubricollis		
Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area
Thinornis cucullatus cucullatus as Thinornis rubricollis rubricollis		
Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area overfly marine area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area

Scientific Name	Threatened Category	Presence Text
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Whales and Other Cetaceans

[Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Park Name	Zone & IUCN Categories
Apollo	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Bay of Islands Coastal Park	Conservation Park	VIC
Cooriemungle Creek F.R	Nature Conservation Reserve	VIC
Curdie Vale N.C.R.	Natural Features Reserve	VIC
Great Otway	National Park	VIC
Johanna Falls S.R.	Natural Features Reserve	VIC
Latrobe B.R.	Natural Features Reserve	VIC
Port Campbell	National Park	VIC
Princetown W.R	Natural Features Reserve	VIC
The Arches	Marine Sanctuary	VIC
Twelve Apostles	Marine National Park	VIC

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included. Please see the associated resource information for specific caveats and use limitations associated with RFA boundary information.

RFA Name	State
West Victoria RFA	Victoria

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Princetown Wetlands	VIC

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Decommissioning of the Minerva Pipeline in Victorian state waters	2024/09879		Completed
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia East	2024/09795		Completed
Otway Astrolabe 3D Marine Seismic Survey, Otway Basin	2012/6421		Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Alston-1 petroleum exploration well, permit VIC/P44	2003/1315	Controlled Action	Post-Approval
Casino Gas Field Development	2003/1295	Controlled Action	Post-Approval
Otway Development	2002/621	Controlled Action	Post-Approval
Schomberg 3D Marine Seismic Survey	2007/3754	Controlled Action	Completed
Strike Oil Gas Exploration Well, Otway Basin (VIC/P44)	2000/97	Controlled Action	Completed
Twelve Apostles Saddle Lookout	2019/8571	Controlled Action	Post-Approval
VICP61 2D Marine Seismic Survey	2008/4075	Controlled Action	Completed
Not controlled action			
CO2 geosequestration - Otway Basin Pilot Project	2006/2699	Not Controlled Action	Completed
Enterprise 1 Exploration Drilling Program, near Port Campbell, Vic	2019/8438	Not Controlled Action	Completed
Exploration drilling for liquid/gaseous hydrocarbons	2004/1681	Not Controlled Action	Completed
Gas Field Development	2006/2635	Not Controlled Action	Completed
Gas Fields Development	2011/5879	Not Controlled Action	Completed
Halladale and Speculant Gas Pipeline Project, North of Port Campbell, Vic	2015/7551	Not Controlled Action	Completed
Henry-1 Exploration Well, Petroleum Permit Area VIC/P44	2005/2147	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Minerva Cut Back Project, Vic	2017/8036	Not Controlled Action	Completed
Newfield wind farm	2007/3226	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Nirranda South Wind Farm Pty Ltd	2002/763	Not Controlled Action	Completed
Offshore exploration drilling within permit area VIC/P 37(v)	2004/1466	Not Controlled Action	Completed
Port Campbell Headland Walking Trail Realignment	2012/6676	Not Controlled Action	Completed
Track construction - Great Ocean Walk	2002/793	Not Controlled Action	Completed
VIC-P44 Stage 2 Gas Field Development	2007/3767	Not Controlled Action	Completed
Victorian Generator Project	2005/1984	Not Controlled Action	Completed
Wind Farm Construction and Operation	2001/471	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Moonlight Head' 3D seismic survey, VIC/P38(V), VIC/P43 and VIC/RL8	2005/2236	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2005/2295	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2003/1214	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey near King Island	2004/1461	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic program VIC/P38(v), VIC/P43 and VIC/RL8	2003/1137	Not Controlled Action (Particular Manner)	Post-Approval
Astrolabe 3D Marine Seismic Survey	2011/6048	Not Controlled Action (Particular Manner)	Post-Approval
BHPBilliton Otway 3D Seismic Survey	2007/3443	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Deepwater Sorell Basin 2001 Non-Exclusive 2D Seismic Survey	2001/156	Not Controlled Action (Particular Manner)	Post-Approval
Drill and Profile Exploration Well Somerset 1, License Area T34P	2009/5037	Not Controlled Action (Particular Manner)	Post-Approval
Enterprise Three-dimensional Transition Zone Seismic Survey, Victoria	2016/7800	Not Controlled Action (Particular Manner)	Post-Approval
Geographe-A gas exploration well	2000/82	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
La Bella 3D Marine Seismic Survey, Otway Basin, VIC	2012/6683	Not Controlled Action (Particular Manner)	Post-Approval
Otway Basin Exploration Drilling Campaign, Vic	2011/6125	Not Controlled Action (Particular Manner)	Post-Approval
Santos Otway 3d Seismic VIC/P44	2007/3367	Not Controlled Action (Particular Manner)	Post-Approval
Schomberg 3D Marine Seismic survey	2007/3868	Not Controlled Action (Particular Manner)	Post-Approval
SEA Gas Project transmission pipeline	2001/513	Not Controlled Action (Particular Manner)	Post-Approval
Shaw River Power Station construct gas pipeline and associated infrastructure	2009/5089	Not Controlled Action (Particular Manner)	Post-Approval
Southern Gas Pipeline Project	2002/619	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Speculant 3D Transition Zone Seismic Survey	2010/5558	Not Controlled Action (Particular Manner)	Post-Approval
Strike Oil NL Seismic Surveys	2000/107	Not Controlled Action (Particular Manner)	Post-Approval
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, Vic	2012/6565	Not Controlled Action (Particular Manner)	Post-Approval
Thylacine-A Exploration Well	2000/81	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5700	Not Controlled Action (Particular Manner)	Post-Approval
Vic/P37(v) and Vic/P44 3D marine seismic survey	2003/1102	Not Controlled Action (Particular Manner)	Post-Approval
VIC P44 Gas Exploration Wells	2002/662	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 2D seismic survey	2002/811	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, VIC	2012/6545	Referral Decision	Completed
VICP61 2D Marine Seismic Survey	2008/3975	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region

Name	Region
West Tasmania Canyons	South-east

Biologically Important Areas

[Resource Information]

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Likely to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present

Scientific Name	Behaviour	Presence
Balaenoptera musculus brevicauda		
Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

A.3 Light Exposure Area - Derrick (Navigation Lights) (38 km)

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 29-Aug-2024

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	91
Listed Migratory Species:	55

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	2
Commonwealth Heritage Places:	None
Listed Marine Species:	92
Whales and Other Cetaceans:	28
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	1
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	18
Regional Forest Agreements:	1
Nationally Important Wetlands:	3
EPBC Act Referrals:	58
Key Ecological Features (Marine):	1
Biologically Important Areas:	15
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places

[Resource Information]

Name	State	Legal Status
Historic		
Great Ocean Road and Scenic Environs	VIC	Listed place

Commonwealth Marine Area

[Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Ecological Communities

[Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	Endangered	Community likely to occur within area
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area
Grassy Eucalypt Woodland of the Victorian Volcanic Plain	Critically Endangered	Community likely to occur within area
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	Community may occur within area
Natural Temperate Grassland of the Victorian Volcanic Plain	Critically Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species

[Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat may occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Climacteris picumnus victoriae Brown Treecreeper (south-eastern) [67062]	Vulnerable	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area
FISH		

Scientific Name	Threatened Category	Presence Text
Hoplostethus atlanticus Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area
Nannoperca obscura Yarra Pygmy Perch [26177]	Endangered	Species or species habitat likely to occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Seriolella brama Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
FROG		
Litoria raniformis Southern Bell Frog,, Growling Grass Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Antechinus minimus maritimus Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Endangered	Species or species habitat known to occur within area
Miniopterus orianae bassanii Southern Bent-wing Bat [87645]	Critically Endangered	Roosting known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Petauroides volans Greater Glider (southern and central) [254]	Endangered	Species or species habitat may occur within area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus trisulcatus Long-nosed Potoroo (southern mainland) [86367]	Vulnerable	Species or species habitat known to occur within area
Pseudomys fumeus Smoky Mouse, Konoom [88]	Endangered	Species or species habitat may occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
PLANT		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Astelia australiana Tall Astelia [10851]	Vulnerable	Species or species habitat likely to occur within area
Caladenia concolor Crimson Spider-orchid, Maroon Spider-orchid [5505]	Vulnerable	Species or species habitat may occur within area
Dianella amoena Matted Flax-lily [64886]	Endangered	Species or species habitat may occur within area
Eucalyptus strzeleckii Strzelecki Gum [55400]	Vulnerable	Species or species habitat known to occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat known to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat known to occur within area
Lepidium aschersonii Spiny Peppercress [10976]	Vulnerable	Species or species habitat may occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat may occur within area
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat known to occur within area
Prasophyllum suaveolens Fragrant Leek-orchid [64956]	Endangered	Species or species habitat may occur within area
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Pterostylis cucullata Leafy Greenhood [15459]	Vulnerable	Species or species habitat known to occur within area
Pterostylis tenuissima Swamp Greenhood, Dainty Swamp Orchid [13139]	Vulnerable	Species or species habitat known to occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat known to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area
Thelymitra matthewsii Spiral Sun-orchid [4168]	Vulnerable	Species or species habitat may occur within area
Thelymitra orientalis Hoary Sun-orchid [88011]	Critically Endangered	Species or species habitat may occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Delma impar Striped Legless Lizard, Striped Snake-lizard [1649]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Lissolepis coventryi Swamp Skink, Eastern Mourning Skink [84053]	Endangered	Species or species habitat known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Centrophorus uyato Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area

Scientific Name	Threatened Category	Presence Text
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area

Migratory Terrestrial Species

Scientific Name	Threatened Category	Presence Text
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Unknown	
Commonwealth Land - [21492]	VIC
Commonwealth Land - [21583]	VIC

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		

Scientific Name	Threatened Category	Presence Text
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris as Puffinus tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Breeding likely to occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area overfly marine area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Stercorarius antarcticus as Catharacta skua Brown Skua [85039]		Species or species habitat may occur within area
Sterna striata White-fronted Tern [799]		Foraging, feeding or related behaviour likely to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei as Thalassarche sp. nov. Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus as Thinornis rubricollis Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area
Thinornis cucullatus cucullatus as Thinornis rubricollis rubricollis Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area overfly marine area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hippocampus minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Vanacampus margaritifer		
Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi		
Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus		
Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri		
Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus		
Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat likely to occur within area
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptile		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Whales and Other Cetaceans

[Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata		
Minke Whale [33]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks

[Resource Information]

Park Name	Zone & IUCN Categories
Apollo	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves

[Resource Information]

Protected Area Name	Reserve Type	State
Aire River	Heritage River	VIC
Aire River W.R.	Natural Features Reserve	VIC
Bay of Islands Coastal Park	Conservation Park	VIC
Cooriemungle	Reference Area	VIC
Cooriemungle Creek F.R	Nature Conservation Reserve	VIC
Coradjil B.R.	Natural Features Reserve	VIC
Coradjil N.C.R.	Natural Features Reserve	VIC
Crinoline Creek	Reference Area	VIC

Protected Area Name	Reserve Type	State
Curdie Vale N.C.R.	Natural Features Reserve	VIC
Great Otway	National Park	VIC
Johanna Falls S.R.	Natural Features Reserve	VIC
Latrobe B.R.	Natural Features Reserve	VIC
Parker River	Reference Area	VIC
Port Campbell	National Park	VIC
Princetown W.R	Natural Features Reserve	VIC
The Arches	Marine Sanctuary	VIC
Timboon I1 B.R	Natural Features Reserve	VIC
Twelve Apostles	Marine National Park	VIC

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included. Please see the associated resource information for specific caveats and use limitations associated with RFA boundary information.

RFA Name	State
West Victoria RFA	Victoria

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Aire River	VIC
Lower Aire River Wetlands	VIC
Princetown Wetlands	VIC

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Decommissioning of the Minerva Pipeline in Victorian state waters	2024/09879		Completed
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia East	2024/09795		Completed
Otway Astrolabe 3D Marine Seismic Survey, Otway Basin	2012/6421		Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Spinifex Offshore Wind Farm - Offshore Investigations	2024/09918		Referral Decision
Controlled action			
Alston-1 petroleum exploration well, permit VIC/P44	2003/1315	Controlled Action	Post-Approval
Casino Gas Field Development	2003/1295	Controlled Action	Post-Approval
Otway Development	2002/621	Controlled Action	Post-Approval
Schomberg 3D Marine Seismic Survey	2007/3754	Controlled Action	Completed
Strike Oil Gas Exploration Well, Otway Basin (VIC/P44)	2000/97	Controlled Action	Completed
Twelve Apostles Saddle Lookout	2019/8571	Controlled Action	Post-Approval
VICP61 2D Marine Seismic Survey	2008/4075	Controlled Action	Completed
Not controlled action			
CO2 geosequestration - Otway Basin Pilot Project	2006/2699	Not Controlled Action	Completed
Enterprise 1 Exploration Drilling Program, near Port Campbell, Vic	2019/8438	Not Controlled Action	Completed
Exploration drilling for liquid/gaseous hydrocarbons	2004/1681	Not Controlled Action	Completed
Gas Field Development	2006/2635	Not Controlled Action	Completed
Gas Fields Development	2011/5879	Not Controlled Action	Completed
Halladale and Speculant Gas Pipeline Project, North of Port Campbell, Vic	2015/7551	Not Controlled Action	Completed
Henry-1 Exploration Well, Petroleum Permit Area VIC/P44	2005/2147	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Minerva Cut Back Project, Vic	2017/8036	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Newfield wind farm	2007/3226	Not Controlled Action	Completed
Nirranda South Wind Farm Pty Ltd	2002/763	Not Controlled Action	Completed
Offshore exploration drilling within permit area VIC/P 37(v)	2004/1466	Not Controlled Action	Completed
Port Campbell Headland Walking Trail Realignment	2012/6676	Not Controlled Action	Completed
Track construction - Great Ocean Walk	2002/793	Not Controlled Action	Completed
VIC-P44 Stage 2 Gas Field Development	2007/3767	Not Controlled Action	Completed
Victorian Generator Project	2005/1984	Not Controlled Action	Completed
Wind Farm Construction and Operation	2001/471	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Moonlight Head' 3D seismic survey, VIC/P38(V), VIC/P43 and VIC/RL8	2005/2236	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2005/2295	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2003/1214	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey near King Island	2004/1461	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic program VIC/P38(v), VIC/P43 and VIC/RL8	2003/1137	Not Controlled Action (Particular Manner)	Post-Approval
Astrolabe 3D Marine Seismic Survey	2011/6048	Not Controlled Action (Particular Manner)	Post-Approval
BHPBilliton Otway 3D Seismic Survey	2007/3443	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Deepwater Sorell Basin 2001 Non-Exclusive 2D Seismic Survey	2001/156	Not Controlled Action (Particular Manner)	Post-Approval
Drill and Profile Exploration Well Somerset 1, License Area T34P	2009/5037	Not Controlled Action (Particular Manner)	Post-Approval
Enterprise Three-dimensional Transition Zone Seismic Survey, Victoria	2016/7800	Not Controlled Action (Particular Manner)	Post-Approval
Geographe-A gas exploration well	2000/82	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
La Bella 3D Marine Seismic Survey, Otway Basin, VIC	2012/6683	Not Controlled Action (Particular Manner)	Post-Approval
Otway Basin Exploration Drilling Campaign, Vic	2011/6125	Not Controlled Action (Particular Manner)	Post-Approval
Santos Otway 3d Seismic VIC/P44	2007/3367	Not Controlled Action (Particular Manner)	Post-Approval
Schomberg 3D Marine Seismic survey	2007/3868	Not Controlled Action (Particular Manner)	Post-Approval
SEA Gas Project transmission pipeline	2001/513	Not Controlled Action (Particular Manner)	Post-Approval
Shaw River Power Station construct gas pipeline and associated infrastructure	2009/5089	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Southern Gas Pipeline Project	2002/619	Not Controlled Action (Particular Manner)	Post-Approval
Speculant 3D Transition Zone Seismic Survey	2010/5558	Not Controlled Action (Particular Manner)	Post-Approval
Strike Oil NL Seismic Surveys	2000/107	Not Controlled Action (Particular Manner)	Post-Approval
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, Vic	2012/6565	Not Controlled Action (Particular Manner)	Post-Approval
Thylacine-A Exploration Well	2000/81	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5700	Not Controlled Action (Particular Manner)	Post-Approval
Vic/P37(v) and Vic/P44 3D marine seismic survey	2003/1102	Not Controlled Action (Particular Manner)	Post-Approval
VIC P44 Gas Exploration Wells	2002/662	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 2D seismic survey	2002/811	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, VIC	2012/6545	Referral Decision	Completed
VICP61 2D Marine Seismic Survey	2008/3975	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
West Tasmania Canyons	South-east

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Likely to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Sharks		

Scientific Name	Behaviour	Presence
Carcharodon carcharias White Shark [64470]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Known Foraging Area	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

A.4 Light Exposure Area - Working Lights (19 km)

Australian Government

Department of Climate Change, Energy,
the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 29-Aug-2024

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	85
Listed Migratory Species:	55

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	89
Whales and Other Cetaceans:	28
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	7
Regional Forest Agreements:	1
Nationally Important Wetlands:	1
EPBC Act Referrals:	47
Key Ecological Features (Marine):	1
Biologically Important Areas:	13
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places [Resource Information]

Name	State	Legal Status
Historic		
Great Ocean Road and Scenic Environs	VIC	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	Endangered	Community likely to occur within area
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Climacteris picumnus victoriae Brown Treecreeper (south-eastern) [67062]	Vulnerable	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area

Scientific Name	Threatened Category	Presence Text
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area
FISH		
Hoplostethus atlanticus Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Nannoperca obscura		
Yarra Pygmy Perch [26177]	Endangered	Species or species habitat may occur within area
Prototroctes maraena		
Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Seriolella brama		
Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
FROG		
Litoria raniformis		
Southern Bell Frog,, Growling Grass Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Antechinus minimus maritimus		
Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Endangered	Species or species habitat known to occur within area
Miniopterus orianae bassanii Southern Bent-wing Bat [87645]	Critically Endangered	Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat likely to occur within area
Potorous tridactylus trisulcatus Long-nosed Potoroo (southern mainland) [86367]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys fumeus Smoky Mouse, Konoom [88]	Endangered	Species or species habitat may occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
PLANT		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat may occur within area
Caladenia concolor Crimson Spider-orchid, Maroon Spider-orchid [5505]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Eucalyptus strzeleckii Strzelecki Gum [55400]	Vulnerable	Species or species habitat known to occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat likely to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat known to occur within area
Lepidium aschersonii Spiny Peppercress [10976]	Vulnerable	Species or species habitat may occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat may occur within area
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat known to occur within area
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat may occur within area
Pterostylis cucullata Leafy Greenhood [15459]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis tenuissima Swamp Greenhood, Dainty Swamp Orchid [13139]	Vulnerable	Species or species habitat known to occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat known to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Thelymitra orientalis Hoary Sun-orchid [88011]	Critically Endangered	Species or species habitat may occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Lissolepis coventryi Swamp Skink, Eastern Mourning Skink [84053]	Endangered	Species or species habitat known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Migration route known to occur within area
Centrophorus uyato Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Migration route known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris as Puffinus tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area overfly marine area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Stercorarius antarcticus as Catharacta skua Brown Skua [85039]		Species or species habitat may occur within area
Sterna striata White-fronted Tern [799]		Foraging, feeding or related behaviour likely to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei as Thalassarche sp. nov. Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini		
Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus as Thinornis rubricollis		
Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area
Thinornis cucullatus cucullatus as Thinornis rubricollis rubricollis		
Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat likely to occur within area overfly marine area
Fish		
Heraldia nocturna		
Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis		
Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps		
Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area

Whales and Other Cetaceans

[Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Current Scientific Name	Status	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves

[Resource Information]

Protected Area Name	Reserve Type	State
Bay of Islands Coastal Park	Conservation Park	VIC
Great Otway	National Park	VIC
Latrobe B.R.	Natural Features Reserve	VIC
Port Campbell	National Park	VIC
Princetown W.R	Natural Features Reserve	VIC
The Arches	Marine Sanctuary	VIC
Twelve Apostles	Marine National Park	VIC

Regional Forest Agreements

[Resource Information]

Note that all areas with completed RFAs have been included. Please see the associated resource information for specific caveats and use limitations associated with RFA boundary information.

RFA Name	State
West Victoria RFA	Victoria

Nationally Important Wetlands

[Resource Information]

Wetland Name	State
Princetown Wetlands	VIC

EPBC Act Referrals

[Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status

Title of referral	Reference	Referral Outcome	Assessment Status
Decommissioning of the Minerva Pipeline in Victorian state waters	2024/09879		Completed
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia East	2024/09795		Completed
Otway Astrolabe 3D Marine Seismic Survey, Otway Basin	2012/6421		Completed
Controlled action			
Alston-1 petroleum exploration well, permit VIC/P44	2003/1315	Controlled Action	Post-Approval
Casino Gas Field Development	2003/1295	Controlled Action	Post-Approval
Otway Development	2002/621	Controlled Action	Post-Approval
Schomberg 3D Marine Seismic Survey	2007/3754	Controlled Action	Completed
Strike Oil Gas Exploration Well, Otway Basin (VIC/P44)	2000/97	Controlled Action	Completed
Twelve Apostles Saddle Lookout	2019/8571	Controlled Action	Post-Approval
VICP61 2D Marine Seismic Survey	2008/4075	Controlled Action	Completed
Not controlled action			
Enterprise 1 Exploration Drilling Program, near Port Campbell, Vic	2019/8438	Not Controlled Action	Completed
Exploration drilling for liquid/gaseous hydrocarbons	2004/1681	Not Controlled Action	Completed
Gas Field Development	2006/2635	Not Controlled Action	Completed
Henry-1 Exploration Well, Petroleum Permit Area VIC/P44	2005/2147	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Minerva Cut Back Project, Vic	2017/8036	Not Controlled Action	Completed
Offshore exploration drilling within permit area VIC/P 37(v)	2004/1466	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Port Campbell Headland Walking Trail Realignment	2012/6676	Not Controlled Action	Completed
Track construction - Great Ocean Walk	2002/793	Not Controlled Action	Completed
VIC-P44 Stage 2 Gas Field Development	2007/3767	Not Controlled Action	Completed
Victorian Generator Project	2005/1984	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Moonlight Head' 3D seismic survey, VIC/P38(V), VIC/P43 and VIC/RL8	2005/2236	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2005/2295	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2003/1214	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey near King Island	2004/1461	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic program VIC/P38(v), VIC/P43 and VIC/RL8	2003/1137	Not Controlled Action (Particular Manner)	Post-Approval
Astrolabe 3D Marine Seismic Survey	2011/6048	Not Controlled Action (Particular Manner)	Post-Approval
BHPBilliton Otway 3D Seismic Survey	2007/3443	Not Controlled Action (Particular Manner)	Post-Approval
Deepwater Sorell Basin 2001 Non-Exclusive 2D Seismic Survey	2001/156	Not Controlled Action (Particular Manner)	Post-Approval
Drill and Profile Exploration Well Somerset 1, License Area T34P	2009/5037	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Enterprise Three-dimensional Transition Zone Seismic Survey, Victoria	2016/7800	Not Controlled Action (Particular Manner)	Post-Approval
Geographe-A gas exploration well	2000/82	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
La Bella 3D Marine Seismic Survey, Otway Basin, VIC	2012/6683	Not Controlled Action (Particular Manner)	Post-Approval
Otway Basin Exploration Drilling Campaign, Vic	2011/6125	Not Controlled Action (Particular Manner)	Post-Approval
Santos Otway 3d Seismic VIC/P44	2007/3367	Not Controlled Action (Particular Manner)	Post-Approval
Schomberg 3D Marine Seismic survey	2007/3868	Not Controlled Action (Particular Manner)	Post-Approval
Strike Oil NL Seismic Surveys	2000/107	Not Controlled Action (Particular Manner)	Post-Approval
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, Vic	2012/6565	Not Controlled Action (Particular Manner)	Post-Approval
Thylacine-A Exploration Well	2000/81	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5700	Not Controlled Action (Particular Manner)	Post-Approval
Vic/P37(v) and Vic/P44 3D marine seismic survey	2003/1102	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
VIC P44 Gas Exploration Wells	2002/662	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 2D seismic survey	2002/811	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, VIC	2012/6545	Referral Decision	Completed
VICP61 2D Marine Seismic Survey	2008/3975	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
West Tasmania Canyons	South-east

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Likely to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

A.5 Potential Impact Area - Flaring (63 km)

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 29-Aug-2024

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance (Ramsar	2
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	8
Listed Threatened Species:	107
Listed Migratory Species:	66

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	3
Commonwealth Heritage Places:	1
Listed Marine Species:	108
Whales and Other Cetaceans:	29
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	3
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	53
Regional Forest Agreements:	1
Nationally Important Wetlands:	8
EPBC Act Referrals:	85
Key Ecological Features (Marine):	2
Biologically Important Areas:	17
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places [Resource Information]

Name	State	Legal Status
Historic		
Great Ocean Road and Scenic Environs	VIC	Listed place

Wetlands of International Importance (Ramsar Wetlands) [Resource Information]

Ramsar Site Name	Proximity
Port phillip bay (western shoreline) and bellarine peninsula	50 - 100km upstream from Ramsar site
Western district lakes	Within Ramsar site

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	Endangered	Community likely to occur within area
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area
Grassy Eucalypt Woodland of the Victorian Volcanic Plain	Critically Endangered	Community known to occur within area
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	Community may occur within area
Natural Temperate Grassland of the Victorian Volcanic Plain	Critically Endangered	Community likely to occur within area

Community Name	Threatened Category	Presence Text
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	Critically Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour may occur within area
Aphelocephala leucopsis Southern Whiteface [529]	Vulnerable	Species or species habitat may occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Climacteris picumnus victoriae Brown Treecreeper (south-eastern) [67062]	Vulnerable	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Melanodryas cucullata cucullata South-eastern Hooded Robin, Hooded Robin (south-eastern) [67093]	Endangered	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat known to occur within area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Pedionomus torquatus Plains-wanderer [906]	Critically Endangered	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
CRUSTACEAN		
Euastacus bispinosus Glenelg Spiny Freshwater Crayfish, Pricklyback [81552]	Endangered	Species or species habitat likely to occur within area
FISH		
Hoplostethus atlanticus Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Nannoperca obscura Yarra Pygmy Perch [26177]	Endangered	Species or species habitat known to occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Seriolella brama Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
FROG		
Litoria raniformis Southern Bell Frog,, Growling Grass Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat known to occur within area
INSECT		
Synemon plana Golden Sun Moth [25234]	Vulnerable	Species or species habitat likely to occur within area
MAMMAL		
Antechinus minimus maritimus Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Endangered	Species or species habitat known to occur within area
Miniopterus orianae bassanii Southern Bent-wing Bat [87645]	Critically Endangered	Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Petauroides volans Greater Glider (southern and central) [254]	Endangered	Species or species habitat likely to occur within area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus trisulcatus Long-nosed Potoroo (southern mainland) [86367]	Vulnerable	Species or species habitat known to occur within area
Pseudomys fumeus Smoky Mouse, Konoom [88]	Endangered	Species or species habitat may occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
PLANT		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Astelia australiana Tall Astelia [10851]	Vulnerable	Species or species habitat known to occur within area
Caladenia concolor Crimson Spider-orchid, Maroon Spider-orchid [5505]	Vulnerable	Species or species habitat may occur within area
Dianella amoena Matted Flax-lily [64886]	Endangered	Species or species habitat likely to occur within area
Dodonaea procumbens Trailing Hop-bush [12149]	Vulnerable	Species or species habitat may occur within area
Eucalyptus strzeleckii Strzelecki Gum [55400]	Vulnerable	Species or species habitat known to occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat known to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat known to occur within area
Lachnagrostis adamsonii Adamson's Blown-grass, Adamson's Blowngrass [76211]	Endangered	Species or species habitat may occur within area
Leiocarpa gatesii Wrinkled Buttons [76212]	Vulnerable	Species or species habitat may occur within area
Lepidium aschersonii Spiny Peppercress [10976]	Vulnerable	Species or species habitat likely to occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pimelea spinescens subsp. spinescens Plains Rice-flower, Spiny Rice-flower, Prickly Pimelea [21980]	Critically Endangered	Species or species habitat may occur within area
Poa sallacustris Salt-lake Tussock-grass [24424]	Vulnerable	Species or species habitat likely to occur within area
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat known to occur within area
Prasophyllum suaveolens Fragrant Leek-orchid [64956]	Endangered	Species or species habitat may occur within area
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat may occur within area
Pterostylis cucullata Leafy Greenhood [15459]	Vulnerable	Species or species habitat known to occur within area
Pterostylis tenuissima Swamp Greenhood, Dainty Swamp Orchid [13139]	Vulnerable	Species or species habitat known to occur within area
Rutidosis leptorhynchoides Button Wrinklewort [67251]	Endangered	Species or species habitat may occur within area
Senecio macrocarpus Large-fruit Fireweed, Large-fruit Groundsel [16333]	Vulnerable	Species or species habitat may occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat known to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Thelymitra matthewsii Spiral Sun-orchid [4168]	Vulnerable	Species or species habitat may occur within area
Thelymitra orientalis Hoary Sun-orchid [88011]	Critically Endangered	Species or species habitat may occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Delma impar Striped Legless Lizard, Striped Snake-lizard [1649]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eulamprus tympanum marnieae Corangamite Water Skink, Dreeite Water Skink [64487]	Endangered	Species or species habitat known to occur within area
Lissolepis coventryi Swamp Skink, Eastern Mourning Skink [84053]	Endangered	Species or species habitat known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Centrophorus uyato Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eubalaena australis as Balaena glacialis australis		
Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isurus oxyrinchus		
Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus		
Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus		
Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus		
Sperm Whale [59]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus		
White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Monarcha melanopsis		
Black-faced Monarch [609]		Species or species habitat may occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Defence	
Defence - WARRNAMBOOL TRAINING DEPOT [21111]	VIC
Unknown	
Commonwealth Land - [21492]	VIC
Commonwealth Land - [21583]	VIC

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Camperdown Post Office	VIC	Listed place

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Ardenna tenuirostris as Puffinus tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Breeding likely to occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area overfly marine area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area overfly marine area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area overfly marine area
Stercorarius antarcticus as Catharacta skua Brown Skua [85039]		Species or species habitat may occur within area
Sterna striata White-fronted Tern [799]		Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Sternula albifrons as Sterna albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei as Thalassarche sp. nov. Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Thalasseus bergii as Sterna bergii		
Greater Crested Tern [83000]		Breeding known to occur within area
Thinornis cucullatus as Thinornis rubricollis		
Hooded Plover, Hooded Dotterel [87735]		Species or species habitat known to occur within area overfly marine area
Thinornis cucullatus cucullatus as Thinornis rubricollis rubricollis		
Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Tringa brevipes as Heteroscelus brevipes		
Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola		
Wood Sandpiper [829]		Roosting known to occur within area overfly marine area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area overfly marine area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area
Fish		
Heraldia nocturna		
Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis		
Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps		
Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus minotaur		
Bullneck Seahorse [66705]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys mollisoni Mollison's Pipefish [66260]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks

[Resource Information]

Park Name	Zone & IUCN Categories
Apollo	Multiple Use Zone (IUCN VI)
Zeehan	Multiple Use Zone (IUCN VI)
Zeehan	Special Purpose Zone (IUCN VI)

Extra Information

State and Territory Reserves

[Resource Information]

Protected Area Name	Reserve Type	State
Aire River	Heritage River	VIC
Aire River W.R.	Natural Features Reserve	VIC
Barham Paradise S.R.	Natural Features Reserve	VIC
Bay of Islands Coastal Park	Conservation Park	VIC

Protected Area Name	Reserve Type	State
Brucknell Creek F.F.R	Nature Conservation Reserve	VIC
Bungador Stoney Rises N.C.R.	Natural Features Reserve	VIC
Calder River	Reference Area	VIC
Carpendeit	Reference Area	VIC
Carpendeit B.R.	Natural Features Reserve	VIC
Cobrico Swamp W.R	Natural Features Reserve	VIC
Cooriemungle	Reference Area	VIC
Cooriemungle Creek F.R	Nature Conservation Reserve	VIC
Coradjil B.R.	Natural Features Reserve	VIC
Coradjil N.C.R.	Natural Features Reserve	VIC
Crinoline Creek	Reference Area	VIC
Curdie Vale N.C.R.	Natural Features Reserve	VIC
Ecklin South Swamp N.C.R.	Natural Features Reserve	VIC
Floating Islands F.F.R	Nature Conservation Reserve	VIC
Framlingham Forest	Indigenous Protected Area	VIC
Gellibrand B.R	Natural Features Reserve	VIC
Gellibrand North B.R.	Natural Features Reserve	VIC
Goose Lagoon W.R	Natural Features Reserve	VIC
Great Otway	National Park	VIC
Hopkins Falls S.R.	Natural Features Reserve	VIC
Hopkins River, Framlingham SS.R.	Natural Features Reserve	VIC

Protected Area Name	Reserve Type	State
Irrewillipe B.R.	Natural Features Reserve	VIC
Jancourt N.C.R.	Natural Features Reserve	VIC
Johanna Falls S.R.	Natural Features Reserve	VIC
Lake Gillear W.R	Natural Features Reserve	VIC
Lake Purrumbete W.R	Nature Conservation Reserve	VIC
Latrobe B.R.	Natural Features Reserve	VIC
Marengo N.C.R.	Nature Conservation Reserve	VIC
Marengo Reefs	Marine Sanctuary	VIC
Merri	Marine Sanctuary	VIC
Nullawarre F.R.	Nature Conservation Reserve	VIC
Olangolah Creek	Reference Area	VIC
Parker River	Reference Area	VIC
Porcupine Creek	Reference Area	VIC
Port Campbell	National Park	VIC
Princetown W.R	Natural Features Reserve	VIC
Stony Creek (Otways)	Reference Area	VIC
The Arches	Marine Sanctuary	VIC
Timboon I1 B.R	Natural Features Reserve	VIC
Tomahawk Creek	Reference Area	VIC
Tower Hill W.R	Natural Features Reserve	VIC
Twelve Apostles	Marine National Park	VIC
Unnamed P0126	Private Nature Reserve	VIC

Protected Area Name	Reserve Type	State
Unnamed P0176	Private Nature Reserve	VIC
Unnamed P0353	Private Nature Reserve	VIC
Wild Dog B.R.	Natural Features Reserve	VIC
Wild Dog Creek SS.R.	Natural Features Reserve	VIC
Wongarra B.R.	Natural Features Reserve	VIC
Yaugher B.R.	Natural Features Reserve	VIC

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included. Please see the associated resource information for specific caveats and use limitations associated with RFA boundary information.

RFA Name	State
West Victoria RFA	Victoria

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Aire River	VIC
Cobden-Terang Volcanic Craters	VIC
Lake Corangamite	VIC
Lower Aire River Wetlands	VIC
Lower Merri River Wetlands	VIC
Princetown Wetlands	VIC
Stonyford-Bungador Wetlands	VIC
Tower Hill	VIC

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Apollo Bay to Skenes Creek Coastal Trail	2022/09274		Assessment
Colac Pipeline Upgrade ? Sections 19, 20, 21, 23 & 25i	2022/09343		Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Decommissioning of the Minerva Pipeline in Victorian state waters	2024/09879		Completed
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia East	2024/09795		Completed
Otway Astrolabe 3D Marine Seismic Survey, Otway Basin	2012/6421		Completed
Spinifex Offshore Surveys	2022/09359		Completed
Spinifex Offshore Wind Farm - Offshore Investigations	2024/09918		Referral Decision
Controlled action			
Alston-1 petroleum exploration well, permit VIC/P44	2003/1315	Controlled Action	Post-Approval
Casino Gas Field Development	2003/1295	Controlled Action	Post-Approval
Otway Development	2002/621	Controlled Action	Post-Approval
Residential Subdivision & Infrastructure Parish of Belfast	2005/1954	Controlled Action	Completed
Schomberg 3D Marine Seismic Survey	2007/3754	Controlled Action	Completed
Strike Oil Gas Exploration Well, Otway Basin (VIC/P44)	2000/97	Controlled Action	Completed
Twelve Apostles Saddle Lookout	2019/8571	Controlled Action	Post-Approval
VICP61 2D Marine Seismic Survey	2008/4075	Controlled Action	Completed
Not controlled action			
Alteration of Grass Maintenance Regime within Powling St Wetlands	2012/6527	Not Controlled Action	Completed
Amrit-1 exploration well	2004/1572	Not Controlled Action	Completed
Apollo Bay Water Storage Basin, VIC	2012/6484	Not Controlled Action	Completed
CO2 geosequestration - Otway Basin Pilot Project	2006/2699	Not Controlled Action	Completed
construction of pump station for pump diversion from the Barham	2003/1242	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
River			
Enterprise 1 Exploration Drilling Program, near Port Campbell, Vic	2019/8438	Not Controlled Action	Completed
Exploration drilling for liquid/gaseous hydrocarbons	2004/1681	Not Controlled Action	Completed
Gas Field Development	2006/2635	Not Controlled Action	Completed
Gas Fields Development	2011/5879	Not Controlled Action	Completed
Gas Pipeline Installation	2005/2495	Not Controlled Action	Completed
Halladale and Speculant Gas Pipeline Project, North of Port Campbell, Vic	2015/7551	Not Controlled Action	Completed
Henry-1 Exploration Well, Petroleum Permit Area VIC/P44	2005/2147	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Kelly Swamp Boardwalk Construction	2010/5371	Not Controlled Action	Completed
Maintenance of Access Track and Weed Removal	2009/4973	Not Controlled Action	Completed
Minerva Cut Back Project, Vic	2017/8036	Not Controlled Action	Completed
Naroghid Wind Farm	2004/1542	Not Controlled Action	Completed
Newfield wind farm	2007/3226	Not Controlled Action	Completed
Nirranda South Wind Farm Pty Ltd	2002/763	Not Controlled Action	Completed
Offshore exploration drilling within permit area VIC/P 37(v)	2004/1466	Not Controlled Action	Completed
Port Campbell Headland Walking Trail Realignment	2012/6676	Not Controlled Action	Completed
Railway Bridge (H0151) Partial Demolition, Merri River	2010/5534	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Residential/Resort/Golf Course development	2002/907	Not Controlled Action	Completed
Salt Creek Wind Farm transmission line, Vic	2016/7763	Not Controlled Action	Completed
Stage 1 residential subdivision, Anna Catherine Drive	2005/1992	Not Controlled Action	Completed
The Sisters Wind Farm	2008/4268	Not Controlled Action	Completed
Track construction - Great Ocean Walk	2002/793	Not Controlled Action	Completed
VIC-P44 Stage 2 Gas Field Development	2007/3767	Not Controlled Action	Completed
Victorian Generator Project	2005/1984	Not Controlled Action	Completed
Wind Farm Construction and Operation	2001/471	Not Controlled Action	Completed
Wind farm development	2005/1960	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Moonlight Head' 3D seismic survey, VIC/P38(V), VIC/P43 and VIC/RL8	2005/2236	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2005/2295	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2003/1214	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey near King Island	2004/1461	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic program VIC/P38(v), VIC/P43 and VIC/RL8	2003/1137	Not Controlled Action (Particular Manner)	Post-Approval
Astrolabe 3D Marine Seismic Survey	2011/6048	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
BHPBilliton Otway 3D Seismic Survey	2007/3443	Not Controlled Action (Particular Manner)	Post-Approval
Deepwater Sorell Basin 2001 Non-Exclusive 2D Seismic Survey	2001/156	Not Controlled Action (Particular Manner)	Post-Approval
Drill and Profile Exploration Well Somerset 1, License Area T34P	2009/5037	Not Controlled Action (Particular Manner)	Post-Approval
Enterprise Three-dimensional Transition Zone Seismic Survey, Victoria	2016/7800	Not Controlled Action (Particular Manner)	Post-Approval
Fuelbreak construction	2009/4915	Not Controlled Action (Particular Manner)	Post-Approval
Gas Pipeline Crossing at Mount Emu Creek	2009/4913	Not Controlled Action (Particular Manner)	Post-Approval
Geographe-A gas exploration well	2000/82	Not Controlled Action (Particular Manner)	Post-Approval
Hydrocarbon exploration wells	2003/1062	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
La Bella 3D Marine Seismic Survey, Otway Basin, VIC	2012/6683	Not Controlled Action (Particular Manner)	Post-Approval
OTE10 2D Marine Seismic Survey	2009/5223	Not Controlled Action (Particular Manner)	Post-Approval
Otway Basin Exploration Drilling Campaign, Vic	2011/6125	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Residential Development and Associated Infrastructure at Port Fairy	2012/6687	Not Controlled Action (Particular Manner)	Post-Approval
Santos Otway 3d Seismic VIC/P44	2007/3367	Not Controlled Action (Particular Manner)	Post-Approval
Schomberg 3D Marine Seismic survey	2007/3868	Not Controlled Action (Particular Manner)	Post-Approval
SEA Gas Project transmission pipeline	2001/513	Not Controlled Action (Particular Manner)	Post-Approval
Shaw River Power Station construct gas pipeline and associated infrastructure	2009/5089	Not Controlled Action (Particular Manner)	Post-Approval
Shaw River Power Station Project - Water Supply Pipeline	2009/5091	Not Controlled Action (Particular Manner)	Post-Approval
Southern Gas Pipeline Project	2002/619	Not Controlled Action (Particular Manner)	Post-Approval
Southern Margins T/35P and T/36P 3D Seismic Surveys	2007/3817	Not Controlled Action (Particular Manner)	Post-Approval
Speculant 3D Transition Zone Seismic Survey	2010/5558	Not Controlled Action (Particular Manner)	Post-Approval
Strike Oil NL Seismic Surveys	2000/107	Not Controlled Action (Particular Manner)	Post-Approval
Surface Geochemical Exploration Program, TAS	2010/5780	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, Vic	2012/6565	Not Controlled Action (Particular Manner)	Post-Approval
Thylacine-A Exploration Well	2000/81	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5700	Not Controlled Action (Particular Manner)	Post-Approval
Vic/P37(v) and Vic/P44 3D marine seismic survey	2003/1102	Not Controlled Action (Particular Manner)	Post-Approval
VIC P44 Gas Exploration Wells	2002/662	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 2D seismic survey	2002/811	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 3D seismic survey	2002/799	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, VIC	2012/6545	Referral Decision	Completed
VICP61 2D Marine Seismic Survey	2008/3975	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Bonney Coast Upwelling	South-east
West Tasmania Canyons	South-east

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Likely to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Morus serrator Australasian Gannet [1020]	Foraging	Known to occur
Pelagodroma marina White-faced Storm-petrel [1016]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Sharks		
Carcharodon carcharias White Shark [64470]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Known Foraging Area	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

A.6 Potential Impact Area – No Flaring (10 km)

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 29-Aug-2024

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	41
Listed Migratory Species:	40

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	63
Whales and Other Cetaceans:	28
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	34
Key Ecological Features (Marine):	1
Biologically Important Areas:	12
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
FISH		
Hoplostethus atlanticus Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area
Seriolella brama Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
MAMMAL		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
REPTILE		

Scientific Name	Threatened Category	Presence Text
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Migration route known to occur within area
Centrophorus uyato Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area

Scientific Name	Threatened Category	Presence Text
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Migration route known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area

Migratory Wetlands Species

Scientific Name	Threatened Category	Presence Text
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]	Vulnerable	Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Stercorarius antarcticus as Catharacta skua Brown Skua [85039]		Species or species habitat may occur within area
Sterna striata White-fronted Tern [799]		Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche bulleri platei as Thalassarche sp. nov.		
Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma		
Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini		
Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Fish		
Heraldia nocturna		
Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis		
Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and Other Cetaceans

[Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

EPBC Act Referrals

[Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia East	2024/09795		Completed
Otway Astrolabe 3D Marine Seismic Survey, Otway Basin	2012/6421		Completed
Controlled action			
Casino Gas Field Development	2003/1295	Controlled Action	Post-Approval
Otway Development	2002/621	Controlled Action	Post-Approval
Schomberg 3D Marine Seismic Survey	2007/3754	Controlled Action	Completed
VICP61 2D Marine Seismic Survey	2008/4075	Controlled Action	Completed
Not controlled action			
Exploration drilling for liquid/gaseous hydrocarbons	2004/1681	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Gas Field Development	2006/2635	Not Controlled Action	Completed
Henry-1 Exploration Well, Petroleum Permit Area VIC/P44	2005/2147	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
VIC-P44 Stage 2 Gas Field Development	2007/3767	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Moonlight Head' 3D seismic survey, VIC/P38(V), VIC/P43 and VIC/RL8	2005/2236	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2005/2295	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey near King Island	2004/1461	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic program VIC/P38(v), VIC/P43 and VIC/RL8	2003/1137	Not Controlled Action (Particular Manner)	Post-Approval
Astrolabe 3D Marine Seismic Survey	2011/6048	Not Controlled Action (Particular Manner)	Post-Approval
BHPBilliton Otway 3D Seismic Survey	2007/3443	Not Controlled Action (Particular Manner)	Post-Approval
Deepwater Sorell Basin 2001 Non-Exclusive 2D Seismic Survey	2001/156	Not Controlled Action (Particular Manner)	Post-Approval
Drill and Profile Exploration Well Somerset 1, License Area T34P	2009/5037	Not Controlled Action (Particular Manner)	Post-Approval
Geographe-A gas exploration well	2000/82	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
La Bella 3D Marine Seismic Survey, Otway Basin, VIC	2012/6683	Not Controlled Action (Particular Manner)	Post-Approval
Otway Basin Exploration Drilling Campaign, Vic	2011/6125	Not Controlled Action (Particular Manner)	Post-Approval
Santos Otway 3d Seismic VIC/P44	2007/3367	Not Controlled Action (Particular Manner)	Post-Approval
Schomberg 3D Marine Seismic survey	2007/3868	Not Controlled Action (Particular Manner)	Post-Approval
Strike Oil NL Seismic Surveys	2000/107	Not Controlled Action (Particular Manner)	Post-Approval
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, Vic	2012/6565	Not Controlled Action (Particular Manner)	Post-Approval
Thylacine-A Exploration Well	2000/81	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5700	Not Controlled Action (Particular Manner)	Post-Approval
Vic/P37(v) and Vic/P44 3D marine seismic survey	2003/1102	Not Controlled Action (Particular Manner)	Post-Approval
VIC P44 Gas Exploration Wells	2002/662	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 2D seismic survey	2002/811	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Referral decision			
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, VIC	2012/6545	Referral Decision	Completed
VICP61 2D Marine Seismic Survey	2008/3975	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
West Tasmania Canyons	South-east

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Likely to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

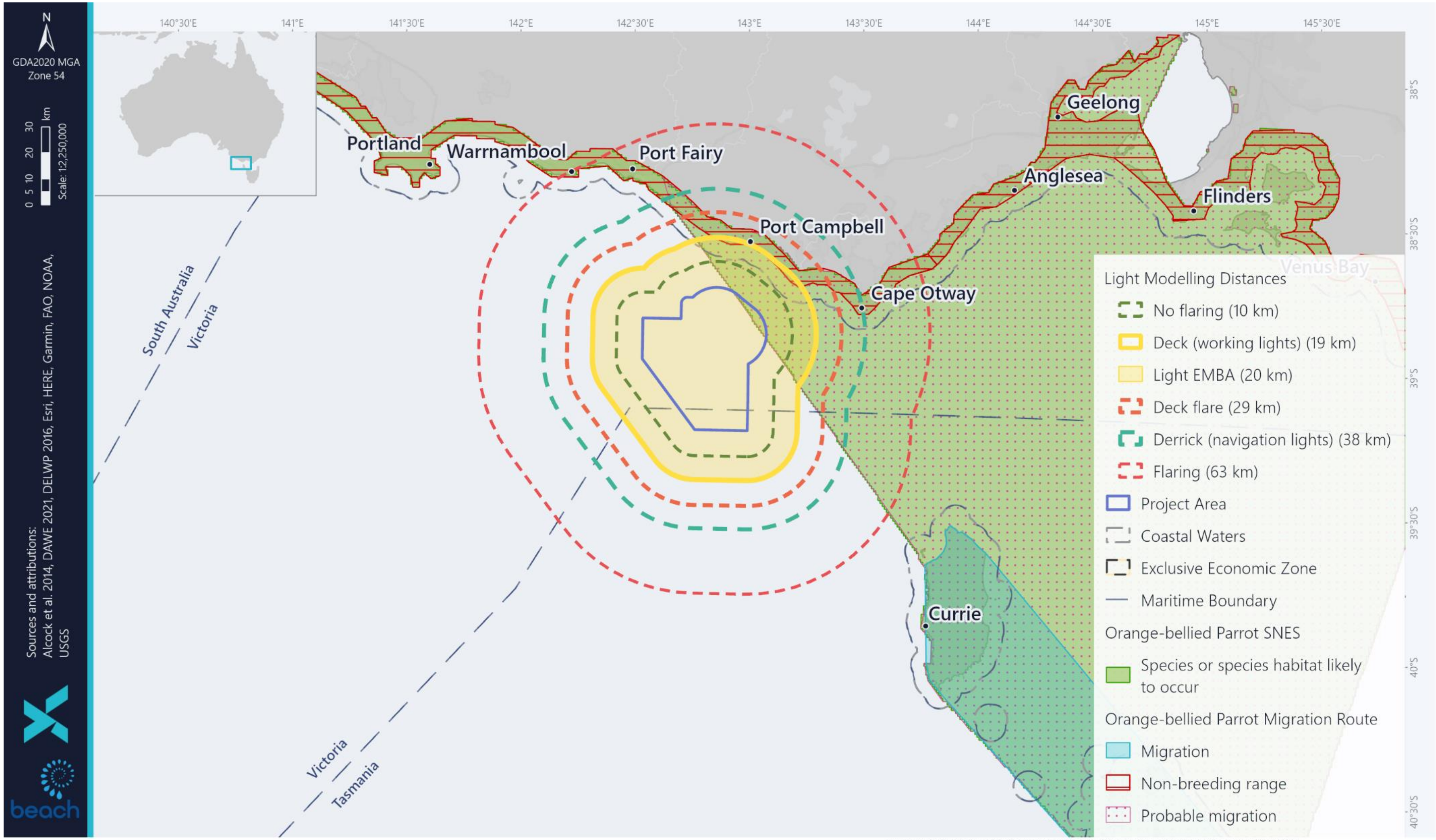
-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

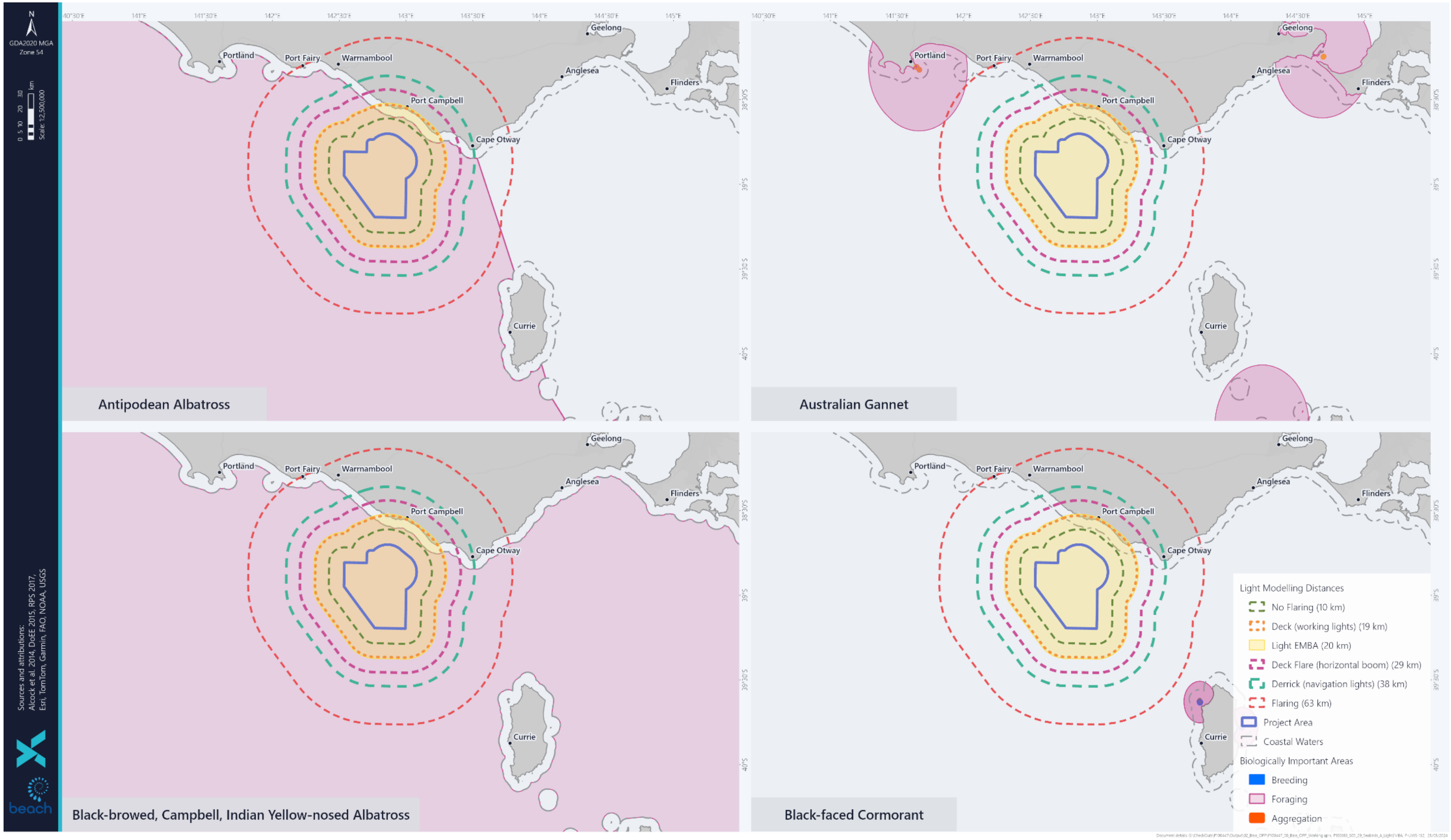
Please feel free to provide feedback via the Contact us page.

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090
Canberra ACT 2601 Australia
+61 2 6274 1111

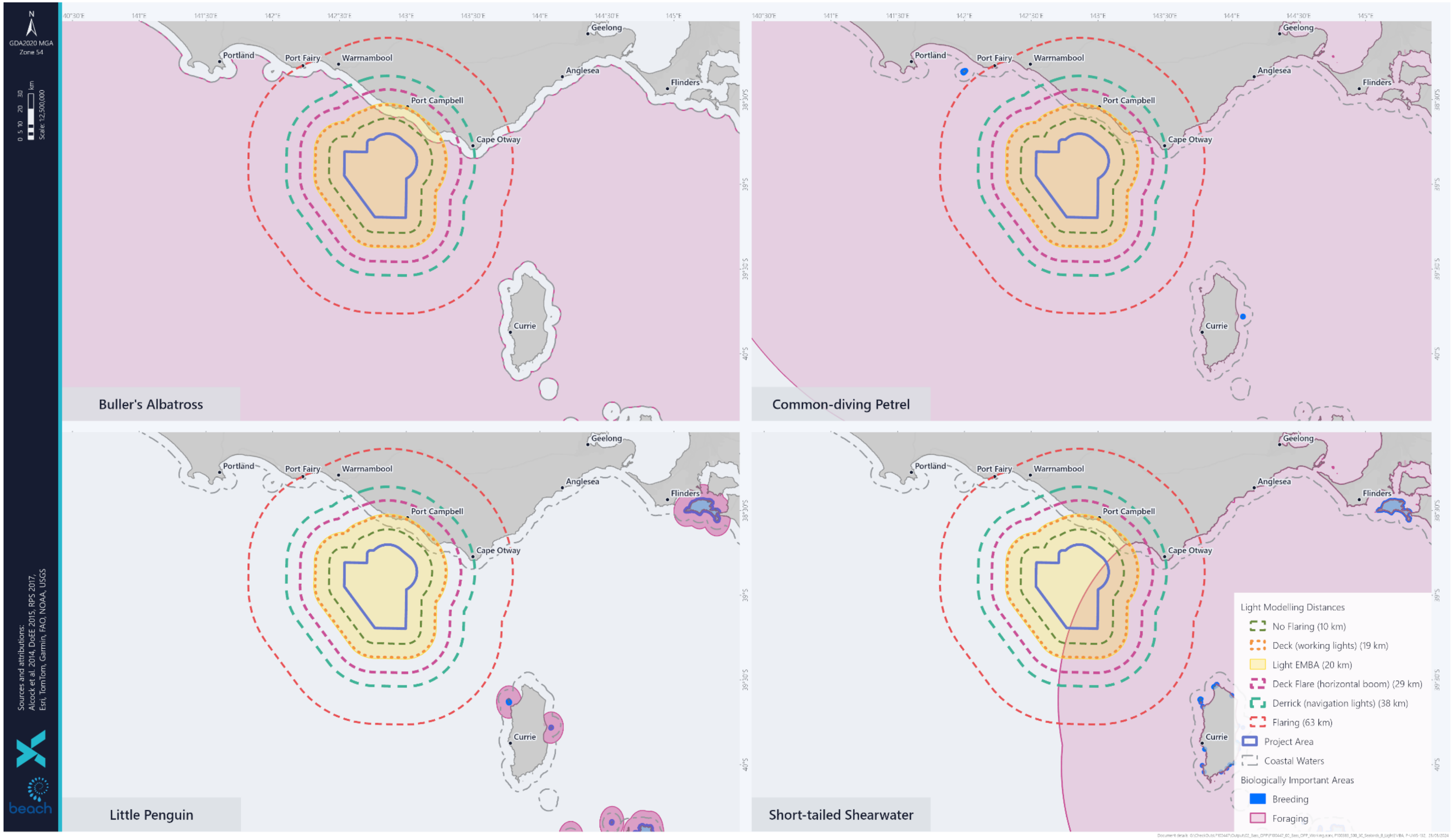
APPENDIX B ADDITIONAL FIGURES - BIOLOGICALLY IMPORTANT AREAS



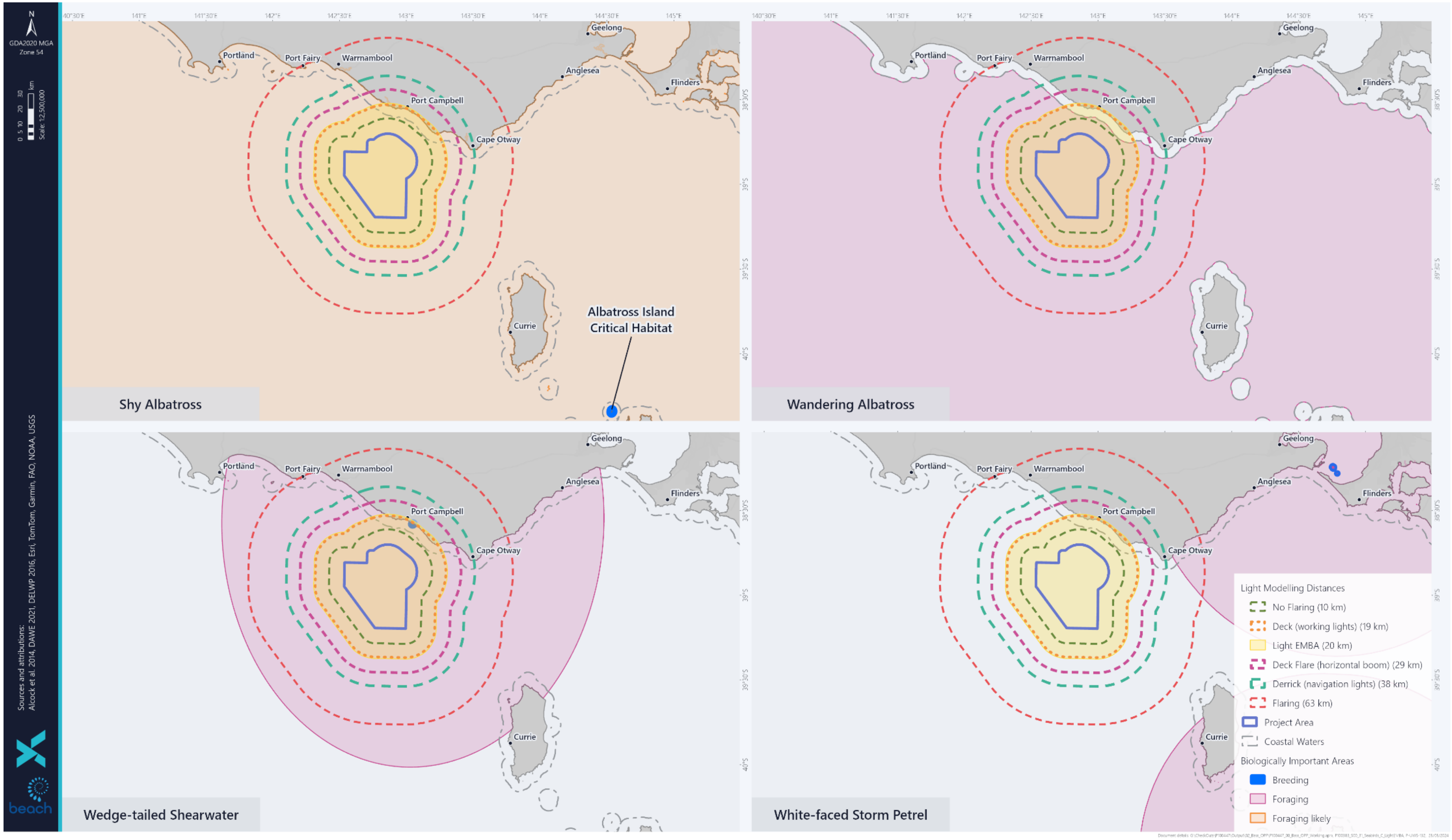
Appendix B-1: Orange-bellied parrot migration route and likely habitat



Appendix B-2: Bird BIAs within the vicinity of the light impact areas



Appendix B-3: Bird BIAs within the vicinity of the light impact areas



Sources and attributions:
Alcock et al. 2014, DAWE 2021, DELWP 2016, Esri, TomTom, Garmin, FAO, NOAA, USGS

Appendix B-4: Bird BIAs within the vicinity of the light impact areas

Appendix P Public Comment Report

Proponent's Report on Public Comments: Otway Offshore Gas Victoria Project Offshore Project Proposal

Date	7 March 2025
Document owner	Beach Energy Limited
Distribution	NOPSEMA

Review record (record the last 3 revisions here or the revisions required to achieve current approval version)

Revision	Date	Reason for issue	Reviewer/s	Consolidator	Approver
0	21/06/2024	OPP (Rev3) Submission to NOPSEMA	AC, CN, LJ	NK	TF
1	28/10/2024	OPP (Rev4) Submission to NOPSEMA		NK	NK
2	07/03/2025	OPP (Rev5) Submission to NOPSEMA		NK	NK

THE THREE WHATS
What can go wrong?
What could cause it to go wrong?
What can I do to prevent it?

Contents

1. Introduction

The Otway Offshore Gas Victoria Project (the Project) intends to develop gas reserves for use in the east coast domestic gas market. These reserves and potential resources are adjacent to existing Beach Energy (Operations) Limited (Beach) permits and infrastructure. The Project would be undertaken through integrated subsea drilling and installation campaigns.

The Project involves exploration, appraisal and development of existing and future gas discoveries in Beach's exploration permits, VIC/P43 and VIC/P73 located in the offshore Otway Basin. It covers an area that is located approximately 17 km south of the Victorian mainland and 80 km west of Tasmania (King Island) at its closest points.

The proposed scope of the Project consists of:

- Seabed surveys (geotechnical and geophysical)
- Drilling and Completions
- Subsea infrastructure installation
- Commissioning
- Operations and maintenance
- Future tiebacks
- Decommissioning

Beach is planning the initial drilling campaign to commence in 2025, with installation of new subsea facilities commencing in 2028 and the earliest achievable date for commissioning and first gas subject to final investment decision, joint venture and regulatory approvals. Production from successful prospects may have an operational life of up to 30 years, dependent upon resource size, well pressure and other factors.

Beach submitted the Offshore Project Proposal (OPP) to National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for Stage 1 assessment on 11 September 2023 (with revisions submitted on 21 December 2023 and 15 February 2024). On 8 March 2024, NOPSEMA advised that the OPP was suitable for publication for public comment in accordance with Section 9 of the OPGGS (Environment) Regulations 2023. The OPP (Revision 2) was published and opened for comment for nine weeks from 18 March 2024 to 20 May 2024.

Beach promoted the public comment process by publishing a public notice in seven different newspapers, emailing the project stakeholder list, and prominently featuring information about the public comment period and links to NOPSEMA's website on Engage Beach, Beach's online consultation hub.

Eleven public submissions were received. Beach acknowledges all those who took time to compile and submit their written comments regarding the OPP. One submission (Submission 3) provided comments that had no merit and were not relevant to the OPP and was not considered further in the OPP public comment process. One submission (Submission 4) was made in response to a public comment process for a separate environmental approval and, by agreement with the submitter, was accepted and managed as part of the public comment process for the environmental approval and excluded from the OPP public comment process.

This report on Public Comment (the Report) relates to the Project's Offshore Project Proposal (OPP) and is a requirement following the completion of the public comment process.

Beach has reviewed the comments and undertook an assessment of the OPP to determine whether comments are adequately addressed in the OPP. Where Beach was satisfied that the comments were adequately addressed in the OPP, the relevant sections of the OPP were referenced and summarised as appropriate and submitted to NOPSEMA for assessment on 21 June 2024 (Revision 3 of OPP). Where Beach updated the OPP in response to comments, these responses are referenced in the OPP.

Beach has subsequently undertaken further reviews of the OPP (Revision 4 submitted on 31 October 2024 and Revision 5 submitted on 7 March 2025) in response to requests for further information from NOPSEMA and to reflect changes made by the proponent to the scope of activity described in the OPP. Beach has removed the development of potential gas fields located in T/30P from this OPP. The T/30P blocks are located in the southern Otway Basin located near Tasmania. The revised OPP has reduced the planned activities, the Project and Planning areas, the affected environment and, related impacts and risks. As a result, revisions to the OPP have been made and are summarised below including reference to specific public comments:

- No proposed development in T/30P (PC288)
- Reduced number of proposed wells (PC200, PC201, PC222, PC244, PC278, PC288) and end of field life of 2045.
- New quantitative spill modelling was undertaken to model the loss of well control in the southern well location to replace T/30P well location (now outside the Project Area) with Thylacine West 1 location (within the Project Area) (see Appendix M, Figure 7-1 and Table 7-17 of OPP) (PC298, PC277, PC279, PC284)
- Zeehan Marine Park – closest proximity to Project Area is 58 km (formerly 1km) (PC182, PC287, PC288, PC289, PC339). The Zeehan Marine Park remains within the Planning Area.
- World Heritage Properties - Tasmania World Heritage Wilderness - not within the Planning Area (or Project Area) (PC345, PC349, PC290, PC291, PC333)
- Key Ecological Features - West Tasmanian Canyon - not within the Project Area (remains in the Planning Area) (PC331)
- New Greenhouse Gas GHG) Emissions Report (Appendix K) was prepared to model the reduced Project scope. The GHG emissions for the Project are estimated to be 13.05 million tonnes CO_2-e (formerly estimated to be 34.6 million tonnes CO_2-e) contributing to approximately 0.19% of the Australian carbon budget (PC326, PC197, PC218, PC207)
- New light EMBA modelling for flaring (from 50km to 63km) (PC232, PC163, PC228, PC238, PC239, PC240, PC242, PC243, PC244, PC245, PC247, PC249, PC250).

2. Proponent's contact details

Proponent's details		
Beach Energy (Operations) Limited – Operator	Business address	Level 8 80 Flinders Street Adelaide South Australia 5000
	Telephone number	(08) 8338 2833
	Email address	info@beachenergy.com.au

	Australian Company Number	007 845 338
Proponent's Liaison Person		
Beach Energy (Operations) Limited	Business address	Level 8 80 Flinders Street Adelaide South Australia 5000
	Telephone number	(08) 8338 2833
	Email address	info@beachenergy.com.au

3. Proponent's Report on Public Comments

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
3.1 Submitter No. 1 & 2		
PC343	I am deeply concerned about the gas energy crisis that is happening in Victoria that I saw on the news -I think that this project will impact me and all Victorian's because we all need access to gas for heating or for products that are manufactured using gas energy. I support the approval of this project as hopefully it will give us a bit more gas and time to transition to other energy sources.	Beach Energy (Operations) Limited (Beach) agrees with the comment that natural gas has an important role to play in providing affordable, reliable, and secure energy to the community as we move through the energy transition.
PC158	Comment: I am unsure why so many wells are going to be closed, surely, we need to keep these wells open to extract any remaining gas left in them if there is a big gas crisis looming.	Beach Energy (Operations) Limited (Beach) agrees with the comment that natural gas has an important role to play in providing affordable, reliable, and secure energy to the community as we move through the energy transition. The comment received appears to be in reference to the plug and abandonment of existing suspended wells that has been addressed in Beach's OGV Drilling and P&A Activities Environment Plan. Under the *Offshore Petroleum Greenhouse Gas Storage Act 2006* and regulations, Beach is required to progressively decommission and remove all property and plug and abandon wells. The plug and abandonment activities in the Offshore Project Proposal (OPP) are relevant for decommissioning of future production wells at the end of commercial production and where an exploration well is confirmed to have no commercial hydrocarbon potential after drilling and evaluation. No change has been made to the OPP in response to this comment.
PC159	Comment: Has Beach identified all relevant areas and protected marine species? I am a bit concerned that I don't see a lot of discussion or analysis of Biologically	Beach Energy (Operations) Limited (Beach) has prepared the Offshore Project Proposal (OPP) to include a comprehensive assessment of the existing environment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	Important Areas - I thought this would be a specific heading. The NOPSEMA website has a thing about it from 24 Feb onwards (https://www.nopsema.gov.au/blogs/industry-proposals-and-nopsema-assessments-have-consideration-changes-biologically-important). Maybe this is something that will be added into the Environmental Plan in more detail down the track. It would be helpful for us members of the public to see the BIA geospatial data overlayed onto the proposed project/impact areas, so it is easier to understand if Beach has identified all the relevant areas and is doing its best to mitigate any negative impacts on protected marine species.	Section 4 of the OPP describes the ecological, socioeconomic, and cultural features of the environment. The assessment includes conservation values and sensitivities for protected areas, heritage areas and key ecological features identified within the Operational and Planning Areas using Environment Protection and Biodiversity Conservation Protected Matters Search Tool Reports. The Biological Important Areas (BIAs) are included in the OPP. While a specific section heading for BIAs is provided in the OPP (Section 2.3.2) to define the importance of BIA, the OPP is structured under headings identifying the relevant species and ecological environment and within each of these headings an assessment of the BIA is included. In this regard, there are over 100 references to BIAs in the OPP. Several figures are included in the OPP showing the overlay of BIAs and the project and planning areas for white sharks (Figure 4-38), birds (Figures 4-39 to 4-41 and 6-1 to 6-3), blue whales (Figures 4-44, 6-6 and 6-8), and southern right whale (Figures 4-56, 6-7 and 6-9). Further to the OPP, Environment Plan(s) (EPs) prepared for specific activities will also identify and assess the BIAs within the existing environment. National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA's) announcement, published on 26 February 2024, advised that the Department of Climate Change, Energy, the Environment and Water is reviewing the BIAs. The most up to date information on BIAs is provided in the OPP, including the recent update for southern right whale BIA. Further EPs that may be developed pursuant to the OPP will also consider BIAs and current relevant research and applicable regulations. Beach is satisfied that the OPP adequately addressed BIAs and no change has been made to the OPP in response to this comment.
PC155	Comment: While I recognise that we need this project to go ahead to help Victorian's like me stay warm in the winter, I am of course worried about the effect of the drilling on marine life as the noise of drilling would be very high, but I am glad that no seismic activity is required.	Beach Energy (Operations) Limited (Beach) agrees with the comments that natural gas has an important role to play in providing affordable, reliable, and secure energy to the community. The Offshore Project Proposal (OPP) includes drilling campaign(s) as part of the Project and has provided an assessment of the potential impacts and risks of drilling on various marine fauna. Drilling is identified as a source of low-intensity continuous sound (Section 6.4.2.3). Section 6.4 of the OPP includes a detailed assessment of the possible disruption to marine fauna from noise.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Tables 6-29 to 6-31 summarise the impact evaluation for underwater noise assessed as Moderate , and the control measures acceptable levels and environmental performance outcomes. A key control to reduce the impact of noise on whales are various Whale Management Procedures. For drilling this includes having independent and trained Marine Mammal Observers (MMOs) or Marine Fauna Observers (MFO) involved in the drilling program to ensure the proper implementation of a Whale Management Procedure. The monitoring and reporting requirements for MMO under the Whale Management Procedure are important control measures designed to comply with various government reporting for vessel strikes or injury of cetaceans. For further information, the Whale Management Procedure to be implemented during the Offshore Gas Victoria (OGV) Drilling and P&A activities is provided as part of the Environment Plan (EP) (Appendix H), which is currently under assessment by NOPSEMA. Beach has successfully used similar whale management procedures in past EPs and would continue to use such procedure in future EPs, adapted as applicable to the activities in EPs and any further relevant studies that may be applicable. In relation to seismic activity, Beach confirms that marine seismic acquisition is not included in the OPP. The OPP does include an option to carry out vertical seismic profiling (VSP) – also known as check shot survey – in wells for future drilling campaigns, if applicable (Section 3.8.3.3). VSP is a potential source of non-continuous or impulsive underwater noise with the potential impacts summarised in Table 6-29 (Section 6.4.4) of the OPP. As above, a key control to reduce the impact of underwater noise on whales is the Whale Management Procedure (Table 6-30). Beach is satisfied that the OPP adequately considers the potential noise impacts of drilling on marine fauna and no change to the OPP has been made in response to this comment.
PC156	Comment: I hope that enough studies have been done on what the impact of drilling for over a year will have on whale migration and that surveillance will be carried on during this process to keep studying the impact it has. Maybe I am mistaken, but it seems that according to your Environmental Plan it is impossible to not be drilling during the migration of some species of whale as the migration dates all overlap.	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding the potential impact of drilling activities on whales. The Offshore Project Proposal (OPP) includes drilling campaign(s) as part of the project and Beach has provided an assessment of the potential impacts and risks of drilling on various marine fauna. Beach has undertaken significant research and compiled over 13,500 hours of observations to determine the presence of whales in the area. Beach describes the potential noise impacts from the activity in detail in Section 6.4 of the OPP. This describes all the potential noise sources that could be generated during the drilling activity.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Beach engaged a noise expert in 2021 (JASCO) to deploy acoustic (noise) monitoring buoys on the seabed during our previous drilling campaign (3 February 2021 – 3 April 2021). These buoys monitored noise generated from all the activities associated with drilling a well. The results from this monitoring were incorporated in sophisticated acoustic models to determine the potential impact on whales (cetaceans). The results from this modelling are shown in Section 6.4 of the OPP. As described in Section 6.4.3 of the OPP, impacts to whales, which may occur from continuous noise emissions associated with the drilling program. The continuous noise source sound behaviour EMBAs for marine mammals of 7.98 km and for marine mammals on shelf edge of 19.6 km intersect the migration BIA for the southern right whale (**Error! Reference source not found.**). These EMBAs are based on the greatest distances from the activity where noise effect criteria are reached for continuous noise sources. Section 6.4.3 of the OPP describes the potential for marine mammal species to experience injury or mortality through Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) or express a behaviour response because of sound emissions. The PTS and TTS 24-hour criteria are only relevant to those receptors that are likely to be present in the area of sonification for a period of 24 hours. Sound sensitive marine mammal species and behaviours that could occur within the relevant environment that may be affected (EMBA) were identified through Protected Matters Search Tool (PMST). Biologically Important Area (BIAs) were identified from the National Conservation Values Atlas. Section 6.4.3 of the OPP includes an impact assessment specific to each species on published sound exposure criteria thresholds. The largest impact on underwater noise is from the movement of vessels. The propellers from the vessels generated significantly more noise than drilling activities. A key control to reduce the impact of noise on whales is having independent and trained Marine Mammal Observers (MMOs) or Marine Fauna Observers involved in the drilling program to ensure the proper implementation of a Whale Management Procedure. The monitoring and reporting requirements for MMO under the Whale Management Procedure are important control measures that are designed to comply with various government reporting for vessel strikes or injury of cetaceans. For more information, the Whale Management Procedure to be implemented during the Offshore Gas Victoria Drilling and P&A Activities is included in the Environment Plan (Appendix H), which is currently under assessment by National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Beach considers that Section 6.4 of the OPP demonstrates sufficient justification that there will be Moderate (2) residual consequences with no associated population level impacts and no potential to result in serious or irreversible environmental damage. As detailed in the OPP, the assessment considers control measures such as the development of a Whale Management Procedure, include specific measures to minimise anthropogenic noise threats to relevant species, such as, the implementation of safe operating distances between vessels and whales, pre-activity surveys for specific activities, night-time and low visibility controls and establishment of safe points for operational activities in accordance with the Safety Case and Well Integrity requirements. Impacts and risk to threatened and migratory species are thoroughly assessed throughout the OPP in Sections 6 and 7. BIAs for species are taken into consideration and inform the assessment of impact and risk. Environmental Performance Outcomes (EPOs) and control measures ensure that these impacts and risks are reduced to acceptable levels. EPOs and Control Measures are included in the OPP for planned activities relevant to the protection of species undertaking biologically important behaviours such as: • EPO7 No death or injury to marine fauna, including listed threatened or migratory species, from Project activities. • EPO8 Biologically important behaviours can continue while Project activities are being undertaken. • EPO8 Underwater sound emissions in biologically important areas will be managed such that any whale, including blue and southern right whales, continue to utilise the area without injury, and are not displaced from a foraging area. • EPO10: Anthropogenic noise in biologically important areas and habitat critical to the survival of a species will be managed such that: ○ Any blue whale continues to utilise biologically important areas without injury, and is not displaced from a foraging area. ○ It does not prevent any southern right whale from utilising biologically important areas or habitat critical to the survival of a species or cause auditory impairment (TTS and PTS). • EPO11: Implement various control measures for Whale Management Procedures to ensure impacts and risks to whales from underwater sound are managed in accordance with relevant recovery plans. Measures to minimise anthropogenic threats to Southern Right Whales and Pygmy Blue Whales include (but are not limited to) whale management procedures for geophysical surveys, drilling,

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		vertical seismic profiling (VSP) and vessel management. These management procedures include the implementation of pre-start-up visual observations, processes for delayed start up should whales be sighted, nighttime/ low visibility procedures and the use of trained personnel and/or Marine Mammal Observers. Other measures relevant to the protection of species undertaking biologically important behaviours are outlined in the OPP in Section ES6 (Environmental Performance Outcomes, Standards and Control Measures). These measures are in place ensure impacts and risks are reduced to acceptable levels. Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to this comment.
PC160 PC161	Comment: I don't see a lot of info about seals and seabirds either, and how they will be kept safe if they climb (or int he case of birds, fly) onto drilling platforms. If they are protected species then that is of interest to me as an avid bird watcher and lover of nature.	The Offshore Project Proposal (OPP) provides comprehensive information on marine species, *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) status, and habitat and behaviour within the Project and Planning Areas. Beach Energy (Operations) Limited (Beach) has reviewed the OPP on receipt of these comments and confirms that the OPP identifies the protected species within the Project and Planning Areas to include the EPBC listed pinniped (seals) species or habitats (Table 4-24) and the EPBC listed seabirds and shorebirds (Table 4-22). An assessment of seabirds (Section 4.4.9.4) and seals (Section 4.4.9.6) within the existing environment is also provided in the OPP. Beach acknowledges the activities planned for the OPP may have potential environmental impacts and risks on various marine fauna, including seabirds and seals. The OPP includes drilling campaign(s) as part of the project and as such Beach has provided an assessment of the potential impacts and risks of drilling on seabirds and an assessment that impacts are of an acceptable level. Section 6.3 of the OPP includes a detailed assessment of the possible disruption to seabirds from light sources associated with the drilling activities. Light emissions are assessed as having a Minor (1) consequence, which is not considered as having the potential to result in serious or irreversible environmental damage. Beach has assessed various controls to minimise light emissions and in consultation with suitably qualified specialists, will develop and implement a Light Management Plan. The Light

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Management Plan will assist in managing environmental impacts and risks of light emissions in compliance with the National Light Pollution Guidelines for Wildlife (CoA 2023). Further information on the Light Management Plan will be provided in the relevant Environment Plan(s). The potential impact of underwater noise on seals (pinnipeds) is assessed in Section 6.4 with the potential impacts of impulsive noise to pinnipeds considered to be Minor. Interactions with marine fauna, such as seals, is also assessed in the OPP (Section 7.2). A key Environmental Performance Objective (EPO7) contained within the OPP is no death or injury listed threatened or migratory species from Project activities. Beach has reviewed the OPP and is confident it adequately addresses the comments for the reasons outlined above. No change has been made to the OPP in response to these comments.
PC162	Comment: Balance between need for gas and environment protection. Some of the risk scenarios regarding spilling of foul water are a bit scary as the modelling says it is medium risk and the imagery covers a lot of the coast.	Beach Energy (Operations) Limited (Beach) acknowledge concerns about potential spills and discharges to the marine environment. The comment mentions 'foul water,' which appears to be a reference to oil spills, however, may also refer to marine discharges in relation to activities. The potential impacts and risks for discharges and hydrocarbon spill have been assessed in Sections 6.7 to 6.10 and Section 7 of the Offshore Project Proposal (OPP). Beach has modelled the worst-case scenario for a loss of containment from a marine diesel spill and a loss of well control. The loss of containment from unplanned hydrocarbon spill is evaluated in section 7.4 as medium risk. Medium risks are considered lower-order risks that is acceptable with the application of good industry practice (Table 7-26). Under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023*, an Oil Pollution Emergency Plan (OPEP) is required as part of the implementation strategy for the activity-specific EP. The OPEP must include comprehensive and adaptable arrangements for responding to and monitoring oil pollution. The OPEP will be supported by an Operational and Scientific Monitoring Program that provides a detailed strategy for responding to large-scale releases to the marine environment. Beach's review of the OPP finds that it adequately addresses the comments for the reasons outlined above and no change has been made to the OPP in response to these comments.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC163	Comment: Also, will the lights from drilling have any negative effects on hatching turtles if they are going to be having big lights on all night for a year? The plan says it won't affect them, but I don't understand how the mitigations help to stop them being affected and not all flocking to the drilling sites lights thinking it is the moon. I know they are a long way offshore but those baby turtles head from the beach into the open water for hundreds of kilometres. More information about this would be helpful in the detail for the environment plan, are the lights just a special colour or are they very low and so that is why it is not a problem.	Beach Energy (Operations) Limited (Beach) acknowledge the Offshore Gas Victoria Project (the Project) may have potential environmental impacts and risks on various marine fauna, including turtles, from light sources associated with the drilling activities. Section 6.3.3.3 of the Offshore Project Proposal (OPP) assesses the impact of light on hatching turtles. Artificial light can disrupt turtle nesting and hatching behaviours and is listed as a key threat in the Recovery Plan for Marine Turtles in Australia (CoA 2017). Although listed turtle species may occur within the routine light and flaring Environment that May Be Affected (EMBAs), no biologically important behaviours (BIAs) or habitat critical to the survival for marine turtles were identified (Appendix E). Consequently, population level impacts to marine turtles from routine light and flaring emissions are not predicted to occur. The consequence severity of light and flaring impacts for marine reptiles is assessed as Minor. Beach has reviewed the OPP and is confident it adequately addresses the comments about turtles for the reasons outlined above. No change has been made to the OPP in response to this comment.
3.2 Submitter No. 5		
PC164	Comment: [First Nation], its staff and its community are not trained or experienced in this area and a lack of qualifications could reveal concerns unknown to us at this time, which is a concern. Making recommendations without adequate training, this significant and concerning gap continues to ensure Aboriginal people continue to face the loss of cultural heritage to large corporates and governments.	Beach Energy (Operations) Limited (Beach) understands that the Offshore Project Proposal (OPP) is a technical and complex document, primarily as it was developed in accordance with the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act) for assessment by the regulator National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). The public comment process for an OPP provides the opportunity for members of the public to comment on matters of concern to them and requires the titleholder to assess and address (as applicable) those comments in the OPP in accordance with the regulations. While it is open to the public to make any comments in relation to any matters of concern with the offshore project, additional training is not necessary to make these comments. NOPSEMA, as the regulator tasked with assessing the OPP for approval, is resourced with suitably experienced and qualified personnel that are best placed for assessing the contents of the OPP overall. In preparing an Environment Plan, Beach consults with First Nations groups and other persons with offshore functions, interests or activities that may be affected by the Project. Beach provides information in a variety of formats to First Nations groups and other persons that may be affected,

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		to enable different persons and groups to understand the activities, risks and impacts and control measures in a more constructive manner. Beach will continue to engage with First Nation Groups in accordance with the regulations. No change has been made to the OPP in response to this comment.
PC165	Comment: [First Nation] priority is that Sea Country is protected and cared for and that we are part of the process. The 912 tribes of NW were saltwater people.	Beach Energy (Operations) Limited (Beach) acknowledges the cultural significance of Sea Country, which is assessed in detail in Section 4.6 of the Offshore Project Proposal (OPP). Beach has assessed the impact and risk of the project to Sea Country throughout the OPP. Beach is unable to identify a specific comment that merits a change to the OPP.
PC166	Comment: For [First Nation] the continued protection of the ecology of sea country is pivotal to [First Nation] success as we begin to explore business opportunities into sea kelp.	Beach Energy (Operations) Limited (Beach) acknowledges the cultural and socio-economic significance of Sea Country. Beach also acknowledges concerns held by communities about how projects such as the Offshore Gas Victoria Project (the Project) described in the Offshore Project Proposal (OPP) may impact cultural values and sensitives (such as kelp) of First Nations groups. In Chapter 4 of the OPP (Description of the Environment), Beach recognises the importance of Sea Country (Section 4.4.3) and discusses the abundance of kelp in marine environments particular to coastal Victoria and Tasmania and the importance of Kelp to several First Nations groups and the seaweed industry (Section 4.5.14). The OPP identifies and assesses the risk to ecological communities, such as the Giant Kelp Marine Forests, within the Planning Area. The Planning Area is much more expansive than the Project Area. The Project Area is where all infrastructure and activities associated with the Project will be undertaken and the Planning Area is based on the wider environment that may be affected by a spill (based on spill modelling). In the Planning Area the largest extent of Giant Kelp marine forests resides along the South Australian coastline (section 4.4.8.2), with patches around the Victorian coastline as well as King Island. Much of the giant kelp in Tasmania is found in the Tasman Peninsula, which is not within the Planning Area (Figure 4-36). The OPP must assess the environmental impact in the very unlikely event of a spill. As part of the OPP, Beach has modelled the worst-case scenario for a loss of containment from a marine diesel spill and a loss of well control.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		The environmental impact of an unplanned spill on the ecological function of the Giant Kelp Marine Forests of southeast Australia was assessed to be at the low threshold and are not predicted to have an impact (Table 7-25). In addition, Beach is required to have an accepted Environment Plan for all petroleum activities, which must have an Offshore Oil Pollution Emergency Plan in place in the unlikely event that there is a spill. No threatened ecological communities were identified in the Project Area. Beach has reviewed the OPP considering this comment and is satisfied that the OPP adequately addresses the risk to sea kelp and the potential impact on this ecosystem within the Planning Area, without the need for further amendment.
PC167	Comment: [First Nation] would be willing to co-design a process with Beach to facilitate capacity development initiatives.	Beach Energy (Operations) Limited (Beach) welcomes ongoing communication with First Nation groups to ensure that all current and future activities appropriately consider matters of importance to First Nation groups. Beach will continue to communicate and consult with First Nation groups where their functions, interests and activities may be affected by Beach's activities, however discussions around capability development is a matter that is not relevant to Beach's activities as described in the Offshore Project Proposal (OPP) and therefore outside the scope of this response. No changes have been made to the OPP in response to the comment.
PC168	Comment: [First Nation] consider the protection of underwater cultural heritage is of great importance. Challenging as little to no archaeological research in Tasmania.	Beach Energy (Operations) Limited (Beach) recognises the importance of protecting underwater cultural heritage and the statement that there is limited archaeological research in Tasmania. In undertaking project activities, Beach must comply with all relevant legislation and regulations, including the *Underwater Cultural Heritage Act 2018* and *Aboriginal Heritage Act 1975* (Tas). Beach has reviewed the Offshore Project Proposal (OPP) and has updated Section 2.4 of the OPP, in Table 2-4 (Relevant Tasmanian Legislation) to include the *Aboriginal Heritage Act 1975* (Tas).
PC169	Comment: Any artefacts found should be returned to the Aboriginal community.	Beach Energy (Operations) Limited (Beach) acknowledges the importance of preserving cultural heritage artefacts in all its activities. Underwater cultural heritage is protected under the *Underwater Cultural Heritage Act 2018* (Cth), and, under Section 40, the discovery of underwater cultural heritage must be notified to the Minister within 21 days of discovery.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		In Tasmania, cultural heritage is also protected under the *Aboriginal Heritage Act 1975* (Tas), which requires proponents to report an unexpected discovery to Aboriginal Heritage Tasmania who will provide further advice in accordance with the legislation. Beach has reviewed the Offshore Project Proposal (OPP) and updated Table 2-4 (Relevant Tasmanian Legislation) to include the *Tasmanian Aboriginal Heritage Act 1975*. Should any artefacts be found, Beach will act in accordance with all relevant legislation and regulatory requirements.
PC170	Comment: The Aboriginal community should be involved and given opportunity upskill during marine archeaological projects and certainly any repatriation efforts. Should be a condition of the project.	Beach Energy (Operations) Limited (Beach) acknowledges and appreciates the comments around development opportunities for First Nations communities, and their path to self-determination. However, this is not a matter for Beach to comment on or address in relation to the activities in the Offshore Project Proposal in accordance with the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*. No changes have been made to the OPP in response to the comment.
PC171	Comment: No native title areas in Tasmania so there must be allowances for [name] to catch-up in the way of native title comments.	Beach Energy (Operations) Limited (Beach) acknowledges the comment made in relation to the standing of Native Title claims and determinations in Tasmania. However, this is not a matter for Beach to comment on or address in relation to the activities in the Offshore Project Proposal in accordance with the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*. No changes have been made to the OPP in response to the comment.
3.3 Submitter No. 6		
PC320 Heritage Victoria	Comment: The table starting page 58 and listing legislation and regulations is omitting the *Aboriginal Heritage Act 2006* which protects Aboriginal heritage sites to 3nm offshore. Although not administered by Heritage Victoria, this Act is part of the regulatory framework this Project must adhere to.	Beach Energy (Operations) Limited has reviewed the Offshore Project Proposal (OPP) in response to this comment and has amended Table 2-3 - Relevant Victorian Legislations of the OPP to include the *Aboriginal Heritage Act 2006*.
PC321	Comment: On page 62, the table listing legislation and regulations describes the *Underwater Cultural Heritage Act*	Beach Energy (Operations) Limited has reviewed the Offshore Project Proposal in response to this comment and has amended Table 2-2 (Other relevant Commonwealth legislation) to include that

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	2018 with a focus on historic heritage. This act also covers "any trace of human existence" including submerged Aboriginal archaeological sites. The identification, assessment, protection, and regulation of submerged Aboriginal heritage sites in Commonwealth waters should be considered by the Project.	the scope of the *Underwater Cultural Heritage Act 2018* includes submerged Aboriginal archaeological sites.
PC322	Comment: Section 4.2.5 Maritime Archaeological Heritage – this section mentions the Tasmanian government authority responsible for the management of the State's historic shipwrecks and maritime heritage sites but does not mention Heritage Victoria as the Victorian government authority.	Beach Energy (Operations) Limited has reviewed the Offshore Project Proposal in response to this comment and has provided additional text to Section 4.2.5 (Maritime Archaeological Heritage) to state that the *Victorian Heritage Act 1995* is administered by Heritage Victoria.
PC323	Comment: Section 4.2.5 Maritime Archaeological Heritage – the last paragraph mentions use of sub-bottom profiler to identify buried objects, but shipwrecks, aircraft wrecks and objects can also sit on the surface. Has any surveying been done or been planned to identify surface anomalies that may be cultural material? It mentions that sand patches were only 20-30cm, but what sediments lay below, and could they have been deposited on shipwreck material? Could they have been deposited on submerged Aboriginal archaeological sites? Sub-bottom profiler alone cannot exclude the presence of cultural material.	Beach Energy (Operations) Limited (Beach) acknowledge the potential for underwater cultural heritage and recognised that there is a 130 km stretch of coastline in the Otway Basin known as the 'Shipwreck Coast'. Beach currently conducts petroleum operations in the Otway Basin and has previously undertaken geotechnical and geophysical seabed surveys (Surveys) prior to drilling wells and installing seabed infrastructure. One of the purposes of the Surveys is to assess the presence on any geohazards. For the Otway Offshore Gas Victoria (OGV) Project (the Project), Beach is also proposing to undertake further Surveys. National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) has accepted the Environment Plan (EP) for the OGV Project seabed assessment survey, which includes an Environmental Performance Standard for Survey data to be obtained in a manner that can be utilised to obtain information on First Nations underwater cultural heritage. This will be determined in consultation with the appropriate First Nations groups, where engagement can be obtained, and cultural heritage researchers or consultants. No change has been made to the Offshore Project Proposal in response to this comment.
PC324	Comment: Section 4.2.5 Maritime Archaeological Heritage addresses known maritime archaeological sites but does not discuss the potential for unknown archaeological sites, including up to 100 unfound aircraft wrecks that may be	Beach Energy (Operations) Limited (Beach) acknowledge the potential for maritime archaeological sites in the offshore environment in which it operates.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	within the Project and Planning Areas. This should be one of the main reasons to engage an appropriately qualified maritime archaeologist who can review geophysical and visual data to identify any potential maritime archaeological heritage, as noted in CM11.	The Offshore Project Proposal (OPP) includes new geotechnical and geophysical seabed surveys and cultural heritage assessments (the later as a control measure, CM11 - Cultural heritage assessments to identify any maritime archaeological and submerged cultural heritage and landscapes to inform protection priorities, , and develop and implement management measures and reporting requirements, where required, to prevent potential impacts). Beach is satisfied that the OPP adequately considers the potential for maritime archaeological heritage. No change has been made to the OPP.
3.4 Submitter No. 7		
PC325 Executive Summary	Comment: The Project is inconsistent with Australia's emissions reduction commitments under the Paris Agreement, and is contrary to scientific consensus regarding the steps that need to be taken in response to the threats associated with climate change.	Beach Energy (Operations) Limited (Beach) recognise that action to address climate change is necessary and that all energy systems must contribute to meet the targets set out in the Paris Agreement. As an energy company, Beach must play a role in managing its carbon emissions. Beach aspires to reach net zero Scope 1 and 2 emissions by 2050. Beach has an equity emissions reduction target to reduce our Scope 1 and 2 emissions intensity by 35 per cent by 2030. This is aligned with the Australian Government's target of a 43 per cent reduction in carbon emissions from a 2005 base. The emissions reduction is measured against a 2018 baseline, when Beach materially expanded its portfolio through the acquisition of Lattice Energy. The proposed management of the impact is aligned with the Beach Environment Policy, Climate Change Policy, Sustainability Policy, Risk Management Standard, Environment Management Standard and Sustainability Standard as detailed in Section 6.6.3.3 (part 6) of the Offshore Project Proposal (OPP) (Table 6-43). Gas and condensate from OGP is supplied into the domestic Australian market. The scope 3 emissions associated with the processing, transmission/transport and end use of the gas and condensation will occur within Australian Commonwealth jurisdiction. Therefore, the scope 3 emissions will be managed in accordance with Australia's regulatory regime including NGER and the Safeguard Mechanism, which is designed "to deliver emissions reductions consistent with Australia's [NDC] under the Paris Agreement" (DCCEEW, 2023i) and the *Climate Change Act 2022*. As part of the commitment to the Paris Agreement, Australia has an emissions budget for the 2021-2030 decade of 4,353 MtCO2-e. The Project emissions (including all scopes) during this period is ~ 0.1% of this carbon budget.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Further, Beach has calculated the carbon budget for the period of the Project (2025 to 2049) of 6,729 MtCO2-e . The Project emissions (including all scopes) during this period is 0.19% of this carbon budget. No change has been made to the OPP in response to this comment.
PC298 Executive Summary, Impacts on recreational activities and tourism, and Conclusions	Comment:[Name] is concerned that planned and unplanned events associated with the Project may also affect physical, ecological and socio-economic environments beyond the Planning Area, and that the potential impacts from planned and unpanned events, both within and outside the Planning Area, have been understated by Beach Energy. In particular, unplanned spills could have devastating consequences for the health of surfers, the ability of surfers to utilise the Shipwreck Coast and the West Coast of Tasmania, and could also cause disruption to other recreational users and tourism operators who rely upon the environments and coastlines in those areas.	Beach Energy (Operations) Limited (Beach) acknowledge the potential of impacts and risks associated with the Otway Offshore Gas Victoria Project. The comment specifically references the impact of hydrocarbon spills. A hydrocarbon spill is an unplanned event meaning it is not expected to occur but must be assessed to plan for and manage risk. An assessment of risks and impacts of planned and unplanned events is provided in Sections 6 and 7 of the Offshore Project Proposal (OPP). The Planning Area is based on modelling of worst-case scenarios, namely a combination of loss of containment and potential extent of condensate exposure modelled at north and south location within the Project Area. The Planning Area (Figure 4-1) represents the lowest threshold level for a spill which, for shoreline contact, is 10g/m3. The spill model (and report in Appendix M) was prepared by an independent expert, RPS, and represents hundreds of hypothetical individual spill scenarios that are simulated to show where hydrocarbon from a spill could go under different metocean conditions (such as currents, wind, waves and temperature). In this regard, Beach does not consider the spill event is understood to or likely to extend and have consequences outside of the Planning Area. It is important to note that spill modelling does not consider any mitigation activity or response plans. For example, Beach is required by Australia's offshore energy regulator, the National Offshore Petroleum Safety and Environmental Management Authority, to have in place for all relevant project activities, accepted Oil Pollution Emergency Plans and Operations and Scientific Monitoring Plans. The socio-economic impacts from a hydrocarbon spill are evaluated in Section 7.4.4 of the OPP (see Tables 7-20 to 7-25). Beach is satisfied the OPP provides sufficient information on the potential impact of a hydrocarbon spill and has made no change to the OPP in response to this comment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC297 Impacts on recreational activities and tourism	Comment: Beach Energy asserts that the Planning Area represents the physical, ecological and socio-economic environment that may be affected from planned and unplanned events associated with the Project. Such project activities would directly impact surfers and other recreational users of the environments within the Planning Area, and [Name] is understandably concerned about such activities and particularly the risk of spills. In that regard, the OPP notes at section 7.4.2.4.3 that the probability of hydrocarbon accumulation to any shoreline at, or above, the low level (10 g/m2) threshold from the loss of well control at Release Location North would be 100% during summer conditions and 98% during winter conditions.	Beach Energy (Operations) Limited (Beach) acknowledge the potential environmental impact of a hydrocarbon spill. The comment relates to Section 7.4 of the Offshore Project Proposal (OPP) that assesses the consequence of an unplanned spill from a loss of containment from a well or marine diesel spill from a vessel. A hydrocarbon spill is an unplanned event meaning it is not expected to occur but must be assessed to plan for and manage risk. The Planning Area is based on a combination of loss of containment and potential extent of condensate exposure to shorelines at the low-level threshold of 10 g/m2 (see Table 4-1 and 7-19). The low threshold levels are considered to be below levels that would cause environmental harm. Typically, low exposure thresholds of 10 g/m2 predict potential for some socio-economic impact such as visible on the sea surface. In the unlikely event of a spill, the potential impact of shoreline exposure on socio-economic receptors (including recreation and tourism) is summarised in Table 7-24. The National Offshore Environmental and Safety Management Authority (NOPSEMA) and Australian Maritime Safety Authority (AMSA) guidance indicates that the low threshold shoreline hydrocarbon contact would not initiate a clean-up response. The socio-economic impact for recreational activities is ranked as Moderate, reflecting short-term and localised consequences. Based on the modelling (currents, winds, waves, temperature), in the unlikely event of loss of containment of condensate from the well, there is a 96 per cent chance in winter and 99 per cent chance in summer (section 7.4.3.6), of the low threshold levels accumulating on the shoreline. It is important to note the spill model does not take into account any mitigation activity or response plans. Beach is required by NOPSEMA to have in place for all relevant project activities, accepted Oil Pollution Emergency Plans and Operations and Scientific Monitoring Plans. The socio-economic impacts from a hydrocarbon spill are evaluated in Section 7.4.4 of the OPP (see Tables 7-20 to 7-25). Beach is satisfied the OPP provides sufficient information on the potential impact of a hydrocarbon spill and has made no change to the OPP in response to this comment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC326 Climate impacts	Comment: Beach Energy's OPP includes at section 6.6.4 an Impact Evaluation Summary which asserts that emissions related to the Project will be a minor contributor to global GHG emissions and climate change, and that impact solely from the Project emissions will be minor. However, the basis upon which Beach Energy asserts that the Project will only be a minor contributor to global GHG emissions and climate change and that the impact solely from the Project emissions will only be minor is not clear.	Beach Energy (Operations) Limited (Beach) commissioned a report on the greenhouse gas (GHG) emissions from the Otway Offshore Gas Victoria Project over the life of the Project (Appendix K of the Offshore Project Proposal (OPP)). Over the life of the project, the GHG estimate is 13.05 million tonnes CO_2-e. The emissions are discussed in Section 6.6.3.1 and represents the emissions as a percentage of both Australian (0.19%) and global carbon budgets (0.0025%). All comparisons indicate the project is a minor contributor to global (and Australian) carbon budget. Beach has considered this claim and has revised Section 6.6.3 of the OPP to consistently state the percent contribution of emissions from the Project relative to Australian and global carbon budgets.
PC344 Matters of National Environmental Significance	Comment: Beach Energy asserts that the outer boundary of the Planning Area is the worst-case and largest spatial extent where unplanned hydrocarbon releases from Project activities could have an environmental consequence. Despite Beach Energy's assertion, Surfrider is concerned that planned and unplanned events associated with the Project may also affect physical, ecological and socio-economic environments beyond the Planning Area.	Beach Energy (Operations) Limited (Beach) acknowledge the potential impact of an unplanned hydrocarbon spill. The comment relates to Section 7.4 of the Offshore Project Proposal (OPP) that assesses the consequence of an unplanned spill from a loss of containment from a well or marine diesel spill from a vessel. The Planning Area is based on a combination of loss of containment and potential extent of condensate exposure to shorelines at the low-level threshold of 10 g/m2 (see Table 4-1 and 7-19). The low threshold levels are considered to be below levels that would cause environmental harm. Typically, low exposure thresholds of 10 g/m2 predict potential for some socio-economic impact such as visible on the sea surface. Beach is satisfied the OPP provides sufficient information on the potential impact of a hydrocarbon spill. As the comment has not provided any additional information not already assessed in the OPP, no change has been made to the OPP.
PC345 Matters of National Environmental Significance	The Tasmanian Wilderness World Heritage Area (TWWHA) falls within the Planning Area. The TWWHA is a globally significant temperate wilderness area and contains outstanding examples of ongoing geological, biological and ecological processes in addition to numerous rare	The Offshore Project Proposal (OPP) provides an assessment of ecosystems and environments as well as the potential environmental impacts and risks for the Project. As summarised in the Introduction of this Report, revisions to the scope of the Otway Gas Victoria (OGV) Project mean that the following areas are no longer within the Planning Area of the OPP: • Tasmania World Heritage Wilderness

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	flora and fauna species. It is also rich in cultural heritage, with archaeological sites dating back to the Pleistocene. The Planning Area encompasses 3 Threatened Ecological Communities (TECs) that have coastal components: assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria; giant kelp marine forests of south east Australia (Endangered); and subtropical and temperate coastal saltmarsh (Critically Endangered). There are 4 Ramsar wetlands that overlap with the Planning Area: Glenelg Estuary, Lavinia, Port Phillip Bay, and Westernport Bay. These areas play vital ecological roles, providing nursery habitat for birds, fish, reptiles, invertebrates and other species, as well as maintaining water quality and shoreline structure. Wetlands are also powerful carbon sinks, trapping atmospheric carbon dioxide in sediments and vegetation.	• Glenelg Estuary and Discovery Bay Wetlands, Port Phillip Bay (Western Shoreline) and Bellarine Peninsula and Western Port Ramsar wetlands Section 4 of the OPP provides a description of the existing environment including threatened ecological communities, Ramsar wetland and marine parks as habitats for many species. As the comment does not contain any new information about the content of the OPP, no change is made to the OPP.
PC328 Matters of National Environmental Significance	Comment: Australian Marine Parks provide habitat for myriad species and ecological communities, including EPBC-listed species such as blue and pygmy blue whales, southern right whales, humpback whales, fin whales, sei whales, wandering albatross, shy albatross, little penguins, white sharks, New Zealand fur seals, and others. These unique and highly biodiverse ecosystems should be protected from the damaging effects of offshore fossil fuel exploration and operation, such as leaks and spills, planned discharges of hazardous substances, and abandonment of derelict infrastructure at the end of the operational period.	Beach Energy (Operations) Limited (Beach) acknowledge the potential for environmental impact and risk from the proposed drilling activities in the Otway Offshore Gas Victoria Project (the Project). The Offshore Project Proposal (OPP) provides for a detailed description of the existing environment including conservation values and sensitivities and ecological environment (see Chapter 4). The OPP also assesses the environmental impacts and risks to these receptors. These environmental risks and impacts include the potential impact of spills (Section 7.4) and planned discharges (Sections 6.7 to 6.10). Identification and implementation of relevant control measures will ensure that potential environmental impact and risk are of an acceptable level. As the comment has not presented additional information not already included in the OPP, no changes have been made to the OPP. Further, the OPP includes content on the decommissioning phase of the Project (Section 3.8.5), including Beach's responsibility to remove all structures, equipment and property for the title area in accordance with Section 572(3) of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		(OPGGS Act). For the Project, decommissioning will require plug and abandonment of wells and decommissioning of subsea infrastructure. Beach has reviewed the OPP considering this comment and is satisfied it adequately addresses the decommissioning requirements in accordance with Section 7 of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023*. No change has been made to the OPP in response to this comment.
PC315 Key Ecological Features	Comment: As with Marine Parks, KEFs and the species and ecosystems they support should be protected from the impacts of the offshore fossil fuel industry, in both the short and long term.	Beach Energy (Operations) Limited (Beach) acknowledge concerns about the potential environmental impacts and risks of its Otway Offshore Gas Victoria Offshore Project (the Project) on Australian Marine Parks (AMP) and Key Environmental Features (KEF). The AMPs within the Planning Area include the Apollo and Zeehan marine parks. No AMPS are within the Project Area. The KEFs within the Planning Area include the Bonney Coast Upwelling and West Tasmanian Canyons. No KEFs are within the Project Area. The AMP and KEF are environmental receptors that are assessed for potential environmental impacts and risks (See Sections 6 and 7). As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.
PC346 Protected Species and Biologically Important Areas	Comment: Protected species There are 159 threatened species and 81 migratory species listed under the EPBC Act that occur within the Planning Area, including: • 45 fish species • 122 bird species • 32 cetacean species • 4 pinniped species • 3 marine turtle species	Beach Energy (Operations) Limited (Beach) agrees that threatened and migratory species listed under the *Environmental Protection and Biodiversity Conservation Act 1999* may be present within the Planning Area of the Otway Offshore Gas Project (the Project). As summarised in the Introduction of this Report, revisions to the scope of the Otway Gas Victoria (OGV) Project mean that the threatened, migratory, marine or cetacean species protected under the EPBC Act identified within the Project Area and revised Planning Area, now include: • 12 fishes (including sharks) (9 within the Project Area and another 3 within the Planning Area beyond the Project Area) • 111 birds (33 within the Project Area and another 78 within the Planning Area beyond the Project Area)

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	Biologically Important Areas (BIAs) There are 18 species that have BIAs within the Planning Area: 15 bird species, 1 fish species, and 2 cetacean species. Of these 18 species, 13 have BIAs overlapping the smaller Project Area, within which the exploration and development activities are to take place: the antipodean albatross, black-browed albatross, Buller's albatross, Campbell albatross, common diving-petrel, Indian yellow-nosed albatross, short-tailed shearwater, shy albatross, wandering albatross, wedge-tailed shearwater, white shark, pygmy blue whale and southern right whale.	• 34 marine mammals (29 within the Project Area and another 5 within the Planning Area beyond the Project Area) • 3 marine reptiles (within both the Project Area and Planning Area beyond the Project Area) The Offshore Project Proposal (OPP) provides a comprehensive review of threatened and migratory species within the Project and Planning Areas (Section 4.4.9). As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.
PC299 Cetaceans	Comment: There are 32 species of cetacean that are known to occur, likely to occur, or may occur within the Project Area and/or Planning Area. The southern right whale (listed as Endangered under the EPBC Act) is known to occur within the Project and Planning Areas, with a peak from May to October as the whales visit their calving areas near Warrnambool. Pygmy blue whales (Endangered) occur in the Project and Planning Areas and can arrive in their seasonal foraging areas (in the eastern segment of the Bonney Upwelling in western Victoria) as early as November and stay until March and as late as May. Previous research on pygmy blue whale habitat use in the Bonney Upwelling has found that pygmy blue whales utilise habitat areas within and surrounding the proposed Project Area in the Otway Basin (Gill, 2020; Moller et al. 2020)	Beach Energy (Operations) Limited (Beach) acknowledges the comment regarding seasonal presence of southern right whale and pygmy blue whale in the Project and Planning Areas and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Section 4.4.9.7 of the OPP describes pygmy blue whale presence and behaviours within the Project and Planning Areas. Beach has reviewed the references provided in the comment (Gill, 2020; Moller et al. 2020) in the context of the information provided. Gill (2020) is used extensively to support the description of pygmy blue whale in the Project and Planning Areas, whilst tagging studies conducted by Moller et al (2020) (noting that in the OPP the reference is quoted as Möller et al. (2015)) are described in detail in a dedicated sub-section, including figures (e.g. Figure 4-51). As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.
PC300 Fish	Comment: Numerous EPBC-listed fish species fall within the Project and/or Planning Areas, including the red handfish (Critically Endangered), Maugean skate (Endangered), oceanic whitetip shark (Migratory), school shark (Conservation Dependent), whale shark (Vulnerable),	Beach Energy (Operations) Limited (Beach) acknowledge concerns about threatened fish species and the potential environmental impacts and risks from the Otway Offshore Gas Victoria Project (the Project).

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	and the white shark (Vulnerable). Shortfin and longfin eels occur in Victorian waters, beginning their life cycle in estuaries before migrating to their oceanic spawning grounds in the Coral Sea. Shortfin eels hold cultural significance to First Nations people, such as the Gunditjmara in south-western Victoria. Offshore fossil fuel development has been identified as a potential threat to eels during their lifecycle.	Section 4.4.9.3, in particular Table 4-21, of the Offshore Project Proposal (OPP) lists threatened fish species that are likely to be present in the Project and Planning Areas. The OPP also identifies the Biologically Important Areas (BIAs) critical to the survival of a species within the Project and Planning Areas. Revisions to the scope of the Otway Gas Victoria (OGV) Project and mean that the EPBC-listed fish species of Maugean Skate, Red Handfish, Oceanic Whitetip Shark and Whale Shark are no longer within the Project Area and revised Planning Area. For fish species, only the White Shark has foraging BIA overlapping the Planning Area (Table 4-19 and Figure 4-38). Section 4.4.9.3, in particular Table 4-21, of the Offshore Project Proposal (OPP) lists threatened fish species that are likely to be present in the Project and Planning Areas. Beach also recognises the presence of eels in the Planning Area and the cultural significance of eels for First Nations Groups (Section 4.4.9.3.2). The comment states that fossil fuel development has been identified as a potential threat to eels during their lifecycle. The impacts to First Nations values and sensitivities are assessed throughout the OPP. The environmental impacts to eels for light emissions, were assessed as having a residual impact of Minor (Section 6.3.3.6) and migrating eels are unlikely to be impacted by noise emissions (section 6.4.3.1.3). As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.
PC351 Birds & Pinnipeds	Birds Six Endangered seabird species and 10 Endangered bird species are found within the Planning Area. There are also 8 Critically Endangered bird species found within these areas, including the swift parrot, regent honeyeater, plains-wanderer, orange-bellied parrot, King Island scrubtit, eastern curlew, and curlew sandpiper. Pinnipeds The Australian fur seal and long-nosed fur seal are known to breed within the Planning Area and may occur within the Project Area. The Australian sea lion (Endangered) and	Beach Energy (Operations) Limited (Beach) acknowledge concerns about threatened species and the potential environmental impacts and risks from the Otway Offshore Gas Victoria Project (the Project). A description of birds and pinnipeds that may be in the Planning Area are summarised in the Offshore Project Proposal (OPP). As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	southern elephant seal (Vulnerable) can be found within the Planning Area.	
PC301 Marine turtles	Comment: Three EPBC-listed marine turtle species are known to occur within the Project and/or Planning Areas: the green (Vulnerable), leatherback (Endangered) and loggerhead turtle (Endangered). These species use the area for migration and foraging and are susceptible to vessel strike and entanglement.	Beach Energy (Operations) Limited (Beach) acknowledge the Otway Offshore Gas Victoria Project (the Project) may have potential environmental impacts and risks on various marine fauna, including turtles. Considering the comment, Beach has reviewed the Offshore Project Proposal (OPP) and confirms that Section 4 describes the behaviours of the turtle species and Section 7.2.3.2 summarises the risk of vessel collision with turtles. The assessment (Table 7-8) concludes that project vessel collisions with turtles are inherently unlikely due to the offshore location (and resultant low densities of turtles), slow speeds of vessels and diving startle response of turtles. The OPP requires details and evaluation of the environmental impacts and risks of the Project appropriate to the nature and scale of each impact or risk. In light of comment, Beach has provided further detail in the OPP about the presence of turtles in the planning and project area, and the impacts and risks (please refer to PC229 for further detail).
PC329 Cultural heritage	Comment: In Victoria, Registered Aboriginal Parties (RAPs) are legally recognised in accordance with the *Aboriginal Heritage Act 2006* (Vic) as the traditional owner corporation to manage and protect First Nations cultural heritage over their country, including coastal and inshore waters. There are 4 RAPs within the Planning Area: Indigenous Protected Areas (IPAs) are managed by First Nations groups in recognition of their deep and continuing cultural connections to land and sea country. IPAs also contain sites of cultural significance, such as middens, artefacts, engravings, and sacred sites. The IPAs within the Planning Area include the Preminghana IPA and three Future Sea Country IPAs.	Beach Energy (Operations) Limited (Beach) agrees that cultural heritage should be protected. In undertaking all its project activities, Beach must comply with all relevant legislation and regulations, including the *Underwater Cultural Heritage Act 2018* and *Aboriginal Heritage Act 1975* (Tas) and the *Aboriginal Heritage Act 2006* (Vic). The OPP provides a description of native title, Registered Aboriginal Parties and Indigenous Protected Areas within the Planning Area. Cultural heritage is assessed in the Offshore Project Proposal (OPP). It will also be assessed in future Environment Plan(s) through consultation with relevant persons to identify cultural values and sensitivities of First Nations groups. No changes have been made to the OPP in response to the comment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	First Nations groups within the Planning Area have enduring cultural connections with numerous species, ecosystems and landscapes. These are elaborated within the OPP, and taken together represent incredible tangible and intangible cultural heritage that deserves to be protected.	
PC302 Consultation and assessment process	Comment: According to the assessment process detailed by NOPSEMA on its website, the requirement for an OPP such as this one was introduced in 2014 "to allow for public scrutiny and comment on offshore petroleum developments early in the project lifecycle". Further on that website it is stated that "an OPP for a project must be accepted by NOPSEMA before the proponent can submit environment plans that make up the project". This suggests that an OPP should be the first step in regulatory assessment and public consultation on offshore petroleum projects. However, the public comment period for this OPP came after Beach Energy had closed public comment on 2 April 2024 for an Environment Plan (EP) detailing a drilling program on the same titles as the OPP, as well as additional titles in the Bass Basin. The OPP addresses this: "[t]his OPP includes description of exploration and appraisal drilling activity which is an activity that does not require an accepted OPP as part of the environmental permitting framework".	Beach Energy (Operations) Limited (Beach) acknowledges that offshore environmental approvals including those for Offshore Project Proposals (OPP) and Environment Plans (EP) are technical and complex documents with bespoke legislative requirements. Beach confirms that the OPP and Offshore Gas Victoria Drilling and P&A Activities EP (Drilling EP) have been accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) in accordance with all regulatory requirements. Specifically, we note that Beach's Drilling EP covers exploration and appraisal drilling, and plug and abandonment activities and those activities – including exploration drilling – do not require an OPP. Beach refers to the guidance note published on NOPSEMA's website, titled *Offshore environmental approvals*. It states "Exploration activities, such as seismic surveys and exploration drilling, do not require an OPP, but do require an EP." While Beach notes your concern, for the reasons outlined above the Drilling EP does not need to be part of an accepted OPP for Beach to submit an EP to NOPSEMA for assessment. The environmental approvals for the offshore project are summarised in Section 1.5 (OPP Purpose and Scope), Section 2.2 (Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023) of the OPP. Beach has provided additional information in the OPP to describe the environmental approval process in section 3.3.1 of the OPP: <u>An OPP is needed for most new offshore petroleum development projects in Commonwealth waters. An 'offshore project' is defined in the OPGGS (Environment) Regulations as 'one or more activities that are undertaken for the purpose of the recovery of petroleum…".</u> <u>As described in section 1.5.1 of the OPP, section 15 of Environment Regulations allows a proponent to use the OPP arrangements for exploration and appraisal activities. While an OPP must be accepted by NOPSEMA before the proponent can submit EPs for activities that make up</u>

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		an offshore project, this pre-requisite does not apply to exploration and appraisal activities such as exploratory drilling. As such, Beach has submitted an EP to NOPSEMA for the exploration and appraisal drilling activities. The initial exploration and appraisal drilling campaign described in this OPP is part of the OGV Drilling and P&A Activities EP. Activities in the EP include exploration drilling and depending on well results, either P&A or temporary well suspensions.
PC303 Consultation and assessment process	Comment: Further explanation and clarity is required concerning the requirements for OPP approval prior to EP submission. OPPs open for public comment are located in a different section of the NOPSEMA website than EPs open for public comment. This adds an extra layer of complexity to engaging with the OPP for relevant persons and community members who may have an interest in the OPP but are not able to locate the OPP or its public comment portal, as these are not in the same online location as the EPs.	Beach Energy (Operations) Limited (Beach) acknowledge that the environmental approvals for offshore petroleum activities are complex. Further explanation and clarity on the requirements for Offshore Project Proposal (OPP) and Environment Plans (EPs) is provided in above PC302. The remainder of the comments relates to the public comment process and National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) website. NOPSEMA is responsible for managing the public comment process for OPPs and EPs and provides information on its website on the public submission process. In addition to NOPSEMA's website, Beach provides information and invitation for public comment. As outlined in various NOPSEMA policies, Beach promoted the public comment process for the OPP (and its Offshore Gas Victoria Drilling and P&A Activities EP) by publishing a public notice in eight different newspapers, emailing the project stakeholder list, and prominently featuring information about the public comment period and links to NOPSEMA's website on Engage Beach, Beach's online consultation hub. Beach has made no change to the OPP in response to this comment.
PC304 Other concerns	Comment: Transit of vessels to and from the project locations is excluded from the OPP as this is outside the scope of the OPGGS Act. To service the proposed activities, the project will utilise existing support facilities at Geelong and Portland. Vessel traffic needs to be explicitly quantified and included in the risk assessment framework, as vessel strike is a threat to marine megafauna, including cetaceans and marine turtles.	Beach Energy (Operations) Limited (Beach) acknowledge that offshore activities may have potential environmental impacts and risks on marine fauna. The Offshore Project Proposal (OPP) provides for the consideration of whole-of-project environmental impacts and risks. The Environment Plan(s) (EP) required to authorise activities are intended to address environmental impacts and risks at an activity-level, which would typically be a finer scale of detail than the OPP. In this regard, vessel traffic will depend on the type of activity carried out in the offshore environment and will be considered in the relevant EPs. The OPP assesses the potential risk for vessel collision with megafauna (Section 7.2).

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Common controls implemented in relevant EPs to minimise the risk of vessel strikes include Marine Fauna Observers under the Whale Management Procedure for monitoring and reporting, designed to comply with various government reporting for vessel strikes or injury on marine life. The relevant EPs will also highlight that reducing vessel speed has been shown to be an effective measure to reduce vessel strikes for marine species. By implementing these types of control measures, the risk assessment of vessel strike with marine fauna is rated as Low and to be of an acceptable level. Beach is satisfied the OPP adequately addresses the impact of vessel traffic on marine fauna. No change has been made to the OPP.
PC305 Other concerns	Comment: Hydraulic valves in the blowout preventer infrastructure will be vented to sea when closed, releasing an estimated 22-66 litres of hydraulic fluid into the ocean. The OPP comments that this fluid is water soluble and "readily disperses in the receiving waters" but the type of hydraulic fluid is not specified so that this comment of water solubility can be verified. To be water soluble, the hydraulic fluid would need to be one of the following types: water-oil emulsion (such as Shell's polyalkylene glycol (PAG)); water glycol; or biodegradable with a base of soybean, rapeseed, or sunflower oil.	Beach Energy (Operations) Limited (Beach) acknowledge that discharge of hydraulic fluid from blow-out preventers during drilling operations and production operations may occur as part of the Otway Offshore Gas Victoria Project. Beach has reviewed the Offshore Project Proposal (OPP) considering this comment and confirms that the OPP has identified that routine petroleum activities may result in the discharge of glycol based hydraulic fluids into the marine environment to be about 4m^3 per year (Section 3.8.6.1). Hydraulic control fluids are typically low toxicity, readably biodegradable, low potential for bioaccumulation and would rapidly disperse and dilute in the within the marine environment (Section 6.9.2.1). The OPP provides for the consideration of whole-of-project environmental impacts and risks of the project appropriate to the nature and scale of each impact or risk. In the case of discharge of hydraulic fluids, the extent of the discharge is within tens of meters (of the point of discharge) and the impact consequence is assessed as less than Minor. The Environment Plan(s) (EP) required to authorise activities are intended to address environmental impacts and risks at an activity-level, which would typically be a finer scale of detail than the OPP. EPs include more detailed information on chemicals and hazardous materials for use offshore with regards to Beach's Chemical Management Procedure and the Offshore Chemical Notification Scheme, which evaluates all production and drilling chemicals in terms of environmental impact. Beach is satisfied the OPP adequately addresses the impact of discharges to the marine environment. No change has been made to the OPP.

ID	Summary of comments received	Beach’s assessment of merit of comment(s) and response(s) to comments and/or objections
PC316 Other concerns	Comment: The OPP says that materials used as additives during drilling (i.e. dry bulk barite, bentonite, cement) will be discharged to the marine environment. Other planned discharges include condensate, brine, amine-type corrosion inhibitors, and suspension fluids. An explanation of the potential volumes of material, as well as the potential impacts of this dumping on the physical and biological environment, is required in order for relevant persons to make an informed assessment of the impacts of these activities.	Beach Energy (Operations) Limited (Beach) agree that discharge of materials from drilling operations and production operations may occur as part of the Otway Offshore Gas Victoria Project (the Project). Beach has reviewed the Offshore Project Proposal (OPP) considering this comment and confirms that planned discharges (e.g. drill cuttings, drill fluids, cement, commissioning and operational fluids, waste) are assessed in Sections 6.7 to 6.10 of the OPP. The OPP provides for the consideration of whole-of-project environmental impacts and risks. The OPP must provide details and evaluation of the environmental impacts and risks of the project appropriate to the nature and scale of the potential impact and risk. In the case of discharges from drilling activities, the impact consequence is assessed to be minor consequence and of an acceptable level. The Environment Plan(s) (EP) required to authorise activities are intended to address environmental impacts and risks at an activity-level, which would typically be a finer scale of detail than the OPP. For example, the EP for the OGV Drilling and P&A Activities provides the level of detail suggested in the comment in relation to volumes and types of discharges and assessment of potential impacts and risks. For the purpose of the OPP, Beach is satisfied adequate information is provided on discharges and potential impacts and risks. No change has been made to the OPP in response to this comment.
PC327 Conclusions	Comment: The proposed drilling operations threaten these species and habitats through the risk of habitat degradation via condensate and MDO spills, vessel strike of marine fauna, and planned discharges of industrial products at every phase of production.	Beach Energy (Operations) Limited acknowledge the potential for environmental impact and risk from the proposed drilling activities in the Otway Offshore Gas Victoria Project (the Project). The Offshore Project Proposal (OPP) provides for the consideration of whole-of-project environmental impacts and risks. These environmental risks and impacts are assessed in the OPP, including the potential impact of spills (Section 7.4), vessel strike of marine fauna (Section 6.1) and planned discharges (Sections 6.7 to 6.10). In each case, the risk consequence is assessed to be of an acceptable level. The Environment Plan(s) that will be required to authorise activities are intended to address environmental impacts and risks at an activity-level, which would typically be a finer scale of detail than the OPP.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.
3.5 Submitter No. 8		
PC317 Introduction	Comment: According to the International Energy Agency (IEA), any new fossil fuel projects are incompatible with efforts to reach net zero by 2050 and put our oceans and climate at risk of irreversible harm. Moreover, the opening up of new fossil fuel developments is contrary to the globally-agreed imperative to limit warming to 1.5 degrees Celsius. In this OPP, production from Artisan, La Bella and unidentified future prospects is estimated to occur for up to 30 years, until 2055. The OPP notes that this may be extended "subject to future investment and developments in surrounding fields."	Beach Energy (Operations) Limited (Beach) recognise that action to address climate change is necessary and that all energy systems must contribute to meet the targets set out in the Paris Agreement. As an energy company, Beach must play a role in managing its carbon emissions. Beach aspires to reach net zero Scope 1 and 2 emissions by 2050. Beach has an equity emissions reduction target to reduce our Scope 1 and 2 emissions intensity by 35% by 2030. This is aligned with the Australian Government's target of a 43% reduction in carbon emissions from a 2005 base. The emissions reduction is measured against a 2018 baseline, when Beach materially expanded its portfolio through the acquisition of Lattice Energy. The Australian Government released the Future Gas Strategy in May 2024, mapping out its plan for how gas will support the economy's transition to net zero. A key principle of the gas strategy recognises that new sources of gas supply are needed to meet demand during the economy-wide transition to net zero. The Otway Basin is one of several basins identified as possible sources of additional domestic gas supply to the east coast market. The Otway Offshore Gas Victoria Project is consistent with the Future Gas Strategy. Importantly, for the Future Gas Strategy, the need for new gas supply is consistent with principles for emissions reductions, energy affordability and energy transition in Australia and globally. As summarised in the introduction to this Report, the scope of the OPP is revised resulting in a change in the end of field life to 2045.
PC319 Introduction	Comment: This proposal poses significant risk to our oceans, First Nations cultural heritage, and climate.	Beach Energy (Operations) Limited (Beach) acknowledges the Offshore Gas Victoria Project may have potential environmental impacts and risks on marine fauna and ecosystems, as well as potential impacts and risks on cultural values and sensitivities assessed in Section 4.6 of the Offshore Project Proposal (OPP). Sections 6 and 7 of the OPP assess the potential environmental impacts and risks.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		As the comment does not raise any new information or apparent comment about the content of the OPP, no change has made to the OPP.
PC347 Impacts of proposed activities – Cultural heritage	Comment: In Victoria, Registered Aboriginal Parties (RAPs) are legally recognised as the Traditional Owner Corporation to manage and protect First Nations cultural heritage over their Country, including coastal and inshore waters. There are 4 RAPs within the Planning Area: Eastern Maar Aboriginal Corporation; Gunaikurnai Land and Waters Aboriginal Corporation; Gunditj Mirring Traditional Owners Aboriginal Corporation; and Wadawurrung Traditional Owners Aboriginal Corporation. Indigenous Protected Areas (IPAs) are managed by First Nations groups in recognition of their deep and continuing cultural connections to land and sea Country. IPAs also contain sites of cultural significance, such as middens, artefacts, engravings, and sacred sites. The IPAs within the Planning Area include the Preminghana IPA and three Future Sea Country IPAs: Gunditjmara Sea Country IPA, Nanjit to Mallacoota Sea Country IPA, and Tayaritja (Bass Strait Islands) Sea Country IPA. First Nations groups within the Planning Area have enduring cultural connections with numerous species, ecosystems and landscapes. These are elaborated within the OPP, and taken together represent incredible tangible and intangible cultural heritage that deserves to be protected from toxic spills and damage to significant ecosystems and species.	Beach Energy (Operations) Limited (Beach) agrees that cultural heritage should be protected. The OPP provides a description of native title, Registered Aboriginal Parties and Indigenous Protected Areas within the Planning Area and cultural values and sensitivities (see Section 4.6 of OPP). Beach acknowledges the statement summarising the concerns of the potential impact of the Otway Offshore Gas Victoria Project on the cultural heritage values and sensitivities. Sections 6 and 7 of the Offshore Project Proposal (OPP) evaluate the environmental impacts and risks of the Project and identifies where First Nations cultural values and sensitivities may be potentially affected. As the comment does not raise any new information or apparent comment about the content of the OPP, no change has made to the OPP.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC318 Impacts of proposed activities - Protected species	Comment: There are 159 threatened species and 81 migratory species listed under the EPBC Act that occur within the Planning Area, including: - 45 fish species - 122 bird species - 32 cetacean species - 4 pinniped species - 3 marine turtle species Biologically Important Areas There are 18 species that have Biologically Important Areas (BIAs) within the Planning Area: 15 bird species, 1 fish species, and two cetacean species. Of these 18 species, 13 have BIAs overlapping the smaller Project Area, within which the exploration and development activities are to take place: the antipodean albatross, black-browed albatross, Buller's albatross, Campbell albatross, common diving-petrel, Indian yellow-nosed albatross, short-tailed shearwater, shy albatross, wandering albatross, wedge-tailed shearwater, white shark, pygmy blue whale and southern right whale.	Beach Energy (Operations) Limited (Beach) agrees that threatened and migratory species listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) may be present within the Planning Area of the Otway Offshore Gas Project (the Project). As summarised in the Introduction of this Report, revisions to the scope of the Otway Gas Victoria (OGV) Project mean that the threatened, migratory, marine or cetacean species protected under the EPBC Act identified within the Project Area and revised Planning Area, now include: - 12 fishes (including sharks) (9 within the Project Area and another 3 within the Planning Area beyond the Project Area) - 111 birds (33 within the Project Area and another 78 within the Planning Area beyond the Project Area) - 34 marine mammals (29 within the Project Area and another 5 within the Planning Area beyond the Project Area) - 3 marine reptiles (within both the Project Area and Planning Area beyond the Project Area) The Offshore Project Proposal (OPP) provides a comprehensive review of threatened and migratory species within the Project and Planning Areas (Section 4.4.9). The OPP provides a comprehensive review of Biologically important Areas for species within the Project area and Planning area. As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.
PC311 Impacts of proposed activities - Cetaceans	Comment: The southern right whale (listed as Endangered under the EPBC Act) is known to occur within the Project and Planning Areas, with a peak from May to October as the whales visit their calving areas near Warrnambool. Pygmy blue whales (Endangered) occur in the Project and Planning Areas and can arrive in their seasonal foraging areas (in the eastern segment of the Bonney Upwelling in western Victoria) as early as November and stay until March and as late as May.	Beach Energy (Operations) Limited (Beach) acknowledges the comment regarding seasonal presence of southern right whale and pygmy blue whale in the Project and Planning Areas and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Section 4.4.9.7.4 of the OPP describes pygmy blue whale presence and behaviours within the Project and Planning Areas. Beach has reviewed the references provided in the comment (Gill, 2020; Moller et al. 2020) in the context of the information provided. Gill (2020) is used extensively to support the description of pygmy blue whale in the Project and Planning Areas, whilst tagging

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	Previous research on pygmy blue whale habitat use in the Bonney Upwelling has found that pygmy blue whales utilise habitat areas within and surrounding the proposed Project Area in the Otway Basin (Gill, 2020; Moller et al. 2020)	studies conducted by Moller et al (2020) (noting that in the OPP the reference is quoted as Möller et al. (2015)) are described in detail in a dedicated sub-section, including figures (e.g. Figure 4-51). As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.
PC312 Impacts of proposed activities - Fish	Comment: Numerous EPBC-listed fish species fall within the Project and/or Planning Areas, including the red handfish (Critically Endangered), Maugean skate (Endangered), oceanic whitetip shark (Migratory), school shark (Conservation Dependent), whale shark (Vulnerable), and the white shark (Vulnerable). Shortfin and longfin eels occur in Victorian waters, beginning their life cycle in estuaries before migrating to their oceanic spawning grounds in the Coral Sea. Shortfin eels hold cultural significance to First Nations people, such as the Gunditjmara in south-western Victoria. Offshore fossil fuel development has been identified as a potential threat to eels during their lifecycle.	Beach Energy (Operations) Limited (Beach) acknowledge concerns about threatened fish species and the potential environmental impacts and risks from the Otway Offshore Gas Victoria Project (the Project). Section 4.4.9.3, in particular Table 4-21, of the Offshore Project Proposal (OPP) lists threatened fish species that are likely to be present in the Project and Planning Areas. The OPP also identifies the Biologically Important Areas (BIAs) critical to the survival of a species within the Project and Planning Areas. Revisions to the scope of the Otway Gas Victoria (OGV) Project and mean that the EPBC-listed fish species of Maugean Skate, Red Handfish, Oceanic Whitetip Shark and Whale Shark are no longer within the Project Area and revised Planning Area. For fish species, only the White Shark has foraging BIA overlapping the Planning Area (Table 4-19 and Figure 4-38). Section 4.4.9.3, in particular Table 4-21, of the Offshore Project Proposal (OPP) lists fish species that may, or are likely to be present in the Project and Planning Areas. Beach also recognises the presence of eels in the Planning Area and the cultural significance of eels for First Nations Groups (Section 4.4.9.3.2). The comment states that fossil fuel development has been identified as a potential threat to eels (migration and spawning) during their lifecycle. The impacts to First Nations values and sensitivities are assessed throughout the OPP. The environmental impacts to eels for light emissions, were assessed as having a residual impact of Minor (Section 6.3.3.6) and migrating eels are unlikely to be impacted by noise emissions (section 6.4.3.1.3). As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC348 Impacts of proposed activities - Birds and Pinnipeds	Six Endangered seabird species and 10 Endangered bird species are found within the Planning Area. There are also 8 Critically Endangered bird species found within these areas, including the swift parrot, regent honeyeater, plains-wanderer, orange-bellied parrot, King Island scrubtit, eastern curlew, and curlew sandpiper. The Australian fur seal and long-nosed fur seal are known to breed within the Planning Area and may occur within the Project Area. The Australian sea lion (Endangered) and southern elephant seal (Vulnerable) can be found within the Planning Area.	Beach Energy (Operations) Limited (Beach) acknowledge concerns about threatened species and the potential environmental impacts and risks from the Otway Offshore Gas Victoria Project (the Project). A description of birds and pinnipeds that may be in the Project and Planning Areas are assessed in the OPP. As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.
PC314 Impacts of proposed activities - Marine turtles	Comment: Three EPBC-listed marine turtle species are known to occur within the Project and/or Planning Areas: the green (Vulnerable), leatherback (Endangered) and loggerhead turtle (Endangered). These species use the area for migration and foraging and are susceptible to vessel strike and entanglement.	Beach Energy (Operations) Limited (Beach) acknowledge the Otway Offshore Gas Victoria Project (the Project) may have potential environmental impacts and risks on various marine fauna, including turtles. Considering the comment, Beach has reviewed the Offshore Project Proposal (OPP) and confirms that Section 4 describes the behaviours of the turtle species and Section 7.2.3.2 summarises the risk of vessel collision with turtles). The OPP identifies the Recovery Plan for Marine Turtles in Australia 2017-2027 and threat of vessel strikes. The assessment concludes that project vessel collisions with turtles are highly unlikely as the presence of turtles in the Project Area is considered unlikely. The OPP requires details and evaluation of the environmental impacts and risks of the Project appropriate to the nature and scale of each impact or risk. In light of comment, Beach has provided further detail in the OPP about the presence of turtles in the planning and project area, and the impacts and risks (please refer to PC229 for further information).
PC313 Matters of National	Comment: There are multiple protected and ecologically-significant ecosystems that could be contaminated by a	Beach Energy (Operations) Limited (Beach) acknowledge the potential impact of a hydrocarbon spill.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
Environmental Significance	hydrocarbon spill or an accidental release of marine diesel oil during drilling operations under the OGV Project.	The comment relates to Section 7.4 of the Offshore Project Proposal (OPP) that assesses the consequence of an unplanned spill from a loss of containment from wells or marine diesel spills from a vessel. Beach is satisfied the OPP provides sufficient information on the potential impact of a hydrocarbon spill. As the comment has not provided any additional information not already assessed in the OPP, no change has been made to the OPP.
PC349 Matters of National Environmental Significance	The Tasmanian Wilderness World Heritage Area (TWWHA) falls within the Planning Area. The TWWHA is a globally significant temperate wilderness area and contains outstanding examples of ongoing geological, biological and ecological processes in addition to numerous rare flora and fauna species. It is also rich in cultural heritage, with archaeological sites dating back to the Pleistocene. The Planning Area encompasses 3 Threatened Ecological Communities (TECs) that have coastal components: assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria; giant kelp marine forests of south east Australia (Endangered); and subtropical and temperate coastal saltmarsh (Critically Endangered). There are 4 Ramsar wetlands that overlap with the Planning Area: Glenelg Estuary, Lavinia, Port Phillip Bay, and Westernport Bay. These areas play vital ecological roles, providing nursery habitat for birds, fish, reptiles, invertebrates and other species, as well as maintaining water quality and shoreline structure. Wetlands are also powerful carbon sinks, trapping atmospheric carbon dioxide in sediments and vegetation. A total of 8 Australian Marine Parks overlap with the Planning Areas (Table 1). These parks provide habitat for myriad species and ecological communities, including	The Offshore Project Proposal (OPP) provides an assessment of ecosystems and environments as well as the potential environmental impacts and risks for the Project. The comment summarises the information provided in Section 4 (Description of the Environment) of the OPP in relation to Tasmanian World Heritage Area, threatened ecological communities, Ramsar wetland and marine parks and habitats for many species. As summarised in the Introduction of this Report, revisions to the scope of the Otway Gas Victoria (OGV) Project mean that the following areas are no longer within the Planning Area of the OPP: • Tasmania World Heritage Wilderness • Glenelg Estuary and Discovery Bay Wetlands, Port Phillip Bay (Western Shoreline) and Bellarine Peninsula and Western Port Ramsar wetlands Section 4 of the OPP provides a comprehensive assessment of the existing environment which includes the receptors provided in the commentary. As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	EPBC-listed species such as blue and pygmy blue whales, southern right whales, humpback whales, fin whales, sei whales, wandering albatross, shy albatross, little penguins, white sharks, New Zealand fur seals, and others.	
PC330 Matters of National Environmental Significance	Comment: These unique and highly biodiverse ecosystems should be protected from the damaging effects of offshore fossil fuel exploration and operation, such as leaks and spills, planned discharges of hazardous substances, and abandonment of derelict infrastructure at the end of the operational period.	Beach Energy (Operations) Limited (Beach) acknowledge the potential for environmental impact and risk from the proposed drilling activities in the Otway Offshore Gas Victoria Project (the Project). The Offshore Project Proposal (OPP) provides for the consideration of whole-of-project environmental impacts and risks. These environmental risks and impacts are assessed in the OPP, including the potential impact of spills (Section 7.4) and planned discharges (Sections 6.7 to 6.10). As the comment has not presented additional information not already included in the OPP, no changes have been made to the OPP. Further, the OPP includes content on the decommissioning phase of the Project (Section 3.8.5), including Beach's responsibility to remove all structures, equipment and property for the title area in accordance with Section 572(3) of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act). For the Project, decommissioning will require plug and abandonment of wells and decommissioning of subsea infrastructure. Beach has reviewed the OPP considering this comment and is satisfied it adequately addresses the decommissioning requirements in accordance with Section 7 of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023*. No change has been made to the OPP.
PC331 Key Ecological Features	Comment: The project area overlaps with the West Tasmania Canyons Key Ecological Feature (KEF). This KEF is considered to be of regional importance for biodiversity and/or ecosystem integrity. As with Marine Parks, KEFs and the species and ecosystems they support should be protected from the impacts of the offshore fossil fuel industry, in both the short and long term.	Beach Energy (Operations) Limited (Beach) acknowledge concerns about the potential environmental impacts and risks of its Otway Offshore Gas Victoria Offshore Project (the Project) on Australian Marine Parks (AMP) and Key Environmental Features (KEF). The AMP and KEF within the existing environment are described in Section 4 of the Offshore Project Proposal (OPP) and potential environmental impacts and risks for these receptors is evaluated in Sections 6 and 7 of the OPP. As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC309 Consultation and assessment process	Comment: According to the assessment process detailed by NOPSEMA on its website, the requirement for an OPP such as this one was introduced in 2014 "to allow for public scrutiny and comment on offshore petroleum developments early in the project lifecycle". Further on that website it is stated that "an OPP for a project must be accepted by NOPSEMA before the proponent can submit environment plans that make up the project". This suggests that an OPP should be the first step in regulatory assessment and public consultation on offshore petroleum projects. However, the public comment period for this OPP came after Beach Energy had closed public comment on 2 April 2024 for an Environment Plan (EP) detailing a drilling program on the same titles as the OPP, as well as additional titles in the Bass Basin. The OPP addresses this: "[t]his OPP includes description of exploration and appraisal drilling activity which is an activity that does not require an accepted OPP as part of the environmental permitting framework".	Beach Energy (Operations) Limited (Beach) acknowledges that offshore environmental approvals including those for Offshore Project Proposals (OPP) and Environment Plans (EP) are technical and complex documents with bespoke legislative requirements. Beach confirms that the OPP and Offshore Gas Victoria Drilling and P&A Activities EP (Drilling EP) have been accepted by National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) in accordance with all regulatory requirements. Specifically, we note that Beach's Drilling EP covers exploration and appraisal drilling, and plug and abandonment activities and those activities – including exploration drilling – do not require an OPP. Beach refers to the guidance note published on NOPSEMA's website, titled *Offshore environmental approvals*. It states "Exploration activities, such as seismic surveys and exploration drilling, do not require an OPP, but do require an EP." While Beach notes your concern, for the reasons outlined above the Drilling EP does not need to be part of an accepted OPP for Beach to submit an EP to NOPSEMA for assessment. The environmental approvals for the offshore project are summarised in Section 1.5 (OPP Purpose and Scope),Section 2.2 (Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023) of the OPP. Beach has provided additional information in the OPP to describe the environmental approval process in section 3.3.1 of the OPP: An OPP is needed for most new offshore petroleum development projects in Commonwealth waters. An 'offshore project' is defined in the OPGGS (Environment) Regulations as 'one or more activities that are undertaken for the purpose of the recovery of petroleum…". As described in section 1.5.1 of the OPP, section 15 of Environment Regulations allows a proponent to use the OPP arrangements for exploration and appraisal activities. While an OPP must be accepted by NOPSEMA before the proponent can submit EPs for activities that make up an offshore project, this pre-requisite does not apply to exploration and appraisal activities such as exploratory drilling. As such, Beach has submitted an EP to NOPSEMA for the exploration and appraisal drilling activities. The initial exploration and appraisal drilling campaign described in this OPP is part of the OGV Drilling and P&A Activities EP. Activities in the EP include exploration drilling and depending on well results, either P&A or temporary well suspensions.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC310 Consultation and assessment process	Comment: Further explanation and clarity is required concerning the requirements for OPP approval prior to EP submission. OPPs open for public comment are located in a different section of the NOPSEMA website than EPs open for public comment. This adds an extra layer of complexity to engaging with the OPP for relevant persons and community members who may have an interest in the OPP but are not able to locate the OPP or its public comment portal, as these are not in the same online location as the EPs.	Beach Energy (Operations) Limited (Beach) acknowledge that the environmental approvals for offshore petroleum activities are complex. Section 1.6 (OPP Purpose and Scope) and Section 2.2 (Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023) of the Offshore Project Proposal (OPP) summarises the environmental approvals, including the requirements for OPP and Environment Plan(s) (EP) for the Offshore Gas Victoria Project. Further explanation and clarity on the requirements for Offshore Project Proposal (OPP) and Environment Plans (EPs) is provided in above PC309. The remainder of the comments relates to the public comment process and NOPSEMA's website. The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) is responsible for managing the public comment process and provides information on its website on the public submission process for OPPs and EPs. In addition to NOPSEMA's website, Beach provides information and invitation for public comment. As outlined in various NOPSEMA policies, Beach promoted the public comment process for the OPP (and its Offshore Gas Victoria Drilling and P&A Activities EP) by publishing a public notice in eight different newspapers, emailing the project stakeholder list, and prominently featuring information about the public comment period and links to NOPSEMA's website on Engage Beach, Beach's online consultation hub. Beach has made no change to the OPP in response to this comment.
PC308 Other concerns	Comment: Transit of vessels to and from the project locations is excluded from the OPP as this is outside the scope of the OPGGS Act. To service the proposed activities, the project will utilize existing support facilities at Geelong and Portland. Vessel traffic needs to be explicitly quantified and included in the risk assessment framework, as vessel strike is a threat to marine megafauna, including cetaceans and marine turtles.	Beach Energy (Operations) Limited (Beach) acknowledge that offshore activities may have potential environmental impacts and risks on marine fauna. The OPP provides for the consideration of whole-of-project environmental impacts and risks. The Environment Plan(s) (EP) required to authorise activities are intended to address environmental impacts and risks at an activity-level, which would typically be a finer scale of detail than the OPP. In this regard, vessel traffic will depend on the type of activity carried out in the offshore environment and will be considered in the relevant EPs. The Offshore Project Proposal (OPP) assessed the potential risk for vessel collision with megafauna (Section 7.2).

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Common controls implemented in relevant EPs to minimise the risk of vessel strikes include Marine Fauna Observers under the Whale Management Procedure for monitoring and reporting, designed to comply with various government reporting for vessel strikes or injury on marine life. The relevant EPs will also highlight that reducing vessel speed has been shown to be an effective measure to reduce vessel strikes for marine species. By implementing these types of control measures, the risk assessment of vessel strike with marine fauna is rated as Low and to be of an acceptable outcome. Beach is satisfied the OPP adequately addresses the impact of vessel traffic on marine fauna. No change has been made to the OPP.
PC307 Other concerns	Comment: Hydraulic valves in the blowout preventer infrastructure will be vented to sea when closed, releasing an estimated 22-66 litres of hydraulic fluid into the ocean. The OPP comments that this fluid is water soluble and "readily disperses in the receiving waters" but the type of hydraulic fluid is not specified so that this comment of water solubility can be verified. To be water soluble, the hydraulic fluid would need to be one of the following types: water-oil emulsion (such as Shell's polyalkylene glycol (PAG)); water glycol; or biodegradable with a base of soybean, rapeseed, or sunflower oil.	Beach Energy (Operations) Limited (Beach) acknowledge that discharge of hydraulic fluid from blow-out preventers during drilling operations and production operations may occur as part of the Otway Offshore Gas Victoria Project. Beach has reviewed the Offshore Project Proposal (OPP) considering this comment and confirms that the OPP has identified that routine petroleum activities may result in the discharge of glycol based hydraulic fluids into the marine environment to be about 4m^3 per year (Section 3.8.6.1). Hydraulic control fluids are typically low toxicity, readably biodegradable, low potential for bioaccumulation and would rapidly disperse and dilute in the within the marine environment (Section 6.9.2.1). The OPP provides for the consideration of whole-of-project environmental impacts and risks of the project appropriate to the nature and scale of each impact or risk. In the case of discharge of hydraulic fluids, the extent of the discharge is within tens of meters (of the point of discharge) and the impact consequence is assessed as less than Minor. The Environment Plan(s) (EP) required to authorise activities are intended to address environmental impacts and risks at an activity-level, which would typically be a finer scale of detail than the OPP. EPs include more detailed information on chemicals and hazardous materials for use offshore with regards to Beach's Chemical Management Procedure and the Offshore Chemical Notification Scheme, which evaluates all production and drilling chemicals in terms of environmental impact. Beach is satisfied the OPP adequately addresses the impact of discharges to the marine environment. No change has been made to the OPP.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC350 Other concerns	The OPP says that materials used as additives during drilling (i.e. dry bulk barite, bentonite, cement) will be discharged to the marine environment. Other planned discharges include condensate, brine, amine-type corrosion inhibitors, and suspension fluids. An explanation of the potential volumes of material, as well as the potential impacts of this dumping on the physical and biological environment, is required in order for relevant persons to make an informed assessment of the impacts of these activities.	Beach Energy (Operations) Limited (Beach) agree that discharge of materials from drilling operations and production operations may occur as part of the Otway Offshore Gas Victoria Project (the Project). Beach has reviewed the Offshore Project Proposal (OPP) considering this comment and confirms that planned discharges (e.g. drill cuttings, drill fluids, cement, commissioning and operational fluids, waste) are assessed in Sections 6.7 to 6.10 of the OPP. The OPP provides for the consideration of whole-of-project environmental impacts and risks. The OPP must provide details and evaluation of the environmental impacts and risks of the project appropriate to the nature and scale of the potential impact and risk. In the case of discharges from drilling activities, the impact consequence is assessed to be minor consequence and of an acceptable level. The Environment Plan(s) (EP) required to authorise activities are intended to address environmental impacts and risks at an activity-level, which would typically be a finer scale of detail than the OPP. For example, the EP for the OGV Drilling and P&A Activities provides the level of detail suggested in the comment in relation to volumes and types of discharges and assessment of potential impacts and risks. For the purpose of the OPP, Beach is satisfied adequate information is provided on discharges and potential impacts and risks. No change has been made to the OPP in response to this comment.
3.6 Submitter No. 9		
PC172 Climate impacts of gas production	Comment: Methane gas is ~eighty-four times more damaging to the climate than carbon dioxide over a twenty year period. This is a critical consideration for all planetary ecosystems and species.	Beach Energy (Operations) Limited (Beach) recognises that action to address climate change is necessary and that all energy systems must contribute to meet the targets set out in the Paris Agreement. As an energy company, Beach must play a role in managing our carbon emissions. Beach aspires to reach net zero Scope 1 and 2 emissions by 2050. Beach has an equity emissions reduction target to reduce our Scope 1 and 2 emissions intensity by 35 per cent by 2030. This is aligned with the Australian Government's target of a 43 per cent reduction in carbon emissions from a 2005 base. The emissions reduction is measured against a 2018 baseline, when Beach materially expanded its portfolio through the acquisition of Lattice Energy.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		The proposed management of greenhouse gas (GHG) emissions is aligned with the Beach Environment Policy, Climate Change Policy, Sustainability Policy, Risk Management Standard, Environment Management Standard and Sustainability Standard, and Climate Transition Action Plan (CTAP) as detailed in Table 6-43 of the Offshore Project Proposal (OPP). Beach released its CTAP in April 2024. In the CTAP, Beach announced a new target of <0.2 per cent methane emissions intensity by 2025 for its operated assets, calculated on reported methane emissions. The target is in support of the Global Methane Pledge to reduce methane emissions by 30 per cent by 2030 (on 2020 levels), which the Australian government became a signatory of in 2022. Beach's commitment to address methane emissions is reflected in the annual Leak Detection and Repair program, which is in place at all onshore and offshore facilities. This allows Beach to ensure potential leak sources are addressed with priority. Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP for the reasons outlined above. Additional information has been added to Table 6-43 of the OPP regarding Beach's CTAP.
PC173 Climate impacts of gas production	Comment: We write in flat opposition to any project which further industrialises marine ecosystems, in order to produce fossil methane which will further exacerbate and accelerate cataclysmic climate change.	Beach Energy (Operations) Limited (Beach) recognise the submitters opposition to gas projects and the impact on climate change; however, this comment is not considered relevant to the content of the Offshore Project Proposal.
PC174 Climate impacts of gas production	Comment: At the COP 26 meeting the Australian Government signed this country on to the Global Methane Pledge… we pledged to the international community to reduce Australia's methane emissions by 30% from 2020 levels by 2030… We urge methane producers to be ready in the event that future resources ministers and the Federal Government recognise that this means no more gas production in Australia from this moment forward.	Beach Energy (Operations) Limited (Beach) recognise the comments on gas strategy and policy. As an energy company, Beach must play a role in managing our carbon emissions. Beach aspires to reach net zero Scope 1 and 2 emissions by 2050. Beach has an equity emissions reduction target to reduce our Scope 1 and 2 emissions intensity by 35 per cent by 2030. This is aligned with the Australian Government's target of a 43 per cent reduction in carbon emissions from a 2005 base. The emissions reduction is measured against a 2018 baseline, when Beach materially expanded its portfolio through the acquisition of Lattice Energy. The proposed management of greenhouse gas emissions is aligned with the Beach Environment Policy, Climate Change Policy, Sustainability Policy, Risk Management Standard, Environment

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Management Standard and Sustainability Standard, and Climate Transition Action Plan (CTAP) as detailed in Table 6-43 of the Offshore Project Proposal (OPP). Beach released its CTAP in April 2024. In the CTAP, Beach announced a new target of <0.2 per cent methane emissions intensity by 2025 for its operated assets, calculated on reported methane emissions. The target is in support of the Global Methane Pledge to reduce methane emissions by 30 per cent by 2030 (on 2020 levels), which the Australian government became a signatory of in 2022. Beach's commitment to address methane emissions is reflected in the annual Leak Detection and Repair program, which is in place at all onshore and offshore facilities. This allows Beach to ensure potential leak sources are addressed with priority. Further, the Australian Government released the Future Gas Strategy in May 2024, mapping out its plan for how gas will support the economy's transition to net zero. A key principle of the gas strategy recognises that new sources of gas supply are needed to meet demand during the economy-wide transition to net zero. Victoria released its Economic Growth Statement in December 2025 acknowledging the importance of natural gas produced locally to enable more renewables in the electricity network and to support manufacturing jobs, No change has been made to the OPP in response to this comment. <u>Additional information has been added to Table 6-43 of the OPP regarding Beach's CTAP.</u>
PC175 Climate impacts of gas production	Comment: The OPP lists Environmental Performance Outcomes including: *EPO10: Gas is provided to communities sustainably in a manner which is consistent with the objectives of the Paris Agreement and the global response to the threat of climate change.* Unless existing, incidental methane emissions are captured in order to prevent their release into the atmosphere there can be no sustainable provision of gas as a fuel to communities. Certainly producing and releasing currently stored gas from beneath the ocean	Beach Energy (Operations) Limited (Beach) recognise that action to address climate change is necessary and that all energy systems must contribute to meet the targets set out in the Paris Agreement. As an energy company, Beach must play a role in managing our carbon emissions. Beach aspires to reach net zero Scope 1 and 2 emissions by 2050. Beach has an equity emissions reduction target to reduce our Scope 1 and 2 emissions intensity by 35 per cent by 2030. This is aligned with the Australian Government's target of a 43 per cent reduction in carbon emissions from a 2005 base. The emissions reduction is measured against a 2018 baseline, when Beach materially expanded its portfolio through the acquisition of Lattice Energy. The proposed management of greenhouse gas emissions is aligned with the Beach Environment Policy, Climate Change Policy, Sustainability Policy, Risk Management Standard, Environment

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	floor is a disaster for the climate and is in opposition to the stated aims of the Global Methane Pledge.	Management Standard and Sustainability Standard, and Climate Transition Action Plan (CTAP) as detailed in Table 6-43 of the Offshore Project Proposal (OPP). Beach released its CTAP in April 2024. In the CTAP, Beach announced a new target of <0.2 per cent methane emissions intensity by 2025 for its operated assets, calculated on reported methane emissions. The target is in support of the Global Methane Pledge to reduce methane emissions by 30 per cent by 2030 (on 2020 levels), which the Australian government became a signatory of in 2022. Beach's commitment to address methane emissions is reflected in the annual Leak Detection and Repair program, which is in place at all onshore and offshore facilities. This allows Beach to ensure potential leak sources are addressed with priority. The Environmental Performance Outcome relevant to GHG emissions from Project activities is: • EPO15: GHG emissions related to the Project, including (scope 1 [Inside Project Boundary, scope 1* [Outside Project Boundary] and scope 3) emissions are consistent with Australia's international GHG emissions commitments, as outlined in the *Climate Change Act 2022*. Emissions are to be determined based on the NGER scheme and managed by the Safeguard Mechanism. Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP.
PC176 Options under consideration	Comment: The OPP put forward for public comment, on page 103, section 3.9.2.1 entertains the prospect of not proceeding with the project currently under consideration. This can be the only sensible way forward from the perspective of the climate, marine health and economically. The OPP under consideration in this submission acknowledges that this would relegate current Beach Energy infrastructure and gas wells to being stranded assets. This submission suggests that it would be wise to cut your losses rather than adding to them.	Section 7(2)(f) of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023, requires proponents to consider feasible alternate project options in its Offshore Project Proposal (OPP). Alternate options include alternate design concepts (e.g. subsea and platform development options and floating production facility) and a 'do nothing' option (Option 4 in Section 3.9.4 of the OPP). The latter is considered in the context of the gas supply-demand outlook for Victoria – including residential, commercial, and industrial customers – from the Australian Energy Market Operator's (AEMO) March 2024 publication Victorian Gas Planning Report Update. Beach notes that AEMO's new 2024 Victorian Gas Planning Report Update was published in March 2024. It considers the government's new policies and schemes, such as the new residential gas connections ban and gas substitution road map. Notwithstanding these new policies, the gas

ID	Summary of comments received	Beach’s assessment of merit of comment(s) and response(s) to comments and/or objections
		supply-demand balance over the five-year period (2024-28) again highlights the need for more gas supply in Victoria as the forecast supply declines faster than forecast consumption. The comment refers to stranded assets in the Otway Basin. The term ‘stranded asset’ is used in the OPP to describe the new gas reserves in the Otway Basin that are not currently developed. The OPP described subsea development option is to connect the currently stranded gas reserves to existing production infrastructure in the Otway Basin. Beach is committed to the development of gas from its Otway Basin acreage. Beach recognises the submitter’s opposition to all oil and gas projects; however, this comment is not considered relevant to the content of the OPP.
PC177 Options under consideration	Comment: We acknowledge that the Australian Energy Market Operator in their Gas Statement of Opportunities March 2024 forecast gas shortfalls for Victoria during winter peaks by 2027. This submission is written in the knowledge that gas policy in Victoria is progressive in terms of gas demand reduction in practical terms, with new mandated policy measures announced since the release of the GSOO 2024.	Beach Energy (Operations) Limited (Beach) acknowledge several resources that forecast gas shortfalls in Victoria, including Australian Energy Market Operator (AEMO). AEMO's new 2024 Victorian Gas Planning Report Update was published in March 2024. It considers the government's new policies and schemes, such as the new residential gas connections ban and gas substitution road map. Notwithstanding these new policies the gas supply-demand balance over the five-year period (2024-28) again highlights the need for more gas supply in Victoria as the forecast supply declines faster than forecast consumption. Beach recognises the submitter’s support for gas demand side management policies in Victoria; however, this comment is not considered relevant to the content of the Offshore Project Proposal.
PC178 Options under consideration	Comment: It has never been more expensive to connect to, or cheaper to disconnect from fossil gas through the gas distribution system in Victoria. This alongside the Victorian Energy Upgrades Program and the unaffordability of mains gas during a cost of living crisis mark the beginning of an economic death spiral for gas in Victoria.	Beach recognises the submitter’s opposition to gas projects; however, this comment is not considered relevant to the content of the Offshore Project Proposal.
PC179 Options under consideration	Comment: As more households switch to electric appliances, the business model for any gas production that Beach Energy proposes to sell on the domestic market looks increasingly threadbare.	Beach recognises the submitter’s opposition to gas projects; however, this comment is not considered relevant to the content of the Offshore Project Proposal.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC180 Options under consideration	Comment: The Victorian Government estimates that each home in Victoria would save on average $1000/year, rising to $2200/year for renewably powered homes (DEECA, 2023). As this news spreads across the public awareness we predict an exponential stampede away from gas heating.	Beach recognises the submitter's concern about the cost of energy for residential homes; however, this comment is not considered relevant to the content of the Offshore Project Proposal.
PC181 Options under consideration	Comment: We urge Beach Energy to abandon this project and any further gas production expansion, and instead pivot to renewable energy industries. That's certainly where the money will be going forward, with far reduced potential and actual marine environment impacts	Beach Energy (Operations) Limited (Beach) has rights and obligations to explore, appraise and develop gas under its petroleum titles granted and administered under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006.* Beach is committed to the development of gas from its Otway Basin assets. Beach recognises the submitter's opposition to gas projects; however, this comment is not considered relevant to the content of the Offshore Project Proposal (OPP). Similarly, comments about adopting alternatives (to fossil fuels) such as renewable energy sources are not relevant to the content of the OPP and are not considered further.
PC182 Marine Parks	Comment: The project planning area footprint encompasses eight marine parks, established to: help conserve marine habitats and the marine species that live within and rely on these habitats. There is nothing about offshore gas exploration, production or transportation which supports this aim. Of concern in particular is the 1km proximity of the Zeehan Marine Park from the production area. Zeehan Marine Park – along with all of the marine parks within the planning area - is already under application for a Special Prospecting Authority by joint partners TGS and Schlumberger (SLB) and has repeatedly been subject to seismic blasting operations.	Beach Energy (Operations) Limited (Beach) acknowledges concerns regarding marine habitats and species. Section 4.2.2 of the Offshore Project Proposal (OPP) identifies three Australian Marine Parks (AMP) based on PMST reports, however further refinement identifies two AMPs within the Planning Area – Apollo and Zeehan Marine Parks., There are no AMPs within the Project Area. The closest AMP to the Project Area is the Zeehan Marine Park Multiple Use Zone (classified by the International Union for Conservation of Nature (IUCN) VI). As summarised in the introduction to this report, the revision of the OPP means that the Zeehan Marine Park is approximately 58 km from the Project Area. The Commonwealth Director of National Parks (DNP) manages the AMP including compliance with provisions of the South-East Commonwealth Marine Reserves Network Management Plan 2013 – 2023. In preparation of the OPP, Beach consulted with the DNP in accordance with the National Offshore Petroleum Safety and Environmental Management Authority's (NOPSEMA) guidance note (NOPSEMA and Parks Australia Petroleum Activities and Australian Marine Parks June 2023). Further consultation with DNP will be undertake as part of preparation of future Environment Plan(s).

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		The cumulative environmental impacts of the offshore petroleum activities are assessed in Section 8 of the OPP. The proposed marine seismic survey(s) by other proponents in the Otway Basin are considered in the cumulative impact assessment (Table 8-1). Beach is satisfied that the OPP adequately addresses both the AMP and cumulative environmental impacts. As the comment does not introduce new information, no change has been made to the OPP in response.
PC183 Marine Parks	Comment: We appreciate that other abutting or overlapping projects are not the responsibility of the proponent for consideration in the drafting of the associated OPP or EP. However for those of us who have whole-of-marine ecosystem concerns these are certainly projects which cannot be considered in isolation.	Beach Energy (Operations) Limited (Beach) acknowledge concerns relating to the cumulative environmental impacts of offshore petroleum activities. The National Offshore Petroleum Safety Environment Management Authority (NOPSEMA) defines cumulative environmental impacts in the context of offshore petroleum activities, as "successive, additive, or synergistic impacts of collectively significant activities or projects with material impacts on the environment that have the potential to accumulate over temporal and spatial scales" (NOPSEMA Environment Plan Decision Making Guideline, N-04750-GL1721 A524696, Dec 2022). Section 8 of the Offshore Project Proposal (OPP) defines Beach's cumulative impact assessment process. It focuses on building on the planned impact assessments considered in the OPP by further considering the impacts of the proposed activity on key receptors (or key matters) in conjunction with the impacts from other reasonably foreseeable future projects within the spatial and temporal extent of the Project. Beach considers the cumulative environmental impacts are adequately assessed in the OPP and no change has been made to the OPP in response to this comment.
PC184 Threatened ecological communities	Comment: Three threatened ecological communities are also captured within the project planning area, including the endangered Giant Kelp Marine Forest which is subject to a restoration plan under partnership with the Tasmanian Seafood Industry and NRM South$_5$. The Giant Kelp Marine Forest is home to a greater density of endemic species than any other ocean ecosystem on Earth, including some that are endangered and critically endangered including the Victorian ocean faunal emblem, the weedy sea dragon. This forest area has so far showed	Beach Energy (Operations) Limited (Beach) acknowledges concerns regarding threatened ecological communities. Section 4.4.8 of the Offshore Project Proposal (OPP) identifies the threatened ecological communities, the Giant Kelp Marine Forests, within the Planning Area. The largest extent of Giant Kelp Marine Forest is along the South Australian coastline with patches around the Victorian coastline. The Planning Area is defined in Table 4-1 of the OPP as a combination of the marine diesel oil (MDO) Planning Area and Condensate Planning Area based on the spill modelling to the low thresholds. The Planning Area is distinct from the Project Area, as the latter is where all

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	resilience through a marine heatwave (ABC News, 2024[6]) and should be spared further stressors.	infrastructure and activities associated with the Project will be undertaken. No threatened ecological communities were identified in the Project Area. The OPP must assess the environmental impact in the very unlikely event of a spill. Beach has modelled the worst-case scenario for a loss of containment from a marine diesel spill and a loss of well control. The environmental impact of an unplanned condensate on the ecological function of the Giant Kelp Marine Forests of southeast Australia was assessed to be at the Low threshold and not predicted to have an impact (see Table 7-25). In addition, Beach is required by Australia's offshore energy regulator, the National Offshore Petroleum Safety and Environmental Management Authority, to have in place for all relevant project activities, accepted Oil Pollution Emergency Plans and Operational and Scientific Monitoring Plans. Beach recognises the importance of kelp both as an ecosystem – including a habitat for the weedy sea dragon (Section 4.4.8.2) – and seaweed industry (Section 4.5.14). Beach has identified and referenced two research projects on seaweed in Tasmania. In response to the comment, <u>Beach has updated the OPP (Section 4.5.13) to include the Giant Kelp Marine Forest Restoration Project by the Tasmanian Smart Seafood Partnership</u>. Beach has reviewed the information in the comment and the OPP regarding the impact of marine heatwave on giant kelp in the Tasman Peninsula (reference ABC News). As the comment relates to areas outside of the Planning Area for this Project, no change is made to the OPP in response to this comment.
PC185 Threatened ecological communities	Comment: Both the subtropical and temperate coastal saltmarsh communities are critically endangered and EPBC listed. The conservation advice for management of these communities includes: Provide appropriate buffer zones around patches of Coastal Saltmarsh to increase resilience.	Beach Energy (Operations) Limited (Beach) acknowledges concerns regarding subtropic and coastal saltmarsh. Section 4.4.8 of the Offshore Project Proposal (OPP) identifies the Subtropical and Temperate Coastal Saltmarsh as threatened ecological communities within the Planning Area of the Victorian coastline. The OPP includes an assessment of the potential impact to ecological environments in the unlikely event of a spill. The potential consequence evaluation for saltmarsh exposed to shoreline hydrocarbon is assessed to be Moderate as they are expected to be short-term and localised

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		(Table 7-24), while entrained hydrocarbons at the low threshold are not predicted to impact on the ecological function of the Threatened Ecological Communities (Table 7-25). In response to the comment, Beach has reviewed the Conservation Advice (issued under the *Environment Protection and Biodiversity Conservation Act 1999*) for Subtropical and Temperature Coastal Saltmarsh. The Conservation Advice recommends that oil spill contingency planning consider Coastal Saltmarsh as important habitat in all oil spill contingency planning. As the potential risk to the Subtropical and Temperate Coastal Saltmarsh is evaluated to be from a spill, the conversation advice for management of these communities such as buffer zones are not applicable. No change to the OPP is made in response to this comment. In addition, Beach is required by Australia's offshore energy regulator, the National Offshore Petroleum Safety and Environmental Management Authority, to have in place for all relevant project activities, accepted Oil Pollution Emergency Plans and Operational and Scientific Monitoring Plans. Beach has reviewed the information in the comment and the OPP regarding the impact of threatened ecological communities. As the comment relates to areas outside of the Planning Area for this Project, no change is made to the OPP in response to this comment.
PC186 Impacted species	Comment: Of the impacted species, 159 are threatened. For a responsible global citizen this would be enough to ensure that this project never came under serious consideration.	Beach Energy (Operations) Limited (Beach) agrees that threatened and migratory species listed under the *Environmental Protection and Biodiversity Conservation Act 1999* may be present be within the Planning Area of the Otway Offshore Gas Project (the Project). The Offshore Project Proposal (OPP) provides a comprehensive review of threatened and migratory species within the Project and Planning Areas (Section 4.4.9). The OPP also provides an assessment of potential environmental impacts and risks on marine species (including threatened and migratory species) and demonstration of acceptability (Section 6 and 7). The Acceptable levels of impacts for for environmental receptors are defined in Table 5-4 of the OPP. As the comment has not presented additional information not already included in the OPP, no change has been made to the OPP.
PC187 Impacted Species	Comment: Under section 2.3 of the OPP, consideration is made of some of the likely impacts on specific threatened species, with applicable threats and conservation actions	Beach Energy (Operations) Limited (Beach) has reviewed Section 2.3 of the Offshore Project Proposal (OPP) in response to this comment about the use of undefined terms.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	listed in terms of mitigation where appropriate and feasible. However the terms "appropriate" and "feasible" are highly subjective and undefined within the scope of the OPP. Where the stated action is to "evaluate risks" on impacted species there is no definition of the practices involved or the extent to which this evaluation will be undertaken by an independent, credible third party.	Section 2.3 of the OPP summarises the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). The term 'feasible' is used in Table 2-1, page 59, in describing climate change mitigation actions identified in the National Recovery Plan for Albatrosses and Petrels 2022 (CoA, 2022) and the term 'appropriate' is used throughout Table 2-1. In some cases this reflects the language used in the relevant recovery plan and conservation advice. Section 5 of OPP describes the risk assessment methodology and provides information on identification, analysis, evaluation and uncertainty of risks. Beach, as the proponent of the project, prepares the OPP with expert advice from third parties on the environment as well as the review of scientific literature. Australia's offshore energy regulator, the National Offshore Petroleum Safety and Environmental Management Authority, reviews and assesses the OPP to ensure compliance with the relevant environmental regulations. It is not practical for Beach to define all terms used in the OPP, however, certain terms are defined through the OPP. Generally, terms not defined would rely on the normal dictionary meaning. Beach has not changed the OPP in response to this comment.
PC188 Birds	Comment: Sixteen endangered birds and eight critically endangered birds occur within the planning area for this project. Included in the critically endangered bird species likely to be impacted are the iconic orange bellied parrot, of which only fifty were found to have occurred in the wild eight years ago (Australian Government, 20168). Of the impacts on the survival of the orange bellied parrot, the Australian Government assessed climate change to be a very high risk rating. We note that the OPP states that it will manage climate change impacts by the following means: Minimise the impacts of climate change by reducing greenhouse gas concentrations. We believe that producing a powerful climate change accelerant is distinctly at odds with this action. The swift parrot, another critically endangered species, has this year been recorded to have a population of 500 (ANU, 20249).	Beach Energy (Operations) Limited (Beach) acknowledge the comment about threatened bird species and the potential environmental impacts and risks from the Otway Offshore Gas Victoria Project (the Project). Section 4.4.9.4, in particular Table 4-22, lists threatened bird species that are likely to be present in the Planning Area. The orange-bellied parrot is listed as a critically endangered species with a migratory route likely to occur within the Project Area. The National Recovery Plan for the orange-bellied parrot identifies barriers to migration and movement resulting from illuminated boats and structures, and climate change as threats. A review of the Offshore Project Proposal (OPP) confirms the potential impact of light emissions on orange-bellied parrots has been assessed (both in terms of the Project and the cumulative impacts of offshore petroleum activities). The OPP considers the impact of light emission on marine fauna, such as seabirds, to be Minor with the implementation of Light Management Procedure as per the National Light Pollution Guidelines (Commonwealth of Australia, 2020) for the Project activities. The Light Management Procedure will detail mitigations to manage light based on the information in the Seabird Light Mitigation Toolbox and Beach's Vessel Light Management Procedure Guidance.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	We urge Beach Energy to withdraw this project application in the interest of maintaining healthy ecosystems and migration pathways for the significant numbers of bird species occurring within the planning area.	The environmental impact of greenhouse gas (GHG) emissions from the Project is assessed for ecosystems, and species (including threatened and migratory bird species). As emissions from the Project will be a minor contributor to GHG emissions, the impacts are assessed as having a Minor consequence. The comment also refers to Swift Parrots, which are identified in the OPP as a critically endangered species likely to inhabit the Planning Area (Table 4-22). The OPP provides a comprehensive assessment of potential impacts on seabirds in Section 6.3.3.2.2. As the comment does not present additional information not already included in the OPP, no change has been made to the OPP in response to the comments on endangered seabirds.
PC189 Fish species	Comment: Numerous EPBC-listed fish species fall within the Project and/or Planning Areas, including the red handfish (Critically Endangered), Maugean skate (Endangered), oceanic whitetip shark (Migratory), school shark (Conservation Dependent), whale shark (Vulnerable), and the white shark (Vulnerable). Shortfin and longfin eels occur in Victorian waters, beginning their life cycle in estuaries before migrating to their oceanic spawning grounds in the Coral Sea. Shortfin eels hold cultural significance to First Nations people, such as the Gunditjmara in south-western Victoria. Offshore fossil fuel development has been identified as a potential threat to eels during their lifecycle.	Beach Energy (Operations) Limited (Beach) acknowledge concerns about threatened fish species and the potential environmental impacts and risks from the Otway Offshore Gas Victoria Project (the Project). Section 4.4.9.3, in particular Table 4-21, of the Offshore Project Proposal (OPP) lists threatened fish species that are likely to be present in the Project and Planning Areas. The OPP also identifies the Biologically Important Areas (BIAs) critical to the survival of a species within the Project and Planning Areas. Revisions to the scope of the Otway Gas Victoria (OGV) Project and mean that the EPBC-listed fish species of Maugean Skate, Red Handfish, Oceanic Whitetip Shark and Whale Shark are no longer within the Project Area and revised Planning Area. For fish species, only the White Shark has foraging BIA overlapping the Planning Area (Table 4-19 and Figure 4-38). The OPP considers the potential impact of an oil spill on zooplankton (including krill). For example, Table 7-25 assessed the potential consequence to plankton from condensate spill as Minor (1), as the consequence could be expected to result in localised low-level short-term and recoverable impacts. Beach is satisfied that the potential impacts on fish, including foraging BIAs, is adequately addressed in the OPP and no change has been made to the OPP in response to the comment. Section 4.4.9.3, in particular Table 4-21, of the Offshore Project Proposal (OPP) lists threatened fish species that are likely to be present in the Project and Planning Areas. Beach also recognises the presence of eels in the Planning Area and the cultural significance of eels for First Nations Groups (Section 4.4.9.3.2). The comment states that fossil fuel development has been identified as a

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		potential threat to eels during their lifecycle. The impacts to First Nations values and sensitivities are assessed throughout the OPP. The environmental impacts to eels for light emissions, were assessed as having a residual impact of Minor (Section 6.3.3.6) and migrating eels are unlikely to be impacted by noise emissions (section 6.4.3.1.3). As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.
PC340 Cetaceans	Comment: Included in the 32 cetaceans are the endangered pygmy blue whales, of which only 2000 are reported to exist in the Southern Ocean at the time that this submission is written These can occur between November to May for seasonal foraging	Beach Energy (Operations) Limited (Beach) acknowledge comments regarding the pygmy blue whale. Beach has reviewed the Offshore Project Proposal (OPP) and confirms that a detailed review of the existing environment (Section 4) adequately describes the existing habitat and behaviours of the pygmy blue whales, Biologically Important Areas (BIAs) overlapping the Project and Planning Areas, previous surveys of whales in the Otway Basin, and an assessment of the potential impacts and risks. As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.
PC341 Pinniped species	Comment: The vulnerable southern elephant seals travel huge distances from their Antarctic breeding grounds to forage, including in the planning area (Threatened Species Scientific Committee, 201611). The Australian sea lion is listed as endangered both under the EPBC Act and in Victoria under the *Flora and Fauna Guarantee Act 1988* (Department of Climate Change, the Environment, Energy and Water, 202012). Identified threats to the Australian sea lion include pollution from oil spills, sewage, land run-off and toxic contaminants that may bioaccumulate. Both of these species, particularly southern elephant seals, can occur within the planning area. In the interests of precaution we urge Beach Energy to withdraw its application for this project.	The Offshore Project Proposal (OPP) provides comprehensive information on the species, *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) status, and habitat and behaviour within the Project and Panning areas. Beach Energy (Operations) Limited (Beach) has reviewed the OPP considering the comments on seals and confirms that the OPP identifies the protected species (Australian fur seal, Australian sea lion) within the Project and Planning Areas to include the EPBC listed pinniped species or habitats (Tables 4-24 and Section 4.4.9.6), although no Biologically Important Areas (BIAs) overlap either area. Beach acknowledges the activities planned for the OPP may have potential environmental impacts and risks on various marine fauna, including seals, which are assessed in Sections 6 and 7 of the OPP. Beach acknowledges concerns raised about the potential impact of oil spills and other discharges on seals. Section 6 of the OPP assesses the impact of the discharge of routine operational wastes

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		from vessels. All wastewater discharges must comply with various legislation, international (MARPOL) convention and marine orders summarised in Table 4 and Table 6-63. Section 6.9 of the OPP assessed the potential impact of planned discharges from operations as Minor with little or no risk of bioaccumulation, bioconcentration or trophic transfer of chemicals (Table 6-57). Section 6.10 of the OPP assessed the potential impact consequence of discharge of operational wastes (e.g. sewage) as minor as these discharges will result in a low-level decrease in water quality in the vicinity of the discharge with the duration being intermittent and temporary (Table 6-62). Section 7 of the OPP assesses the potential risk of unplanned events such as discharge of materials, and loss of containment of hydrocarbons or chemicals. The consequence of an oil spill on seals is assessed in Table 7-20 as having a Moderate consequence as there could be expected to be minor short-term impacts and some impact on valued species or habitats. The OPP provides for the consideration of whole-of-project environmental impacts and risks. The Environment Plan(s) that will be required to authorise activities are intended to address environmental impacts and risks at an activity-level, which would typically be a finer scale of detail than the OPP. As the comment has not presented additional information not already included in the OPP, no change has been made to the OPP.
PC190 Marine turtle species	Comment: All three marine turtle species found to occur within the planning and/or project area are recognised under the EPBC Act as either vulnerable or endangered. The Recovery Plan for for Marine Turtles in Australia 2017-2027 (Department of Environment and Energy, 201713) lists many threats to the continuing survival of marine turtles in Australia. These include climate change - which will certainly be accelerated by this project's output, marine debris through entanglement and ingestion, chemical discharge, light pollution, habitat modification, dredging, vessel disturbance, noise interference and diseases and pathogens resulting in disturbance to their	Beach Energy (Operations) Limited (Beach) acknowledge the Otway Offshore Gas Victoria Project (the Project) may have potential environmental impacts and risks on various marine fauna including turtles. Beach has reviewed the content of the Offshore Project Proposal (OPP) and confirms that threatened species of turtles may be present in the Project and Planning Areas (Section 4.4.9.5, in particular Table 4-23), although no Biological Important Areas (BIAs) or habitat critical to the survival of marine turtles overlap the Project Area or Planning Area. The Recovery Plan for Marine Turtles in Australia, (CoA, 2017) includes several potential impacts such as light, noise, vessel collision, oil spill, marine debris and entanglement, and discharges (Table 2-1). The potential impact or risk from light emissions (Section 6.3) and noise emissions (Section 6.4) were assessed with the impact consequence ranked as Minor and of an acceptable

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	habitat areas. All of these impacts are likely to be present in the project area specifically and may occur within the planning area	level (see Tables 6-15 and 6-16 for light emissions and Section 6.4.3.2.2 for noise emissions). The potential risk from vessel interactions (Section 7.2) was assessed to have a low-risk rating (Table 7-8). While the Recovery Plan for Marine Turtles in Australia, (CoA, 2017) identifies chemical and terrestrial discharge as a threat, this is mostly in relation to pollution from agricultural, terrestrial industrial and domestic sources. Based on the low toxicity of chemicals and the absence of BIAs or habitat critical for turtles within the Project Area, further assessment of the impact was not undertaken. In light of comment, Beach has provided further detail in the OPP about the presence of turtles in the planning and project area, and the impacts and risks (please refer to PC229 for further information).
PC191 Discharge actual and potential	Comment: The OPP under consideration for this project states that "about 4m^3 per year" of an unspecified "glycol based" hydraulic fluid will be discharged to the marine environment by the actuation of subsea valves. In order to accurately determine the likely impacts of this discharge we believe that the fluid planned for use be specified	Beach Energy (Operations) Limited (Beach) acknowledge that discharge of hydraulic fluid from blow-out preventers during drilling operations and production operations may occur as part of the Otway Offshore Gas Victoria Project. Beach has reviewed the Offshore Project Proposal (OPP) considering this comment and confirms that the OPP has identified that routine petroleum activities may result in the discharge of glycol based hydraulic fluids into the marine environment to be about 4m^3 per year (Section 3.8.6.1). Hydraulic control fluids are typically low toxicity, readably biodegradable, low potential for bioaccumulation and would rapidly disperse and dilute in the within the marine environment (Section 6.9.2.1). The OPP provides for the consideration of whole-of-project environmental impacts and risks of the project appropriate to the nature and scale of each impact or risk. In the case of discharge of hydraulic fluids, the extent of the discharge is within tens of meters (of the point of discharge) and the impact consequence is assessed as less than Minor. The Environment Plan(s) (EP) required to authorise activities are intended to address environmental impacts and risks at an activity-level, which would typically be a finer scale of detail than the OPP. EPs include more detailed information on chemicals and hazardous materials for use offshore with regards to Beach's Chemical Management Procedure and the Offshore Chemical Notification Scheme, which evaluates all production and drilling chemicals in terms of environmental impact.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Beach is satisfied the OPP adequately addresses the impact of discharges to the marine environment. No change has been made to the OPP.
PC192 Discharge actual and potential	Comment: This submission also raises concerns about potential unintended spills from the umbilicals of mono ethylene glycol (MEG) and methanol and its possible impacts on marine species.	Beach Energy (Operations) Limited (Beach) acknowledges that loss of containment of monoethylene glycol (MEG) or methanol from subsea umbilicals or flowlines is identified as a potential risk of the Otway Offshore Gas Victoria Project. Hydrate inhibitors (e.g. MEG or methanol) are mentioned in the Offshore Project Proposal (OPP) as chemicals that may potentially be injected into wells. These fluids operate in a closed loop system, with no planned discharges to the marine environment. The worst-case release volume of umbilical loss of containment and MEG spill is in the order of 400m^3 (Table 7-16). The umbilical loss of containment scenario was not modelled in the OPP due to the relatively small volume and MEG being a Category 'E' Offshore Chemical Notification Scheme chemical with no substitution warning, readily biodegradable with a low potential for bioaccumulation and a Minor potential impact consequence ranking. The OPP provides for the consideration of whole-of-project environmental impacts and risks appropriate to the nature and scale of each impact or risk. The Environment Plan(s) required to authorise activities are intended to address environmental impacts and risks at an activity-level, which would typically be a finer scale of detail than the OPP. No change to the OPP is made in response to this comment.
PC193 Decommissioning	Comment: Importance of a clear plan to meet the legislated required that all offshore oil and gas infrastructure be removed once it is no longer in use. This means not only having a plan in place to remove all infrastructure, but to ensure that Beach Energy has allowed for the significant expense, at the full cost projected for the end of the life of the project, to be covered. This submission believes that full disclosure of the projected cost of decommissioning be made public, including the modelling used to arrive at the disclosed cost, to create public confidence that this won't be yet another example of heavy industry leaving the Australian	The Offshore Project Proposal (OPP) for the Otway Offshore Gas Victoria Project (the Project) summarises the decommissioning phase of the Project (Section 3.8.7 and Sections 9.4). This includes Beach's responsibility to remove all structures, equipment and property for the title area in accordance with Sections 572(3) and 270(3) of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act). For the Project, decommissioning will require plug and abandonment of wells and decommissioning of subsea infrastructure. Beach acknowledges the concern about the cost of decommissioning and ensuring the financial liability for decommissioning is borne by the petroleum industry and does not become the responsibility of government and taxpayers. The OPGGS Act was amended in 2021 to include new provisions referred to as trailing liability for decommissioning of offshore oil and gas infrastructure to ensure the titleholders (current and former, as well as related entities) are liable for

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	taxpayer to foot the bill for their failure to meet their legislative requirements at the end of life for the project.	decommissioning. For the OPP, there is no requirement to provide the cost to decommission and Beach has not made this suggested inclusion to the OPP. Beach has reviewed the OPP considering this comment and is satisfied the OPP adequately addresses the decommissioning requirements for an OPP in accordance with Section 7 of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023*.
PC194 Consultation	Comment: We are concerned that the process of consultation undertaken by Beach Energy appears to fail the requirements stipulated by NOPSEMA (NOPSEMA, 202117). Under NOPSEMA requirements, the release of the OPP for public comment is the first step in public engagement, and only after a rigorous and iterative process concluding in approval can the proponent proceed to release of their associated environment plan (EP). In this case, however, the EP closed for public submission on 2 April 2024, a full 48 days after the public comment period for the OPP concludes. That EP is currently listed as under assessment by NOPSEMA. This submission is written in the belief that this constitutes inadequate adherence to the requirements of consultation for offshore petroleum titles.	Beach Energy (Operations) Limited (Beach) acknowledges that offshore environmental approvals including those for Offshore Project Proposals (OPP) and Environment Plans (EP) are technical and complex documents with bespoke legislative requirements. Beach confirms that the OPP and Offshore Gas Victoria Drilling and P&A Activities EP (Drilling EP) have been accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) in accordance with all regulatory requirements. Specifically, we note that Beach's Drilling EP covers exploration and appraisal drilling, and plug and abandonment activities and those activities – including exploration drilling – do not require an OPP. Beach refers to the guidance note published on NOPSEMA's website, titled *Offshore environmental approvals*. It states "Exploration activities, such as seismic surveys and exploration drilling, do not require an OPP, but do require an EP." While Beach notes your concern, for the reasons outlined above the Drilling EP does not need to be part of an accepted OPP for Beach to submit an EP to NOPSEMA for assessment. The environmental approvals for the offshore project are summarised in Section 1.5 (OPP Purpose and Scope), Section 2.2 (Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023) of the OPP. Beach has provided additional information in the OPP to describe the environmental approval process in section 3.3.1 of the OPP: An OPP is needed for most new offshore petroleum development projects in Commonwealth waters. An 'offshore project' is defined in the OPGGS (Environment) Regulations as 'one or more activities that are undertaken for the purpose of the recovery of petroleum…". As described in section 1.5.1 of the OPP, section 15 of Environment Regulations allows a proponent to use the OPP arrangements for exploration and appraisal activities. While an OPP must be accepted by NOPSEMA before the proponent can submit EPs for activities that make up an offshore project, this pre-requisite does not apply to exploration and appraisal activities such as

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		exploratory drilling. As such, Beach has submitted an EP to NOPSEMA for the exploration and appraisal drilling activities. The initial exploration and appraisal drilling campaign described in this OPP is part of the OGV Drilling and P&A Activities EP. Activities in the EP include exploration drilling and depending on well results, either P&A or temporary well suspensions.
3.7 Submitter No. 10		
PC195 Paragraph 3	Comment: Beach comments that this Project will produce gas for use in the east coast domestic market and will repurpose an existing pipeline and gas processing plant through "tie-backs." In fact, the Project will require the buildout of substantial fossil fuel infrastructure and will support expansion of offshore gas production in the Otway Basin.	Beach Energy (Operations) Limited (Beach) acknowledge the statement summarising the scope and purpose of the Otway Offshore Gas Victoria Project (the Project). The Project considers the subsea development of gas fields adjacent by utilising the existing gas infrastructure in the Otway Basin. Beach is unable to identify a comment within this statement.
PC196 Paragraph 4	Comment: Beach proposes to undertake the Project in Nyamat Mirring, the Sea Country of the Gunditjmara people[2]. Nyamat Mirring is connected to the rest of Gunditjmara Country as part of a continuous, connected landscape[3]. Nyamat Mirring holds values that are fundamental to the wellbeing of Gunditjmara and other people who live on Country. The customary obligations of Gunditjmara to Country, Ceremony, language (Wurrung), lore, relationships, and identities are inter-connected with Nyamat Mirring[4]. [2] *Gunditj Mirring Traditional Owners Aboriginal Corporation (GMTOAC), Gunditjmara Nyamat Mirring Plan 2023-2033 (2023) (Gunditjmara Nyamat Mirring Plan), p. 8.* [3] *Gunditjmara Nyamat Mirring Plan, p. 11.* [4] *Gunditjmara Nyamat Mirring Plan, p. 8.*	Beach Energy (Operations) Limited (Beach) acknowledge the statement on the location of the Otway Offshore Gas Victoria Project as Sea Country of the Gunditjmama people. Beach understands the importance of Sea Country for First Nations Groups including the the intangible cultural values and sensitivities that exist for other First Nations groups that are not directly adjacent to the Project Area, due to the interconnectedness of marine ecosystems and existences of various marine fauna and flora and intangible cultural values (see section 4.6.3 of the OPP). While Beach is unable to identify a comment within this statement, we do recognise reference to the Gunditjmara Sea Country Plan which has been added to the OPP: Section 4.6.3.2 of the OPP has been updated to include the Gunditjmara Sea Country Plan - The Gunditjmara published their Sea Country Plan, Gunditjmara Nyamat Mirring Plan 2023-2033, on 13 March 2024 (GMTOAC 2023). This plan details Gunditjmara's values and species of cultural significance in the Sea Country.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC197 Paragraph 5a	Comment: In summary, the Project raises the following concerns for the Gunditjmara people: a. Contribution to climate change: In increasing greenhouse gas (GHG) emissions and prolonging fossil fuel production, the Project is not consistent with the pathway to a safe climate. Climate change is a major threat to the cultural and natural values of Nyamat Mirring. This Project locks in substantial GHG emissions from the production of fossil gas over its 30-year lifespan, amounting to over 2% of Australia's remaining carbon budget for securing a safe climate. At a time when Australia should be phasing out fossil fuels completely and rapidly cutting emissions, this Project is indefensible.	Beach Energy (Operations) Limited (Beach) acknowledge the statement summarising the concerns of the potential impact of the Otway Offshore Gas Victoria Project on the cultural heritage values and sensitivities of the Gunditjmara People. Sections 6 and 7 of the Offshore Project Proposal (OPP) evaluate the environmental impacts and risks of the Project and identifies where First Nations cultural values and sensitivities may be potentially affected. Section 4.6.3.2 of the OPP has been updated to include the Gunditjmara Sea Country Plan - The Gunditjmara published their Sea Country Plan, Gunditjmara Nyamat Mirring Plan 2023-2033, on 13 March 2024 (GMTOAC 2023). This plan details Gunditjmara's values and species of cultural significance in the Sea Country. Beach considers this to be a general statement with specific comments addressed throughout this public comment report. The greenhouse gas (GHG) emissions for the Project are assessed in Section 6.6 and Appendix K of the Offshore Project Proposal (OPP). Subsequent to the revision of the scope of activities proposed in the OPP, the GHG emissions report for the Project and section 6.6 of the OPP were revised. As described in the Introduction of this report, the GHG emissions for the Project are estimated to be 13.05 million tonnes CO_2-e. As part of the commitment to the Paris Agreement, Australia has an emissions budget for the 2021-2030 decade of 4,353 $MtCO_2$-e. The Project emissions (including all scopes) during this period is ~ 0.1% of this carbon budget. Beach has calculated the carbon budget for the period of the Project (2025 to 2049) to be 6,729 $MtCO_2$-e . The Project emissions (including all scopes) during this period is 0.19% of this carbon budget. No change is made to the OPP in response to this comment.
PC198 Paragraph 5b	Comment: Risks to culturally significant species: Gunditjmara people are spiritually connected with the rich biodiversity of species in Nyamat Mirring. The Project threatens endangered whale, bird, and turtle species, since drilling, subsea installation, and production operations carry risks of noise pollution, light pollution, and vessel interactions with marine fauna. The OPP fails to provide	Beach Energy (Operations) Limited (Beach) acknowledge the potential environmental impacts and risks of the Otway Offshore Gas Victoria Project (the Project) on the marine species. Beach has also included an assessment of the First Nations Groups values and sensitivities and where relevant included in the risk and impact assessments of the Otway Offshore Project Proposal (OPP). In this regard, sections 6 and 7 of the OPP assess the potential impacts and risks of the Project on the marine environment. The OPP provides for the consideration of whole-of-project environmental impacts and risks. The OPP requires details and evaluation of the environmental impacts and risks

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	sufficient information to determine the significance of such impacts	of the project appropriate to the nature and scale of each impact or risk. The Environment Plan(s) that will be required to authorise activities are intended to address environmental impacts and risks at an activity-level, which would typically be a finer scale of detail than the OPP. The statement does not provide any specific example of where the OPP fails to provide sufficient information. Beach considers this to be a general statement with specific comments addressed throughout this public comment report.
PC199 Paragraph 5c	Comment: Risks to the marine environment: Through Nyamat Mirring, the Gunditjmara are interconnected with the marine environment. Other risks to the environment include toxic discharges from Project activities and potential hydrocarbon spills, which could affect benthic communities and marine species across the food chain. The OPP evaluates the risk of a spill which cover large tracts of the southern coast of mainland Australia and the western coast of Tasmania, impacting marine parks, wetlands, and heritage sites, as well as countless species. Even so, it has failed to model the worst-case spill scenario. The gaps and errors in the OPP suggest that this Project should not proceed to the next stage of approval	Beach Energy (Operations) Limited (Beach) acknowledge the potential environmental impacts and risks of the Otway Offshore Gas Victoria Project (the Project) on the marine environment. The Offshore Project Proposal (OPP) provides for the consideration of whole-of-project environmental impacts and risks. The OPP requires details and evaluation of the environmental impacts and risks of the project appropriate to the nature and scale of each impact or risk. The statement specifically references the risk of hydrocarbon spills. Beach commissioned an independent expert, RPS Group, to prepare a spill model and report (Appendix M). The statement does not provide any specific comment or example of gaps or errors or failures relating to the spill model. Beach considers this to be a general statement with specific comments addressed throughout this public comment report.
PC200 Paragraph 7	Comment: Beach proposes to undertake drilling and completion of up to 17 wells[5], using a semisubmersible drilling rig (Mobile Offshore Drilling Unit or MODU), commencing in 2025[6]. Assuming the drilling campaigns are successful, the Project will require subsea installation and move to the production phase. The estimated duration for operations and production spans up to 34 years, with decommissioning to be completed by 2058[6]. 5 *One well, Artisan 1, will be re-entered and completed (since it has already been drilled). See Beach Energy (Operations) Limited, Otway Offshore Gas Victoria Project:*	Beach Energy (Operations) Limited (Beach) acknowledge the statement summarising the scope and purpose of the Otway Offshore Gas Victoria Project (the Project). Beach considers this to be a general statement with specific comments addressed throughout this public comment report. As summarised in the introduction to this Report, the scope of the Project has been revised which is reflected throughout the OPP. In particular Chapter 3 for the description of activities is updated to for a reduction in total well number and end of field life.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	Offshore Project Proposal (Revision 2, 15 Feb. 2024) (OPP), p. 394. [6] *OPP, p. 37.* [7] *OPP, p. 394.*	
PC201 Paragraph 8	Comment: The production of fossil gas from the 17 prospects could be significant. Beach intends to transport recovered gas through the existing Otway Gas Production Pipeline (Otway Pipeline) to the Otway Gas Plant near Port Campbell, Victoria. The Project presupposes the viability of using the Otway Pipeline, already approaching 20 years old, for another 30 years	Beach Energy (Operations) Limited (Beach) acknowledge the statement summarising the scope and purpose of the Otway Offshore Gas Victoria Project (the Project). Beach considers this to be a general statement with specific comments addressed throughout this public comment report.
PC202 Paragraph 9	Comment: Beach proposes "tie-backs" to this existing pipeline. Subsea infrastructure would need to be installed, including wellheads, flowlines, umbilicals, and facilities that will connect any producing wells to the current infrastructure. There would be tie-backs of two gas discoveries near the Thylacine platform, known as Artisan and La Bella, to the existing infrastructure, plus "future tie-backs" of any other gas discoveries made during the drilling campaigns[8] [8] *OPP, p. 37.*	Beach Energy (Operations) Limited (Beach) acknowledge the statement summarising the scope and purpose of the Otway Offshore Gas Victoria Project (the Project). Beach considers this to be a general statement with specific comments addressed throughout this public comment report.
PC203 Paragraph 10	Comment: This Project enables the expansion of offshore gas production in the region by setting up infrastructure that will connect "future campaigns" to the Otway Pipeline and Plant, and locks in substantial GHG emissions for decades to come.	Beach Energy (Operations) Limited (Beach) acknowledge the statement summarising the scope and purpose of the Otway Offshore Gas Victoria Project (the Project). Beach considers this to be a general statement with specific comments addressed throughout this public comment report.
PC204 Paragraph 11	Comment: The Project is not consistent with greenhouse gas emissions reduction targets and securing a safe climate	Beach Energy (Operations) Limited (Beach) acknowledge the statement about greenhouse gas emissions reduction targets. Beach considers this to be a general statement with specific comments addressed throughout this public comment report.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC205 Paragraph 12	Comment: Climate change is a leading concern for the Gunditjmara people. Climate change impacts threaten the cultural and natural values of Nyamat Mirring; for example, increased ocean acidification undermines the abundance of culturally significant marine species, while sea level rise affects the habitat of intertidal species (such as limpets) on which Gunditjmara people rely for harvesting.[9] Ensuring a safe climate is essential to the survival of Gunditjmara and all First Nations communities. This Project should not be allowed, first and foremost, because of its contribution to climate change. [9] *Gunditjmara Nyamat Mirring Plan, p. 22.*	Beach Energy (Operations) Limited (Beach) acknowledges the comment regarding climate change and impacts on marine and intertidal species in the Planning Area and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach acknowledges the cultural significance to the Gunditjmara people of marine species including shellfish such as limpets (GMTOAC 2023). It is noted in the OPP (Tables 6-40 and 6-42), that most threatened invertebrate species are suffering as a result from largescale habitat degradation and loss of biodiversity. However, no invertebrate species including limpets are listed as threatened under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) or under the *Victorian Flora and Fauna Guarantee Act 1988* Threatened List. Whilst changes in regional temperature, humidity and rainfall may impact invertebrate distribution, development, and reproduction, as outlined in Section 6.6.3, invertebrates are expected to be more responsive to habitat changes than vertebrates due to short generation times, high reproduction rates and sensitivity to climatic variables. Beach does not expect activities associated with the Project to impact invertebrate species within local intertidal areas. Beach Energy has considered this comment and has updated Table 6-40 to clarify that no invertebrate species including limpets are listed as threatened under the EPBC Act or under the Victorian Flora and Fauna Guarantee Act 1988 Threatened List. Section 6.6.3 of the OPP provides an evaluation of potential impact of greenhouse gas emissions and climate change, including sea level rise and acidification. As these comments do not introduce new information not already included in the OPP, no further changes are made. *Reference:* *GMTOAC (2023). Gunditjmara Nyamat Mirring Plan 2023-2033 (2023) Gunditj Mirring Traditional Owners Aboriginal Corporation (GMTOAC), Gunditjmara Nyamat Mirring Plan 2023-2033 (2023) (Gunditjmara Nyamat Mirring Plan)*
PC206 Paragraph 13	Comment: Beach comments that the impacts from the Project's GHG emissions are aligned with the principles of ecologically sustainable development, on the basis that "[g]as will be sold into the domestic market and will provide a clean energy source to allow the transition from	Beach Energy (Operations) Limited (Beach) acknowledge the comment about greenhouse gas emissions and the role of energy sources in the energy transition. The comment makes reference to Section 6.6 of the Offshore Project Proposal (OPP) and specifically the Ecologically Sustainable Development (ESD) Principles in Table 6-45 of the OPP.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	coal to renewables to occur in an orderly fashion."[10] However, the International Energy Agency estimates that the burning of natural gas globally contributed around 7.5 billion tonnes of carbon dioxide to the atmosphere in 2021, which equates to approximately 21% of global carbon dioxide emissions.[11] The notion that fossil gas is a "clean energy source" is plainly false, and a concerning misstatement to find within Beach's analysis of GHG emissions impacts. [10] *OPP, p. 409 (emphasis added).* [11] *International Energy Agency, Global Energy Review: CO2 Emissions in 2021 (2022).*	Beach has reviewed the Section 6.6 and the ESD principles and has amended the ESD principles presented in Table 6-45 of the OPP, notably: <u>"Gas and condensate from OGP is supplied into the domestic Australian market. The scope 3 emissions associated with the processing, transmission/transport and end use of the gas and condensation will occur within Australian Commonwealth jurisdiction. Therefore the scope 3 emissions will be managed in accordance with Australia's regulatory regime including NGER and the Safeguard Mechanism, which is designed "to deliver emissions reductions consistent with Australia's [NDC] under the Paris Agreement" (DCCEEW, 2023i) and the Climate Change Act 2022."</u>
PC207 Paragraph 14	Comment: In its stakeholder consultation information sheets, Beach spreads further misinformation on the role of fossil gas in addressing climate change. Even if "[c]arbon emissions of natural gas are significantly lower than coal" when the product is burned, this does not account for the methane emissions from gas production and transport. Methane is a more potent GHG source and driver of climate change.[12] Methane leaks and purposeful venting of methane from gas developments alone contribute 1.2 billion tonnes of carbon dioxide equivalent (CO2-e) to the atmosphere every year.[13] Beach estimates that its proposed Project will emit over 34.6 million tonnes of CO2-e in its lifetime [12] *According to the IPCC Sixth Assessment Report, fugitive and production methane from fossil fuel is 29.8 times more potent as a GHG source than carbon dioxide over a 100-year period. IPCC, Sixth Assessment Report, Annex II: Definitions, Units & Conversions (2021), p. 1831. (We also note with concern that Beach used a lower conversion*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding emissions and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach reports its Australian scope 1 and scope 2 emissions in accordance with the National Greenhouse and Energy Reporting Act 2007 (NGER Act), the National Greenhouse and Energy Reporting Regulations 2008 (NGER Regulations) and National Greenhouse and Energy Reporting (Measurement) Determination 2008. The NGER Regulations define the global warming potentials (GWP) which are used to calculate the carbon dioxide equivalence of various substances for compliance with the NGER Act. This was last amended in 2020 and reflects the values specified by the IPCC in the Fifth Assessment Report AR5 (https://www.ipcc.ch/) of the GWP of methane as 28. The proposed management of the impact of GHG emissions is aligned with the Beach Environment Policy, Climate Change Policy, Sustainability Policy, Risk Management Standard, Environment Management Standard, Sustainability Standard and Climate Transition Action Plan (CTAP) as detailed in Section 6.6 8 of the OPP (Table 6-43). In Beach's CTAP, released in April 2024, Beach announced a new target of <0.2% methane emissions intensity by 2025 for our operated assets, calculated on reported methane emissions. The target is in support of the Global Methane Pledge to reduce methane emissions by 30% by 2030 (on 2020 levels), which the Australian government became a signatory to in 2022. Our commitment to address methane emissions is reflected in the annual Leak Detection and Repair

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	factor of 28, citing NGER Regulations (Compilation 26) (see OPP, p. 1234), potentially [13] *International Energy Agency, Global Methane Tracker 2022: Overview (2022). In converting fugitive fossil methane to CO2-e, see: Intergovernmental Panel on Climate Change, Sixth Assessment Report, Annex II: Definitions, Units & Conversions (2021), p. 1833.*	(LDAR) program that is in place at all onshore and offshore facilities, allowing us to ensure potential leak sources are addressed with priority. As per previous comments and responses, Beach has updated Table 6-43 of the OPP to include the CTAP. Subsequent to the revision of the scope of activities proposed in the OPP, the GHG emissions for the Project were revised. As described in the Introduction of this report, the GHG emissions for the Project are estimated to be 13.05 million tonnes CO_2-e. As part of the commitment to the Paris Agreement, Australia has an emissions budget for the 2021-2030 decade of 4,353 $MtCO_2$-e. The Project emissions (including all scopes) during this period is ~ 0.1% of this carbon budget. Beach has calculated the carbon budget for the period of the Project (2025 to 2049) to be 6,729 $MtCO_2$-e . The Project emissions (including all scopes) during this period is 0.19% of this carbon budget. Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to this comment.
PC208 Paragraph 15	Comment: Beach comments that gas has an important role in Australia's transition to renewable energy: "As old coal fired power stations are removed from Australia's energy mix, electricity powered from natural gas ensures a stable energy supply as our economy transitions to a different mix of energy sources for electricity generation."[14] However, Beach provides no evidence to support its implicit assertions that this new gas Project will displace coal power in Australia's electricity mix, and that there are no cleaner and more feasible renewable energy alternatives that will provide a stable power supply [14] *OPP, Appendix N, p. 4.*	Beach Energy (Operations) Limited (Beach) has reviewed the comment, in particular the reference to the Information Sheet dated September 2023 (Appendix N). The comment relates to the role natural gas will play as Australia transition to renewable energy. The full context of the statement in the Information Sheet about the role of gas as an energy source in the energy transition includes reference to the Australian Energy Market Operator's (AEMO) Integrated System Plan (ISP) of 2022 for the National Electricity Market which forecast that more gas-fired generation is required to reach Net Zero by 2050. Consistent with the ISP 2022, the Draft ISP 2024 demonstrates the important role that gas will play in Australia's transition to a net zero economy. The Draft ISP 2024 was published by AEMO in December 2023, with the final report due out in June 2024. The Australian Government's Future Gas Strategy (FGS) highlights that gas will be a transition fuel that firms renewable power generation and is required for manufacturing and minerals processing until such time as alternatives are viable. (Page 4, FGS).

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		No change is made to the OPP in response to this comment.
PC209 Paragraph 16	Comment: It is misleading to suggest that fossil gas has a role in the clean energy transition. Continued use of fossil gas will not allow global emissions to reduce consistently within the carbon budget for limiting warming to 1.5°C. Instead, energy demand will need to be met by renewable, zero-emissions sources. Meeting this demand by increasing gas supply will produce emissions that cannot credibly fit within the carbon budget	Beach Energy (Operations) Limited (Beach) is of the opinion that there will be an ongoing role for natural gas in the energy transition in enabling the greater penetration of renewable energy. As stated above (e.g. PC 208), both the Australian Energy Market Operator's (AEMO) Integrated System Plan (ISP) Reports and the Australian Government's Future Gas Strategy (FGS) confirm natural gas will continue to be critical to ongoing economic prosperity as lower emissions technologies are developed and integrated into energy supply systems. As described in the Introduction of this report, the GHG emissions for the Project are estimated to be 13.05 million tonnes CO_2-e. As part of the commitment to the Paris Agreement, Australia has an emissions budget for the 2021-2030 decade of 4,353 $MtCO_2$-e. The Project emissions (including all scopes) during this period is ~ 0.1% of this carbon budget. Beach has calculated the carbon budget for the period of the Project (2025 to 2049) to be 6,729 $MtCO_2$-e . The Project emissions (including all scopes) during this period is 0.19% of this carbon budget. No change is made to the OPP in response to this comment.
PC210 Paragraph 17	Comment: The Project will compromise efforts to keep the global average temperature increase below 1.5°C.This Project will expand gas production at a time when new and expanded fossil fuel development must end. It will compromise Australia's emission reduction targets and contribute to the climate crisis, exacerbating climate-related harms to First Nations' cultural heritage, communities, and the environment.	Beach Energy (Operation) Limited (Beach) acknowledge the statement about global temperatures and emissions reduction targets. Section 6.6 of the Offshore Project Proposal assess the greenhouse gas emissions of the Otway Offshore Gas Victoria Project. As described in the Introduction of this report, the GHG emissions for the Project are estimated to be 13.05 million tonnes CO_2-e. As part of the commitment to the Paris Agreement, Australia has an emissions budget for the 2021-2030 decade of 4,353 $MtCO_2$-e. The Project emissions (including all scopes) during this period is ~ 0.1% of this carbon budget. Beach has calculated the carbon budget for the period of the Project (2025 to 2049) of 6,729 $MtCO_2$-e . The Project emissions (including all scopes) during this period is 0.19% of this carbon budget. Table 6-45 of the OPP summarises the acceptability of the Project in relation to GHG emissions.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Beach is unable to identify a specific comment within this statement that merits an amendment to the OPP the Offshore Project Proposal (OPP). Beach acknowledges the statements about First Nations' cultural heritage. Section 4.6 of the OPP describes the cultural values and sensitives of the environment, while Sections 6 and 7 of the OPP assess potential impacts and risks. Beach is unable to identify a specific comment within this statement that merits an amendment to the OPP.
PC211 Paragraph 18	Comment: The need to limit the global average temperature to below 1.5°C is reflected in the Paris Agreement ratified by Australia. In the Sharma case, the Federal Court of Australia relevantly made the finding (not disturbed on appeal[15]) that, if the carbon budget for 2°C or even 1.5°C is exceeded, it will lead to severe, irreversible, and potentially cascading climate change harm[16] [15] *See Minister for the Environment v Sharma [2022] FCFCA 35.* [16] *Sharma v Minister for Environment [2021] FCA 560 at [74]-[90], [249]. "[T]he risk of harm … from climatic hazards brought about by increased global average surface temperatures … is on a continuum in which both the degree of risk and magnitude of the potential harm will increase exponentially if the Earth moves beyond a global average surface temperature of 2°C, towards 3°C and then to 4°C above the pre-industrial level": Sharma v Minister for Environment [2021] FCA 560 at [75].*	Beach Energy (Operations) Limited (Beach) notes the statement regarding the Paris Agreement, the international agreement that aims to strengthen the global response to the threat of climate change. Beach also note that Article 2 of the Paris Agreement states that the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, includes "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change". Australia's commitment to the Paris Agreement is reflected in the *Climate Change Act 2022*, which describes these same goals, and informs matters such as the Safeguard Mechanism and Australia's Nationally Determined Contribution. <u>In response to this comment, Beach has reviewed sections 6.6.3.3.1 and 6.6.3.3.5 of the OPP and has amended these section to provide further clarity of the Paris Agreement and the International Energy Agency (IEA) World Energy Outlook.</u> Beach notes the references to the Sharma v Minister for Environment. Beach considers this is a general statement and does not relate Beach's obligations in respect of the OPP.
PC212 Paragraph 19	Comment: There is an emerging international consensus that it will be impossible to keep global average temperatures below 1.5°C without stopping the expansion of new fossil fuel development. The International Energy Agency has concluded that the scientifically credible pathway to limiting warming to 1.5°C – the goal of the	Beach Energy (Operations) Limited (Beach) notes the statement regarding the Paris Agreement, the Intergovernmental Panel on Climate Change (IPCC) and International Energy Agency (IEA). Section 6.6 of the Offshore Project Proposal assess the greenhouse gas emissions of the Otway Offshore Gas Victoria Project, in the context of various Australian and international instruments.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	Paris Agreement – requires that no new gas and oil fields be approved for development after 2021. The Intergovernmental Panel on Climate Change (IPCC), the leading international scientific authority on climate change, has recently made clear that even emissions from existing fossil fuel infrastructure will push the world beyond 1.5°C of warming, and that "[g]lobal warming is more likely than not to reach 1.5°C between 2021 and 2040 even under the very low GHG emission scenarios."[18] The IPCC report states: "Pathways consistent with 1.5°C and 2°C carbon budgets imply rapid, deep, and in most cases immediate GHG emission reductions in all sectors (high confidence)."[19] In that context, the United Nations Secretary-General has warned that "[i]nvesting in new fossil fuel infrastructure is moral and economic madness[20] [17] *International Energy Agency, 'Net Zero by 2050: A Roadmap for the Global Energy Sector – Summary for Policymakers' (May 2021), p. 11.* [18] *Hoesung Lee et al., Synthesis Report of the IPCC Sixth Assessment Report (AR6) (2023), p. 56 (Figure 3.5).* [19] *Hoesung Lee et al., Synthesis Report of the IPCC Sixth Assessment Report (AR6) (2023), p.46.* [20] *UN Secretary-General Antonio Guterres, 'Secretary-General Warns of Climate Emergency, Calling Intergovernmental Panel's Report 'a File of Shame', While Saying Leaders 'Are Lying', Fuelling Flames' (Media Release SG/SM/21228, 4 April 2022).*	Beach also notes the detail regarding Article 2 of the Paris Agreement as provided in the response to PC211. Beach is unable to identify a specific comment within this statement that merits an amendment to the Offshore Project Proposal.
PC213 Paragraph 20	Comment: There is no budget for new and expanded gas production. According to the United Nations Environment Programme (UNEP), in carbon budgets consistent with 1.5°C of warming, gas production must decline	Beach Energy (Operations) Limited (Beach) notes the statement regarding the global carbon budget. Section 6.6 of the Offshore Project Proposal assess the greenhouse gas emissions of the Otway Offshore Gas Victoria Project, in the context of various Australian and international instruments and global (see Table 6-39) and Australian carbon budgets.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	significantly after 2020. If gas production rises at all, it is inconsistent with limiting warming to even 2°C, let alone 1.5°C. Similarly, the IPCC finds that in carbon pathways consistent with a 50% chance of limiting warming to 1.5°C with no or limited overshoot, there is a major reduction in demand for fossil gas, with net zero emissions from the global energy sector required between 2033 and 2057.[21] [21] *IPCC Sixth Assessment Working Group III, Chapter 3, Section 3.4.2 (2022).*	Beach is unable to identify a specific comment within this statement that merits an amendment to the Offshore Project Proposal.
PC214 Paragraph 21	Comment: Figure 1 below shows a stark difference between countries' current plans/projections of GHG emissions (or even their production implied by current climate pledges), and reductions needed to limit warming to 1.5°C (the so-called "production gap"	Beach Energy (Operations) Limited (Beach) notes the comment about various countries greenhouse gas emissions. Beach is unable to identify a comment within this statement.
PC215 Paragraph 22	Comment: Current global commitments would produce a mid-range estimate of warming of 2.8°C by the end of the century[23], and there are increased risks of human and environmental harm in all warming scenarios. As the global temperature rises above 1.5°C, Australia has rapidly increasing likelihood of severe heatwaves, coral bleaching, bushfires, droughts, and other extreme events[24] [23] *United Nations Environment Programme., Emissions Gap Report 2022 (2022), p. iv.* [24] *A. King et al., 'Australian Climate Extremes at 1.5°C and 2°C of Global Warming' (2017) 7 Nature Climate Change 412. See also Australian Climate Council, 'Impacts at 1.5 and 2 Degrees of Warming', Resources (15 April 2023).*	Beach Energy (Operations) Limited (Beach) note the statement about global temperatures and extreme climate events. Section 6.6.3 and Appendix K of the OPP provides an analysis and evaluation of GHG emissions and climate change. Beach is unable to identify a comment within this statement that merits change to the OPP.
PC216 Paragraph 23	Comment: Given that immediate and deep emissions reductions are required to limit warming and avoid catastrophic impacts on Australia's people and	Beach Energy (Operations) Limited (Beach) recognises that action to address climate change is necessary and that all energy systems must contribute in order to meet the targets set out in the Paris Agreement. As an energy company, Beach must play a role in managing our carbon

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	environment, and the Project does not reduce current emissions but instead contributes at least 34.6 million tonnes of additional emissions, then it simply cannot follow that the Proposal is environmentally acceptable. The basic mathematics of carbon budgets cannot be ignored. Australia and Australian corporations are not exempt from the global obligation to reduce gas production in line with a 1.5°C compatible pathway	emissions. Beach has an equity emissions reduction target to reduce our Scope 1 and 2 emissions intensity by 35% by 2030. The emissions reduction is measured against a 2018 baseline, when Beach materially expanded its portfolio through the acquisition of Lattice Energy. This target is aligned with the Australian Government's Nationally Determined Contribution., a 2030 target of a 43% reduction in carbon emissions from a 2005 base, and falls within the envelope of pathways to limit warming to 2˚C. Section 6.6.3 and Appendix K includes an assessment of GHG emissions from the Project. The GHG emissions are presented throughout this section by source (Table 6-37), quantity (Table 6-38) and in relation to percent of global carbon budgets (Table 6-39). As described in the Introduction of this report, the GHG emissions for the Project are estimated to be 13.05 million tonnes CO_2-e. As part of the commitment to the Paris Agreement, Australia has an emissions budget for the 2021-2030 decade of 4,353 $MtCO_2$-e. The Project emissions (including all scopes) during this period is ~ 0.1% of this carbon budget. Beach has calculated the carbon budget for the period of the Project (2025 to 2049) of 6,729 $MtCO_2$-e . The Project emissions (including all scopes) during this period is 0.19% of this carbon budget. Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to this comment.
PC217 Paragraph 24	Comment: The Project could consume four times more of Australia's carbon budget than the OPP comments	Beach Energy (Operations) Limited (Beach) acknowledge the statement about the Otway Offshore Gas Victoria Project (the Project) and Australia's carbon budget. This is a general statement with specific comments about carbon budgets are addressed throughout this public comment report (see PC218 to 220).
PC218 Paragraph 25	Comment: According to Beach's calculations, the Project will emit over 34.6 million tonnes of carbon dioxide equivalent, or 0.531% of Australia's remaining carbon budget of 6,428 million tons CO2-e, consistent with keeping global average temperatures below 1.5°C.25 However, according to leading climate scientists Prof. Malte Meinshausen and Dr. Zebedee Nicholls, as of 2021,	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding emissions and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Section 6.6.3 and Appendix K includes an assessment of GHG emissions from the Project. The GHG emissions are presented throughout this section by source (Table 6-37), quantity (Table 6-38) and in relation to percent of global carbon budgets (Table 6-39). As described in the Introduction of this report, the GHG emissions for the Project are estimated to be 13.05 million tonnes CO_2-e.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	Australia's share of the remaining global carbon budget, for a 50% likelihood of staying below 1.5°C of warming, was only 4,010 million tons CO2-e as of January 2021, and was being depleted at an average rate of 609 million tonnes CO2-e per year (over the previous seven years).26 Assuming the same emissions rate going forward, by January 2025, Australia's carbon budget would have been reduced by 2,430 million tonnes to 1,580 million tonnes CO2-e. Thus the Project would comprise over 2% of Australia's budget remaining in 2025 [25] *OPP, p. 394-395.* [26] *M. Meinshausen and Z. Nicholls, 'Updated assessment of Australia's emission reduction targets and 1.5°C pathways', Climate Resource (June 2023), p. 11 (calculating that Australia's emissions were 4,260 million tons between 2013 and 2020, or an average of 609 million tons per year over 7 years; 609 million tons x 4 years of 2021, 2022, 2023, and 2024 = 2,430 million tons to subtract from the budget; 4,010 million tons as of January 2021 – 2430 million tons emitted between 2021 through 2024 = 1580 million tons remaining as of January 2025. 34.6 million tons is 2.19% of 1,580 million tons.)*	The Australian carbon budget over the period of the Project (2025 to 2049) was calculated to be 6,729 MtCO$_2$e. The total direct and indirect GHG emissions from the Project are estimated to be approximately 0.19% of the Australian carbon budget. We note the typographical error of 6428 MtCO$_2$-e stated in the previous revision of the OPP published for public comment.
PC219 Paragraph 26	Comment: Beach Energy irresponsibly suggests that "discernible impact on GHG concentrations in the atmosphere" is the benchmark by which this Project should be evaluated.[27] While we disagree that this should be a benchmark, 2% of Australia's carbon budget is not only "discernible", but it is a significant percentage that can and must be avoided by reducing gas production, use, and export in Australia [27] *OPP, p. 395.*	Beach Energy Operations (Limited) (Beach) acknowledges comments regarding emissions and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. The greenhouse gas (GHG) emissions for the Project are assessed in Section 6.6 and Appendix K of the OPP. Subsequent to the revision of the scope of activities proposed in the OPP, the GHG emissions report for the Project and section 6.6 of the OPP were revised. As described in the Introduction of this report, the GHG emissions for the Project are estimated to be 13.05 million tonnes CO$_2$-e.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		As part of the commitment to the Paris Agreement, Australia has an emissions budget for the 2021-2030 decade of 4,353 $MtCO_2$-e. The Project emissions (including all scopes) during this period is ~ 0.1% of this carbon budget. Beach has calculated the carbon budget for the period of the Project (2025 to 2049) of 6,729 $MtCO_2$-e . The Project emissions (including all scopes) during this period is 0.19% of this carbon budget. Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to this comment.
PC220 Paragraph 27	Comment: Beach comments that it has an "equity emissions reduction target" to reduce Scope 1 and 2 emissions intensity by 35% by 2030. This means that it will reduce emissions only in accordance with its "share of equity in the operation."[28] This is essentially window dressing and relatively insignificant from a climate perspective. Scope 1 and 2 emissions are only 13% of this Project's emissions, and the emissions from the Project may not be reduced at all. Instead, Beach uses a net zero approach that promises emissions reduction only from the Moomba Carbon Capture and Storage Project, which has yet to prove its viability[29] [28] *Beach Energy, Reducing Emissions (Web Page, 2024).* [29] *Beach Energy, Reducing Emissions (Web Page, 2024).*	Beach Energy (Operations) Limited (Beach) has an equity emissions reduction target to reduce our Scope 1 and 2 emissions intensity by 35% by 2030. The emissions reduction is measured against a 2018 baseline, when Beach materially expanded its portfolio through the acquisition of Lattice Energy. This target is aligned with the Australian Government's target of a 43% reduction in carbon emissions from a 2005 base, and falls within the envelope of pathways to limit warming to 2˚C. Beach Energy (Operations) Limited acknowledge the importance of emissions abatement measures in ensuring that energy is supplied to meet the needs of society, while reducing emissions intensity. Beach is doing its share to reduce its emissions whilst supporting the orderly transition to a lower emissions energy sector. We are reducing the carbon emissions from natural gas production through carbon capture and storage and continued pursuit of emissions abatement projects at our existing facilities. We are proud of our investment in the Moomba Caron Capture Storge (CCS) project, operated by our joint venture partner Santos. Constructed adjacent to the Moomba Gas Plant in the Cooper Basin, the project is one of the world's largest CCS projects and will deliver a material greenhouse gas reduction for Beach's portfolio. Upon its completion, Moomba CCS will safely store up to 1.7 million tonnes per annum of carbon emissions in the depleted reservoirs near the Moomba Gas Plant. (FY23 Sustainability Report, CTAP). Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to this comment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC221 Paragraph 28	Comment: The Project will require a substantial infrastructure buildout and drive the expansion of fossil fuel production	Beach Energy (Operations) Limited (Beach) acknowledge the statement summarising the Otway Offshore Gas Victoria Project (the Project). The Project considers the subsea development of gas fields adjacent by utilising the existing gas infrastructure in the Otway Basin. This is a general statement with specific comments addressed in this public comment report (see PC222 to 223).
PC222 Paragraph 29	Comment: Beach appears to downplay the new fossil fuel infrastructure required for the Project, instead emphasising that it will utilise existing infrastructure.[30] However, the Project will lead to a substantial infrastructure buildout in the region as it includes, among other things, "tie-backs", including flowlines, umbilicals, and other subsea infrastructure, connecting up to 17 wells with existing infrastructure. [31] In addition, it could also necessitate a new gas pipeline to replace the ageing Otway Gas Pipeline, which is nearly 20 years old[32]. There is considerable data to show that offshore gas pipelines decline after 20 years, and the risk of pipeline failure steadily increases with age[33]; the recommended lifetime is no more than 40 years [30] *See for example OPP, pp. 39, 72.* [31] *OPP, pp. 72-73.* [32] *Since the plant started processing natural gas piped from the Geographe and Thylacine offshore production wells in 2006, it is assumed the pipeline began operating prior to 2006: see Beach, Otway Basin Victoria (Web Page, 2024).* [33] *See U.S. Department of Transportation, Pipelines and Hazardous Materials Safety Administration, Pipeline Replacement Background (8 April 2024).*	The Otway Offshore Gas Victoria Project is the development of gas resources in the Otway Basin utilising existing infrastructure at the Thylacine platform and Otway gas pipeline (offshore) as well as existing onshore pipelines and the Otway gas plant. The development of gas fields will require new subsea flowlines and umbilicals to existing infrastructure. The OPP for the Otway OGV Project does not include the construction or operation of a new gas pipeline. The ongoing operation and maintenance of the Otway Gas Pipeline is managed in the relevant pipeline Safety Case, and the potential environmental impacts and risks are assessed in the five-yearly reviews of the accepted Environment Plan as required under the relevant Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations and Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations, respectively. The Otway pipeline is maintained and inspected on a regular basis to ensure the pipeline integrity. The Otway pipeline has a design life of 35 years and if an extension to the operating life is required, the appropriate approvals to demonstrate the pipeline integrity will be undertaken. No change is made to the OPP in response to this comment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC223 Paragraph 30	Comment: It would be inconceivable for Beach to continue to use the Otway Gas Pipeline for another 34 or so years, as proposed. Decommissioned pipelines would generally need to be replaced with new lines, rather than repurposed. As such, Beach must address and evaluate the potential environmental and health impacts of both continuing to use an aging pipeline and constructing a new pipeline	The Otway Offshore Gas Victoria Project is the development of gas resources in the Otway Basin utilising existing infrastructure at the Thylacine platform and Otway gas pipeline (offshore) as well as existing onshore pipelines and the Otway gas plant. The development of gas fields will require new subsea flowlines and umbilicals to existing infrastructure. The OPP for the Otway OGV Project does not include the construction or operation of a new gas pipeline. The ongoing operation and maintenance of the Otway Gas Pipeline is managed in the relevant pipeline Safety Case, and the potential environmental impacts and risks are assessed in the five-yearly reviews of the accepted Environment Plan as required under the relevant Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations and Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations, respectively. The Otway pipeline is maintained and inspected on a regular basis to ensure the pipeline integrity. The Otway pipeline has a design life of 35 years and if an extension to the operating life is required, the appropriate approvals to demonstrate the pipeline integrity will be undertaken. No change is made to the OPP in response to this comment.
PC224 Paragraph 31	Comment: The Project poses significant risk of harm to culturally important marine species	This is general statement with specific comments summarised and addressed in PC225.
PC225 Paragraph 32	Comment: The Gunditjmara people are closely connected with many coastal and marine species that may be affected by the Project. Several species in Nyamat Mirring serve as an ongoing source of food and hold strong cultural value for Gunditjmara. Special dreaming stories, ceremonies, and traditional livelihood practices are associated with important species including Karntubul (Whales), Kooyang (Eels), and Koorn Moorn (Seals).[34] As traditional custodians of Nyamat Mirring, Gunditjmara are concerned by direct impacts from the proposed Project on threatened species, as well as indirect impacts from its contribution to climate change	The cultural values and sensitivities of First Nations groups is reviewed in section 4.6 of the OPP. The Offshore Project Proposal (OPP) provides for the consideration of whole-of-project environmental impacts and risks. The OPP requires details and evaluation of the environmental impacts and risks of the project appropriate to the nature and scale of each impact or risk. An assessment of risks and impacts of planned and unplanned events is provided in section 6 and 7 of the Offshore Project Proposal (OPP). Section 4.6.3.2 of the OPP has been updated to include the Gunditjmara Sea Country Plan - The Gunditjmara published their Sea Country Plan, Gunditjmara Nyamat Mirring Plan 2023-2033, on 13 March 2024 (GMTOAC 2023). This plan details Gunditjmara's values and species of cultural significance in the Sea Country. See also additional changes to the OPP in response to PC274 and PC230

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	[34] *Gunditjmara Nyamat Mirring Plan, pp. 18-9.*	
PC226 Paragraph 33	Comment: The OPP identifies species with biologically important areas (BIAs) that overlap with the Project Area: 10 birds, one fish (White Shark), and two cetaceans (Pygmy Blue Whale and Southern Right Whale).[35] The Southern Right Whale, an endangered[36] and migratory species, has a biologically important migration route through the Project Area. The Pygmy Blue Whale, also an endangered and migratory species (as a subspecies of the Blue Whale), has annual high-use foraging BIAs that are "known to occur" within both the Project Area and Planning Area[37] [35] *See OPP, p. 55 (Table 6). BIAs are defined as "spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration": OPP, p. 54.* [36] *"Endangered" means that the species is facing a "very high risk of extinction in the wild in the near future": Environment Protection and Biodiversity Conservation Act 1999 (Cth), s 179(4).* [37] *OPP, p. 55 (Table 6).*	Beach Energy (Operations) Limited (Beach) acknowledges the comment regarding the presence of Biologically Important Areas (BIAs) in the Project and Planning Area and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. The BIAs mentioned in this comment have been identified in each respective species section of the Description of the Environment (Section 4). Impacts and risk to threatened and migratory species are thoroughly assessed throughout the OPP in Sections 6 and 7. BIAs for species are taken into consideration and inform the assessment of impact and risk. Environmental Performance Outcomes (EPOs) and control measures ensure that these impacts and risks are of an acceptable level. As the comment does not contain new information, no change to the OPP is made in response to this comment.
PC227 Paragraph 34	Comment: The Protected Matters Search Tool (PMST) has a significantly longer list of protected species, including critically endangered, endangered, vulnerable, and migratory species, which are known to occur or likely to occur in the Project and/or Planning Area[38] [38] *OPP, Appendix A (PMST Report for the Project Area); Appendix B (PMST Report for the Planning Area).*	Beach Energy (Operations) Limited (Beach) acknowledges the comment regarding the inclusion of protected species and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. The OPP Description of Environment (Section 4) includes all species with an *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) listing those that have a presence in the Project or Planning Area, as identified in the Protected Matters Search Tool (PMST) Report. As described in Section 4.4.9. (Threatened and Migratory Species), species listed as threatened or migratory under the EPBC Act and known or likely to occur in the Project or Planning Areas and/or

ID	Summary of comments received	Beach’s assessment of merit of comment(s) and response(s) to comments and/or objections
		have an intercepting Biologically Important Areas (BIAs) with the Project or Planning Areas are discussed in more detail. The description of environment is the basis for the impact and risk assessment. Species with higher status of protection, or those engaging in biologically important behaviours, are assessed in the greatest detail to account for nature and scale of impacts. The PMST tool detects all EPBC Act listed species with an occurrence in the area. Due to the grid sizes used in the PMST search tool, species outside of the actual input area can be detected, including terrestrial species. Species that only occur in terrestrial habitat are not included in the OPP as they do not have potential to be impacted by the activities. Terrestrial/ freshwater species that appear in the PMST and were not included in the OPP are: • Giant Freshwater Crayfish/ Tasmanian Giant Freshwater Lobster • Glenelg Spiny Freshwater Crayfish/ Pricklyback • Green and Golden Bell Frog • Growling Grass Frog • Insects • Swamp Atechinus (mainland) • Spot-tailed Quoll (SE mainland and Tasmanian populations) • Southern Brown Bandicoot • Eastern Barred Bandicoot • Broad-toothed Rat (mainland) • Southern Bent-wing Bat (mainland and Tasmanian populations) • Greater Glider (southern and central) • Yellow-bellied Glider (south-eastern) • Long-nosed Potoroo • Smoky Mouse • New Holland Mouse • Heath Mouse • Grey-headed Flying-fox • Tasmanian Devil • Striped Legless Lizard

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		- Swamp Skink These species occur in terrestrial habitat or freshwater only and do not have the potential to be impacted by activities associated with the Project (DCCEEW, 2024a). As such they have not been included in the OPP. Other species that appeared in the PMST and were not included in the OPP: - Southern Bluefin Tuna (Conservation Dependent, species or species habitat likely to occur within the Project Area and Planning Area). The Southern Bluefin Tuna had been included in the list of commercial fisheries as a target species, however, was missing from the section on fish within the Project and Planning Area. The OPP has been updated to include the Southern Bluefin Tuna in Section 4.4.9.7- Fish. *References* *DCCEEW. (2024a) Species Profile and Threats Database- SPRAT Profile. Department of Climate Change, Energy, the Environment and Water. Accessed May 2024 at: https://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.*
PC228 Paragraph 35	Comment: Notably, the PMST Report indicates that the critically endangered Orange-bellied Parrott is likely to have a migration route within the Project Area. "Critically endangered" species warrant protection under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act), as these species are at "extremely high risk of extinction in the wild in the immediate future."[39] Even impacts on purportedly low numbers of those species (such as light impacts, discussed below) could be significant and should not be disregarded. [39] *Environment Protection and Biodiversity Conservation Act 1999 (Cth), s 179(3) (emphasis added).*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding the Orange-bellied parrot and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. The Orange-bellied parrot is listed in Table 4-22 and described in detail in Section 4.4.9.4.4, including details of probable migration behaviour within the Project and Planning Areas (see Figure 4-42). Potential impacts to Orange-bellied parrots from light emissions are identified and assessed in Section 6.3.3.2.5 with migration route likely to occur with the light EMBAs (Table 6-12 and Figure 6-4). The control measures associated with industry best practice are considered appropriate to ensure the environmental impacts relating to light emissions from vessels and the Mobile Offshore Drilling Unit (MODU) and at acceptable levels. These control/mitigation measures are provided in Table 6-15. Beach has taken into consideration the National Light Pollution Guidelines for Wildlife (DCCEEW 2023). These guidelines recommend using Best Practice Lighting Design and undertaking an environmental risk assessment (i.e. the impact and risk assessment within the OPP)

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		where there is important habitat within light EMBAs. In addition, Beach has committed to the development of a Light Management Plan that will assist in managing environmental impacts and risks of light emissions to acceptable levels and is legally required to be completed prior to commencement of activity. Beach will contract a suitably qualified specialist to develop and support the implementation of the Plan as per the National Light Pollution Guidelines for Wildlife (DCCEEW 2023). The National Recovery Plan for the Orange-bellied parrot (DELWP 2016) identifies that the behaviour of this species may be modified by the presence of barriers such illuminated structure and boats, with the impacts of barriers greatest where they occur on migration routes, though there is little more than anecdotal evidence to support this. The Project Area, as detailed in Section 3.5 (Project Area Definition), overlaps an area of probably migration by <0.01 per cent and as such, the activities of the MODU and vessels when undertaking the petroleum activity do not present the same barrier risk as that associated with illuminated structures or illuminated boats within the migration route. The light and flaring EMBA overlaps the probable migration route of the orange-bellied parrot by 2.2% and 8.6%, respectively. Impacts associated with flaring, which will not occur within the migration route but rather may change ambient light in the area, will be temporary and of short duration. Therefore, a change in ambient light is unlikely to cause behavioural changes or result in injury/mortality to the Orange-bellied parrot. Project activities, as detailed in Section 3 (Description of the Project and Alternatives Analysis) involve seabed surveys through to decommissioning of wells and infrastructure installed as part of the Project. These activities will involve the use of either a semi-submersible or jack-up MODU and appropriate support vessels. The presence of the MODU and support vessels will be short term and temporary as detailed in Section 3.8 (Description of Activities) and will not be permanently present over the 30-year life of the Project as commented. Successfully drilled wells will be tied back to existing infrastructure, which may include the existing, normally unmanned, Thylacine A platform. The Thylacine A platform is situated ~33 km from an area of probably migration according to DELWP (2016). This is greater than the 20 km threshold to undertake an environmental risk assessment (as detailed within the National Light Pollution Guidelines (DCCEEW 2023)) with a change of ambient light in the area of probably migration not expected. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments, however <u>references to the National Light</u>

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Pollution Guidelines for Wildlife (DCCEEW 2023) have been amended throughout to ensure the correct revision is referenced. *References:* *DELWP (2016). National Recovery Plan for the Orange-bellied Parrot, Neophema chrysogaster. Department of Environment, Land, Water and Planning, Canberra.* *DCCEEW 2023, National Light Pollution Guidelines for Wildlife, Department of Climate Change, Energy, the Environment and Water, Canberra, May. CC BY 4.0*
PC229 Paragraph 36	Comment: In addition to the Blue Whale and Southern Right Whale, several other endangered species are also likely or known to occur in the Project Area, including the Northern Royal Albatross; Southern Giant Petrel; Shy Albatross; Loggerhead Turtle; and Leatherback Turtle.[40] As these species have habitat in the Project Area, they are susceptible to impacts from noise pollution, light pollution, and vessel traffic related to Project activities such as drilling, production operations, and subsea installation (discussed below) [40] *OPP, Appendix A (PMST Report for the Project Area).*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding the presence of endangered species and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. All species listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) that may be impacted by activities associated with the Project have been assessed in the OPP. These species are determined through a Protected Matters Search Tool (PMST) Report for each relevant area. As the PMST is run on large grid sizes, determination of the likelihood of species occurring in relevant areas is also supported by peer reviewed scientific literature and/or management plans. The Northern Royal Albatross, Southern Giant Petrel and Shy Albatross are identified as light sensitive species in the OPP, as described in Section 6.3.3 and Table 6-12 (Emissions- Light, Impact Analysis and Evaluation). This accurately reflects the PMST search for light EMBAs (Appendix E). Seabirds (including the Northern Royal Albatross, Southern Giant Petrel and Shy Albatross) are not assessed for underwater sound or vessel interaction in the OPP as they are not vulnerable to these aspects. Noise emitted to air dissipates rapidly and is not a concern due to the distance offshore (Section 6.4.1 Hazard Description, Emissions- Underwater Sound). The National Recovery Plan for Albatrosses and Petrels (2022) (CoA, 2022) identifies light emissions as a threat, though classifies marine infrastructure interactions including those associated with artificial light as having no risk category priority and affecting 'Nil' species in Australian jurisdiction (Section 6.3.3.1.2). Receptors that may be impacted underwater sound and vessel interaction are described in Section 6.4 (Emissions- Underwater Sound) and Section 7.2 (Physical Presence- Interaction with Marine Fauna).

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Impacts to marine reptiles from underwater sound, light and vessel interactions associated with the Project have been assessed in the OPP. The PMST Reports identified three marine turtle species with potential to occur in the Project Area and/or Planning Area (Table 4-23, Section 4.4.9 – Threatened and Migratory Species). The Leatherback and Loggerhead turtles are 'likely' to occur within the project area and the Green Turtle 'may occur' within the Project Area (Table 4-23, Section 4.4.9-Threatened and Migratory Species). The PMST tool uses large grid sizes in offshore waters and hence peer reviewed scientific information and management plans are used to verify the presence of species. Risk of interaction with marine fauna (vessel strike) associated with the Project is assessed in Section 7.2 (Physical Presence – Interaction with Marine Fauna). The impact assessment described the likely presence of turtles as 'remote'. Section 7.2.3.2 (Physical Presence – Interaction with Marine Fauna, Potential Impacts) has been updated to include further explanation of the presence of turtles in the Project Area: 'The presence of turtles in the Project Area and surrounds is considered unlikely, based on the following information provided in Section 4.4.9.5: • Green Turtles are predominantly found in Australian waters off the Northern Territory, Queensland, and Western Australian coastlines, with limited numbers in New South Wales, Victoria, and South Australia. There are no known nesting or foraging grounds for Green Turtles offshore Victoria; they occur only rarely in these waters (DoE 2023m) (Section 4.4.9.5.1). • This species (Leatherback Turtle) is an occasional visitor to the Otway shelf and has been sighted on a number of occasions during aerial surveys undertaken by the Blue Whale Study Group, particularly to the southwest of Cape Otway (CoA 2017a). (Section 4.4.9.5.2). • Loggerhead Turtles forage in all coastal states and the Northern Territory, but are uncommon in South Australia, Victoria, and Tasmania (CoA 2017a). Due to water depths, it is unlikely Loggerhead Turtle would be present in the Project Area but may be occasional visitors to the Planning Area (Section 4.4.9.5.3 Loggerhead Turtle).' Impacts to turtles from underwater sound associated with the Project are assessed in Section 6.4 (Emissions- Underwater Sound). The furthest distance to noise effect criteria for turtles is 3.9 km (behavioural), within the Project Area. As such, the predicted occurrence of turtle species that may be impacted by noise is based on the PMST search for the Project Area, supported by peer reviewed literature.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Section 6.4.3.2.2 (Emissions- Underwater Sound, Marine Turtles) has been updated to provide further explanation of the presence of turtle species: Three marine turtle species are 'known' or 'likely' to occur within the Project Area based on the PMST search, however no BIAs or habitat critical to the survival of the species are present. The PMST presence for the Loggerhead Turtle is classified as 'breeding likely to occur'. The presence of turtles in the Project Area and surrounds is considered unlikely, based on the following information provided in Section 4.4.9.5: • Green Turtles are predominantly found in Australian waters off the Northern Territory, Queensland, and Western Australian coastlines, with limited numbers in New South Wales, Victoria, and South Australia. There are no known nesting or foraging grounds for Green Turtles offshore Victoria; they occur only rarely in these waters (DoE 2023m) (Section 4.4.9.5.1). • This species (Leatherback Turtle) is an occasional visitor to the Otway shelf and has been sighted on a number of occasions during aerial surveys undertaken by the Blue Whale Study Group, particularly to the southwest of Cape Otway (Section 4.4.9.5.2). • Loggerhead Turtles forage in all coastal states and the Northern Territory, but are uncommon in South Australia, Victoria, and Tasmania (CoA 2017a). Due to water depths, it is unlikely Loggerhead Turtle would be present in the Project Area but may be occasional visitors to the Planning Area (Section 4.4.9.5.3 Loggerhead Turtle).' Impacts to turtles from light emissions associated with the Project are assessed in Section 6.3 (Emissions- Light). Section 6.3.3 (Light Emissions- Impact Analysis and Evaluation) states 'Although listed turtle species may occur within the routine light and flaring EMBAs, no biologically important behaviours, BIAs, or habitat critical to survival for marine turtles were identified (Appendix E)'. Section 6.3.3.1.3 (Light Emissions- Impact Analysis and Evaluation) has been updated to include the presence of loggerhead turtle as 'breeding likely to occur;' within the light EMBAs: 'The PMST identified that the loggerhead turtle has a presence of 'breeding likely to occur'. Although the PMST presence indicates potential breeding, there are no designated BIAs overlapping the Light EMBAs and the main Australian breeding areas are generally confined to southern Queensland and Western Australia (Cogger et al. 1993). Loggerhead turtles show a strong fidelity to their breeding areas (Limpus 2008). They forage in all coastal states, though are uncommon in Victoria and hence are expected to be occasional visitors in the Light EMBA (CoA 2017a). Species or habitat is 'known to occur' for the leatherback turtle and 'may occur' for the

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		green turtle within the light EMBAs (OPP Appendix E: Protected Matters Report for the Light EMBAs). No designated BIAs, or habitat critical to survival for marine turtles were identified (Appendix E). Consequently, population level impacts to marine turtles from routine light and flaring emissions are not predicted to occur. The consequence severity of light and flaring impacts for marine reptiles is assessed as Minor based on: • Artificial light is listed as a key threat in the Recovery Plan for Marine Turtles in Australia (CoA 2017), however, no BIAs, or habitat critical to survival for marine turtles were identified within the light or flaring EMBAs. • All turtle species are expected to be occasional visitors to the light EMBAs.' Beach has reviewed the OPP and is satisfied that impacts and risks to species have been adequately addressed. The sections described above have been updated to accurately reflect the determination of likelihood of turtle species.
PC230 Paragraph 37	Comment: The Gunditjmara people maintain a strong spiritual connection with all species of whales that travel through Gunditjmara Country; "[p]rotection of this species is paramount to Gunditjmara spiritual, physical wellbeing."[41] As mentioned, there are two endangered and migratory whale species with BIAs in the Project Area: the Southern Right Whale and Pygmy Blue Whale. The Blue Whale's annual high-use foraging BIA along the southern coast of Australia, which directly overlaps with the entire Project Area, appears to be the largest high-use foraging zone for Blue Whales in/near Australia by far;[42] it is an extremely unique and vital foraging area for these endangered whale species in Australian waters. The majority of that special zone also overlaps with the proposed Planning Area[43] [41] *Gunditjmara Nyamat Mirring Plan, p. 19.* [42] *OPP, p. 240 (Figure 53).*	Beach Energy (Operations) Limited (Beach) acknowledges the comment regarding the cultural significance of whales and protection of their Biologically Important Areas (BIAs) and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach acknowledges the Gunditjmara people maintain a strong spiritual connection with all species of whales that travel through Gunditjmara Country. The OPP currently includes a description of sea country values, including whales (Section 4.6.3.4 Sea Country Values-Resources- Whales). Beach has revised the provided reference and the following text has been added to the Section 4.6.3.4: 'Karntubul (Whales) have featured in dreaming stories, ceremony, song and dance of Gunditjmara people for millennia. Gunditjmara maintain a strong spiritual connection to all species of whales that travel through Gunditjmara country (GMTOAC RNTBC, 2023). Karntabul yarkeen (whale dreaming) stories connect Aboriginal groups all along the coasts of Australia, neighbouring groups in Victoria, including Gunditjmara, still gather today to strengthen the connection of groups to whales and their stories. The arrival of Karntabul in Gunditjmara waters also signifies the beginning of the 'big wet' season (May-Oct), 1 of 6 Gunditjmara seasons. Whales are also a food source, in traditional times, tribes would send up smoke signals and gather when whales got

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	[43] *OPP, p. 238 (Figure 52).*	beached. Protection of whales is paramount to Gunditjmara spiritual, physical wellbeing (GMTOAC RNTBC, 2023).' Impacts and risks to Southern Right Whales and Pygmy Blue Whale BIAs have been assessed in detail throughout the OPP • Section 6.4 Emissions – Underwater Sound • Section 6.7 Planned Discharge – Drill Cuttings and Fluids • Section 6.8 Planned Discharge – Cement • Section 6.9 Planned Discharge – Commissioning and Operational Fluids • Section 6.10 Planned Discharge – Routine Operational Wastes from Vessels • Section 7.2 Physical Presence – Interaction with Marine Fauna • Section 7.3 Accidental Discharge – Hazardous and Non-Hazardous Material • Section 7.4 Loss of Containment – Hydrocarbons and Chemicals • Section 8- Cumulative Impact Assessment). BIAs for these species that overlap the Project Area and Planning Area are identified in the OPP (Table 4-19) and included in the assessment of impacts and risks. Cultural values and sensitivities that are identified as potentially being affected by activities associated with the Project have been identified in each impact and risk assessment section. Beach has considered this comment and included additional information to OPP Section 4.6.3.4 (Sea Country Values- Resources- Whales**)** as described above. Beach is satisfied that impacts and risks to whales have been adequately assessed. *References* *Gunditj Mirring Traditional Owners Aboriginal Corporation RNTBC. 2023. Gunditjmara Nyamat Mirring Plan 2023-2033. Report prepared by Helen Arundel.*
PC231 Paragraph 38	Comment: The Planning Area also intersects with Bonney Coast Upwelling in Nyamat Mirring, which provides critical sustenance for Blue Whales and many culturally significant species.[44] This upwelling is a Key Ecological Feature, "considered to be of regional importance for either the region's biodiversity or ecosystem function and integrity	Beach Energy (Operations) Limited (Beach) acknowledges the statement regarding the Bonney Coast Upwelling Key Ecological Feature (KEF) and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these statements. As mentioned in this comment, the ecological values of the Bonney Coast Upwelling KEF are described in Section 4.2.12.1 (Conservation Values and Sensitivities- Bonney Coast Upwelling) and Section 4.3.8 (Physical Environment- Bonney Coast Upwelling).

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	of a Commonwealth Marine Area."[45] It brings a seasonal upwelling of nutrient-rich water to the sea surface and supports high productivity and species diversity, and hosts foraging areas for whales.[46] The OPP provides detailed factual background on the ecological importance of the Bonney Coast Upwelling; it is noted as "one of 12 known Blue Whale feeding aggregation areas globally." [47] The OPP notes that Pygmy Blue Whales have foraging BIAs which are "associated with the timing of the Bonney Coast Upwelling and the presence of the kril[48] [44] Gunditjmara Nyamat Mirring Plan, p. 19. [45] *OPP, p. 145.* [46] *OPP, p. 146.* [47] *OPP, p. 364.* [48] *OPP, p. 364.*	No amendments to the OPP are required in response to this statement.
PC232 Paragraph 39	Comment: However, despite the recognised ecological significance, Beach fails to fully review the potential impacts of the Project on the Bonney Coast Upwelling and related ecosystem effects, including on Blue Whale species. The only discussion of impacts on this upwelling in the OPP concerns noise emissions. Direct impacts on whales from noise pollution from the Project are considered below. In relation to impacts on zooplankton, the OPP contends that even if noise from geophysical surveys causes mortality or mortal injury effects on zooplankton, that "does not impact on pygmy blue whales being able to feed on them as the krill will still be available within the water column."[49] This is an illogical argument. It does not consider how increasing mortality or mortal injury could lead to a decline in the population of	Beach Energy (Operations) Limited (Beach) acknowledges the comment regarding the Bonney Coast Upwelling Key Ecological Feature (KEF) and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. The ecological values of the Bonney Coast Upwelling KEF are described in Section 4.2.12.1 (Conservation Values and Sensitivities- Bonney Coast Upwelling) and Section 4.3.8 (Physical Environment- Bonney Coast Upwelling). The Bonney Coast upwelling is defined as a key ecological feature as it is an area of enhanced pelagic productivity and has high aggregations of marine life (DCCEEW 2023a). In addition to whales, many endangered and listed species frequent the area, possibly also relying on the abundance of krill that provide a food source to many seabirds and fish. The high productivity of the Bonney Coast upwelling is also capitalised on by other higher predator species such as little penguins and Australian fur-seals feeding on baitfish (CoA 2015c) (OPP Section 4.2.13.1 (Conservation Values and Sensitivities- Bonney Coast Upwelling)). Beach has reviewed the assessment of impacts to plankton from impulsive noise associated with the Project. Impacts of underwater acoustic emissions on plankton, associated with the geophysical survey and vertical seismic profiling (VSP) have been assessed in Section 6.4.3.2. The

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	zooplankton, which will in turn affect the foraging habits of whale species. [49] *OPP, p. 364*	effect criteria for injury to plankton for the boomer was predicted at a maximum distance of 4 m and 0.8 m for the sub-bottom profiler (SBP) for the peak sound pressure level (PK) while the noise effect criteria based on the sound exposure level (SEL) was not reached. Neither noise effect criteria were reached for VSP. This extent does not overlap the Bonney Coast Upwelling, however, does overlap pygmy blue whale (PBW) high density, known and possible foraging Biologically Important Areas (BIAs). PBW foraging is associated with the timing of the Bonney Coast Upwelling and the presence of krill, hence it is assessed. Section 6.4.3.2.1 (Impulsive Noise Sources- Plankton) comprehensively assesses potential impacts to plankton from impulsive noise, as summarised: Impacts to the Bonney Coast Upwelling and its role it plays in ecosystem function and productivity is not predicted as: • Impacts to phytoplankton are not predicted • Mortality or mortal injury effects to zooplankton are within natural mortality rates and zooplankton communities can begin to recover during the geophysical survey such that a continuous decline in zooplankton throughout the duration of the survey is not anticipated and parts of the survey area would be replenished as the survey progressed • Mortality or mortal injury effects to zooplankton, including krill, does not impact on marine fauna being able to feed on them as they will still be available within the water column. Section 6.4.3.2.1 (Impulsive Noise Sources- Plankton) has been updated to provide further description and references for effects to zooplankton: "Mortality or mortal injury effects to krill does not impact on pygmy blue whales being able to feed on them as they will still be available within the water column. If zooplankton are impacted, they may remain in the water column for several days and are likely scavenged or otherwise sink to the seafloor to be consumed by benthic organisms (Krillin et. al. 2012, Tang et al. 2014, Dubovskaya et al. 2015).' Impacts to blue whale foraging from continuous noise is described in Section 6.4.3.3.3 (Continuous Noise Sources- Marine mammals). The impact assessment describes that the largest sound EMBA is ~50 km from the Bonney Coast Upwelling KEF, which is a known feeding aggregation area (Gill et al. 2011; McCauley et al. 2018). The sound EMBAs are within an area where the occurrence of an upwelling event between 2002 and 2016 was assessed as very unlikely with an upwelling frequency of <10 per cent (Huang and Wang 2019). Thus, blue whale foraging is likely to be opportunistic within the sound EMBAs.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Controls have been implemented to ensure that any impacts to blue whales and their biologically important behaviours are mitigated and reduced to acceptable levels. These include whale management procedures and noise assessments (Table 6-30). The Bonney Coast Upwelling intersects the Planning Area and has been assessed for the risk of an accidental large-scale release of hydrocarbons or chemicals (Section 7.4 Loss of Containment – Hydrocarbons and impact Chemicals). The Bonney Coast Upwelling is predicted to be exposed at the Low threshold of in water hydrocarbons (moderate reached for dissolved in-water exposure only). This is identified in Section 7.4.2.3 (Loss of Well Control at Release Location North- Potential extent of in-water dissolved hydrocarbon exposure). The Bonney Coast Upwelling KEF may be exposed to entrained hydrocarbons at low thresholds within the upper 0-10 m water column with no impacts predicted (see Table 7-22 and 7-25). The Bonney Coast Upwelling KEF does not intersect with the Project Area or light EMBAs hence has not been assessed for any other impacts or risks within these extents. Beach has considered these comments and updates have been made to the OPP as outlined above. *References* *CoA (2015c). South-east Marine Region Profile: A description of the ecosystems, conservation values and uses of the South-east Marine Region. Commonwealth of Australia.* *DCCEEW. (2023a) Species Profile and Threats Database: Bonney coast upwelling. Department of Climate Change, Energy, the Environment and Water. Accessed August 2023 at:* https://www.environment.gov.au/sprat-public/action/kef/view/89;jsessionid=01AD87551D0DE1B0248C8722BE137004 *Dubovskaya, O.P., Tang, K.W., Gladyshev, M.I., Kirillin, G., Buseva, Z., et al. (2015). Estimating In Situ Zooplankton Non-Predation Mortality in an Oligo-Mesotrophic Lake from Sediment Trap Data: Caveats and Reality Check. PLOS ONE Volume 10, Issue 7. https://doi.org/10.1371/journal.pone.0131431* *Gill, P. C., Morrice, M. G., Page, B., Pirzl, R., Levings, A. H., & Coyne, M. (2011). Blue whale habitat selection and within-season distribution in a regional upwelling system off southern Australia. Marine Ecology Progress Series, 421. 243–263. Retrieved from* http://www.intres.com/articles/meps_oa/m421p243.pdf.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Huang Z. and Wang X.H. (2019). Mapping the spatial and temporal variability of the upwelling systems of the Australian south-eastern coast using 14-year of MODIS data, Remote Sensing of Environment. Volume 227, 2019, Pages 90-109, ISSN 0034-4257. *Kirillin G., Grossart H-P., Tang K. W. (2012). Modeling sinking rate of zooplankton carcasses: effects of stratification and mixing, Limnol. Oceanogr., Volume 57, Pages 881-894.* *McCauley, R.D., A.N. Gavrilov, C.D. Jolliffe, R. Ward, and P.C. Gill. 2018. Pygmy blue and Antarctic blue whale presence, distribution and population parameters in southern Australia based on passive acoustics. Deep Sea Research Part II 157–158: 154-168.* https://doi.org/10.1016/j.dsr2.2018.09.006. *Kam W. Tang, Michail I. Gladyshev, Olgo P. Dubovskaya, Georgiy Kirillin, Hans-Peter Grossart. (2014). Zooplankton carcasses and non-predatory mortality in freshwater and inland sea environments. Journal of Plankton Research, Volume 36, Issue 3, Pages 597–612.* https://doi.org/10.1093/plankt/fbu014.
PC233 Paragraph 40	Comment: Beach's self-assessment indicates that the residual impacts of underwater noise emissions, after applying mitigation measures, is "moderate."[50] This is concerning to Gunditjmara people, given their special relationship with marine mammals such as whales. Cetaceans are highly vulnerable to underwater noise as species that primarily rely on auditory senses for their basic biological functions [51]. The endangered Blue Whale is particularly susceptible to auditory impacts. [52] [50] *OPP, p. 31.* [51] *See OSPAR Commission, Underwater Noise (Web Page, 2023).* [52] *Risks to Blue Whales include tissue rupture, hearing loss, disruption of echolocation, inability to detect important sounds, habitat abandonment, aggression, calf abandonment, and behavioural disturbance: Department of the Environment, Australian Government, Conservation Management Plan for the Blue Whale: A Recovery Plan*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding the assessment of underwater noise, specifically related to culturally significant marine mammal species, and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. The evaluation for underwater noise concludes that the potential for continuous underwater sound emissions to cause PTS, TTS and displacement impacts to blue whales and southern right whales results in a Moderate (2) consequence for these receptors. As a result, potential impacts to cultural values and sensitivities are also considered to be Moderate (2) consequences. With the adoption of controls to prevent the onset of injury and displacement to blue whales and southern right whales, these impacts will not have significant impacts on individuals or at impacts to population levels. With no potential impacts to the abundance or distribution of marine fauna including species of commercial value, impacts to socio-economic values are not expected. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	under the Environment Protection and Biodiversity Conservation Act 1999 (2015), p. 24.	
PC234 Paragraph 41	Comment: Underwater noise from Project activities can affect aquatic species' ability to communicate, navigate, avoid predators, mate, and locate food.[53] As the OPP notes, sound emissions can impact marine fauna by inducing stress, masking other biologically important sounds, leading to behavioural changes, and leading to temporary hearing loss (TTS) or permanent hearing loss/threshold shift (PTS)—and even mortality.[54] In addition, acoustic harms are not limited to individual species; they can have ecosystem- and population-level effects [55] [53] *C. Erbe, 'Underwater Passive Acoustic Monitoring and Noise Impacts on Marine Fauna: A Workshop Report' (2013) 41(1) Acoustics Australia 113, pp. 116-7.* [54] *OPP, p. 361. See also C. Erbe, 'Underwater Passive Acoustic Monitoring and Noise Impacts on Marine Fauna: A Workshop Report' (2013) 41(1) Acoustics Australia 113, pp. 116-7.* [55] *See C. Erbe, 'Underwater Passive Acoustic Monitoring and Noise Impacts on Marine Fauna: A Workshop Report' (2013) 41(1) Acoustics Australia 113, pp. 116-7.*	Beach Energy (Operations) Limited (Beach) acknowledges comments related to potential effects to marine fauna from underwater noise emissions and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Section 6.4.3 describes in detail the potential effects to marine fauna from continuous and impulsive underwater sound emissions expected during the Project. These are listed in the overview (Section 6.4.3.1). As mentioned in the comment, if species effects are above a certain threshold, then population-level and ecosystem effects can occur. The potential for population-level and ecosystem effects is assessed in the inherent impact assessment (Section 6.4.3.2 and 6.4.3.3). Additionally, the impact evaluation summary (Table 6-30) considers the risks and impacts with the principles of Ecologically Sustainable Development (ESD) and defined acceptable levels. No population-level or ecosystem effects are predicted for any species as a result of the Project. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC235 Paragraph 42	Comment: The proposed Project will produce impulsive (short, pulsed, broadband) noise emissions from geophysical surveys and vertical seismic profiling; as well as continuous (nonpulsed) noise emissions from drilling and completions using the MODU, subsea installations, well plugging and abandonment (including subsea cutting and removal of wellheads), and vessel operations (including from pipelaying, construction and support	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding the continuous noise from vessel activity and the impacts on blue whales and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Impacts from continuous noise sources on marine mammals, including blue whale, are discussed and evaluated in detail in Section 6.4.3. Based on independent underwater sound modelling, the continuous noise source sound behaviour Environment that May Be Affected (EMBA) for marine mammals is predicted to be 7.98 km / 19.6 km on the shelf edge. This behaviour EMBA intersects

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	vessels).[56] Ship noise is likely to be the main source of acoustic disturbance, as a continuous and chronic source in areas with regular vessel traffic.[57] Ship noise has been shown to impact the communication of Blue Whales, and construction activities like drilling and pipelaying are known to lead to avoidance of the area or habitat changes[58] [56] *OPP, pp. 354-5.* [57] *C. Erbe, 'Underwater Passive Acoustic Monitoring and Noise Impacts on Marine Fauna: A Workshop Report' (2013) 41(1) Acoustics Australia 113, p. 114.* [58] *Department of the Environment, Australian Government, Conservation Management Plan for the Blue Whale: A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 (2015), p. 25.*	the foraging Biologically Important Areas for blue whale. The EMBA is based on individual whales remaining in the same position (and therefore receiving a continuous intensity and frequency of sound) for 24 hours during drilling activities, which are predicted to be short-term (30-40 days). For all other activities, such as installation, Inspection Maintenance and Repair, Offshore Support Vessel (OSV) standby and transit, the behavioural EMBA is significantly smaller. Beach acknowledges reference made to Erbe (2013) and DOA (2015). Erbe (2013) states that "ship noise is a continuous and chronic source", however it also describes how the marine soundscape is site-specific, due to both the variation in sound sources and the sound transmission regime. This is why independent, site-specific modelling was undertaken by experts in the underwater noise emissions field, to ensure that a site-specific understanding of potential noise footprints was used in the OPP to support the assessment of inherent impacts. The OPP also references site specific ambient noise monitoring undertaken in the Otway (Section 4.3.7), published by Erbe et al. (2016). As described in DOA (2015) and the OPP (Section 6.4.3.2.3), shipping and industrial noise are classed as 'minor' consequence (defined as: individuals are affected but no effect at a population level). Section 5 of DOA (2013) goes on to clarify that industrial noise for offshore industries is at its peak when activities such as pile-driving and trenching are required, both of which are not within the scope of the Project. References made to avoidance of an area or habitat changes resulting from industrial noise relate to bowhead whale in the Alaskan Beaufort Sea (Schick 2000), which are not a suitable comparison for blue whale in the Otway Basin due to the significant differences in anthropogenic sound sources and marine soundscape. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments. *References* *Schick RS, Urban DL (2000) Spatial components of bowhead whale (Balaena mysticetus) distribution in the Alaskan Beaufort Sea. Canadian Journal of Fisheries and Aquatic Sciences 57:2193–2200.*
PC236 Paragraph 43	Comment: The OPP states that noise emissions from seabed surveys will travel relatively short distances compared to emissions from other sources such as vessel traffic. However, the duration of the activities is important. The OPP suggests that noise from geophysical surveys	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding the duration of geophysical surveys and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. As described in Section 3.8.1, geophysical techniques (which include impulsive sound sources) will be undertaken at various stages of the Project. In the initial phase of the project, there will be

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	alone could last for up to 1,020 days or 146 weeks in total;[59] drilling, installation, and inspection, maintenance and repair activities will take similar periods of time[60] [59] OPP, p. 384. Elsewhere, the OPP states that these surveys could take "up to in the order of forty days to complete, depending on the length of the flowline routes"; or that surveys could take "10-20 days duration per tie-back", which means up to 340 days in total: see OPP, p. 85. [60] OPP, p. 384.	seven locations where seabed surveys are required and seven potential tie-backs. Seabed surveys for these locations would happen sequentially, with no potential for two seabed surveys to be undertaken concurrently within the Operational Area. During installation and commissioning, seabed surveys will be required for pre-lay of infrastructure and flowlines, whilst during decommissioning seabed surveys may require the use of geotechnical techniques. Seabed surveys typically take 10-20 days to complete; <u>the OPP has been updated to remove ambiguity surrounding duration</u>. Impulsive sound emissions generated by seabed surveys will cease immediately when the surveys complete, with no lasting change to the ambient sound levels in the localised or regional area. Therefore, it is appropriate to assess the individual survey campaigns discretely instead of combining them, as they will be undertaken as separate events. At no point will there be 1,020 days of noise emissions, as mentioned in the comment. Seabed surveys will be undertaken in very short, discrete campaigns of 10-20 days per flowline, over the course of the Project. Beach has considered this comment and <u>updated the OPP to clarify the duration of seabed surveys included in the Project (Section 3.8.1)</u>.
PC237 Paragraph 44	Comment: Given the significant duration and number of activities producing noise pollution, it is concerning that the OPP overlooks cumulative and chronic noise impacts on marine fauna. Impulsive noise produced by geophysical surveys and seismic profiling not only results in harm from the acute shock of individual pulses, but can also harm species through repeated exposure over time and the corresponding increase in ambient noise. Chronic noise exposure increases stress and changes behaviour, which may lead to decreased reproductive activity, decreased foraging,[61] decreases in predator avoidance,[62] immunosuppression,[63] and ultimately reductions in survivorship.64 These chronic and cumulative impacts have not been adequately addressed. [61] *See C. Magnhagen et al., 'Effects of motorboat noise on foraging behaviour in Eurasian perch and roach: a field*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding cumulative and chronic noise impacts on marine fauna and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach notes that 'seismic profiling,' as mentioned in this comment, is not planned as part of the Project. As stated in Section 3.8 (Description of Activities) certain short-term, temporary activities, often misinterpreted as seismic surveys, are included within the scope of the OPP including Vertical Seismic Profiling (VSP) and geophysical surveys. While VSP is not expected to be required for the initial drilling campaign, VSP may be performed at some stage in the Project, such as during future drilling campaigns within the in-field development area. VSP provides a seismic image of the geology in the immediate vicinity of the well, with the survey operating over a very short time, approximately 8 to 24 hours per well. VSP noise is not continuous. Each discharge of the seismic source generates a short, discrete, low frequency sound impulse. Seismic impulses during VSP are typically much lower than those generated during typical marine seismic surveys.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	experiment' (2017) 564 Marine Ecology Progress Series, 115-125. [62] *See S. Simpson et al., 'Anthropogenic noise compromises antipredator behaviour in European eels' (2015) 21(2) Global Change Biology 586-593; see also S. Simpson et al., 'Anthropogenic noise increases fish mortality by predation' (2016) 7 Nature Communications 10544.* [63] *See F. Filiciotto et al., 'Impact of aquatic acoustic noise on oxidative status and some immune parameters in gilthead sea bream Sparus aurata (Linnaeus, 1758) juveniles' (2017) 48(4) Aquaculture Research 1895-1903; see also M. Vazzana et al., 'Noise elicits hematological stress parameters in Mediterranean damselfish (Chromis chromis, Perciformes): A mesocosm study' (2017) 62 Fish & Shellfish Immunology 147-152.* [64] *S. Simpson et al., 'Anthropogenic noise increases fish mortality by predation' (2016) 7 Nature Communications 10544.*	Geotechnical and geophysical surveys may be required to be undertaken to assess the suitability of the seabed for drilling, infrastructure or surveys may be needed along the length of proposed flowlines routes. These surveys would be expected to take up to in the order of 10 to 20 days. Impulsive sound sources generated by the Project are limited to discreet activities, which will occur throughout the lifecycle of the Project. Based on the proposed project schedule, Beach can confirm that there will be no instances where more than one impulsive sound source is present within the operational area. Each activity generating impulsive sound is short, with a maximum duration of 10 to 20 days occurring during pre-lay survey along flowline routines. All other activities will have a shorter duration. Following cessation of each activity, ambient noise in the operational area will return to background levels, with no long-term change to the ambient noise levels as a result of the Project. Cumulative environmental impacts in the context of offshore petroleum activities are successive, additive, or synergistic impacts of collectively significant activities or projects with material impacts on the environment that have the potential to accumulate over temporal and spatial scales (NOPSEMA Environment Plan Decision Making Guideline, N-04750-GL1721 A524696, Dec 2022) (OPP Section 8.1). Cumulative impacts to marine fauna are considered in detail in Section 8.3 of the OPP. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC238 Paragraph 45	Comment: Despite the known presence of endangered birds, endangered turtles and other light sensitive species in and around the Project area, the OPP dismisses the potential risks of light pollution on these fauna.	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding risks to protected species from light pollution and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach has provided detailed assessment of the potential risks to light sensitive species from light pollution. Section 4 (Description of the Environment) of the OPP describes the physical, biological, and socio-economic environment that may be affected by the project including light sensitive species. Section 6.3 of the OPP evaluates the impacts to the environment from light emissions resulting from activities associated with the Project. For the light assessment, the identification of light sensitive receptors was undertaken within two light Environment that May Be Affected (EMBAs), 20 km for routine light and 63 km for flaring

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		light. These EMBAs cover routine light emissions from both MODU and vessels, and light emissions from flaring during drilling from any location in the Project Area. As stated within the OPP, the EMBA for routine light emissions is based on the National Light Pollution Guidelines for Wildlife (the Guidelines) (DCCEEW 2023). The Guidelines recommend undertaking a light impact assessment where important habitat for listed species that are sensitive to light are located within 20 km of the light source. The 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings demonstrated to occur at 15 to 18 km and fledgling seabirds grounded in response to artificial light 15 km away (DCCEEW 2023). Seabird grounding, as described in Rodriguez et al (2014), relates to impacts of onshore fixed light sources such as streetlights and buildings and the effect this can have on young fledgling birds making their first flight from their nests to the open ocean. The 20 km light EMBA adopted is highly conservative based on the following studies. These studies used a Mobile Offshore Drilling Unit (MODU) as the basis for assessing routine light emissions from MODU and vessels given the MODU would be the largest and tallest piece of infrastructure used: • A light assessment study was undertaken for the Otway Exploration Drilling Campaign (Xodus, 2024, Appendix O). The study predicted that the area of potential impact from lighting would be up to 10 km from the MODU as there was no measurable changes to ambient light intensity levels beyond this distance. • A light assessment study was undertaken for the Browse FLNG development (Woodside, 2014) to assess the likely light density levels from a MODU. This study predicted light density levels at representative of background levels beyond 12.6 km from the MODU. The EMBA for flaring light emissions of 63 km was based on the following: The light assessment study undertaken for the Otway Exploration Drilling Campaign (Xodus, 2024, Appendix O). Table 6-12 lists bird species with BIAs or behaviours within the light EMBAs. A summary of the impact assessment for light emissions from the Project are presented in Table 6-14 of the OPP. The potential consequence (residual) of light emissions is assessed as minor within the OPP. Wildlife potentially vulnerable to light (i.e. seabirds and marine turtles) are highly unlikely to be disrupted, nor displaced from important habitat and will be able to continue critical behaviours such as foraging and reproduction. Project activities will be short term and temporary with flaring also occurring for only short periods of time with no permanently lit structures installed. In addition, during MODU and vessel

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		operations lighting levels will be reduced to acceptable levels through implementation of controls and limiting of light to only that required for navigational, safety and emergency requirements. Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to this comment.
PC239 Paragraph 46	Comment: It is well established that artificial lighting can have disturbing impacts on coastal species such as birds and turtles, and accordingly on ecosystem health as a whole.[65] Projects with potentially significant increases in light pollution are required to comply with recommendations under the National Light Pollution Guidelines for Wildlife, including to evaluate the risk of artificial light on wildlife and, if required, implement appropriate mitigation measures.[66] *[65] See, e.g., T. Davies et al., 'The Nature, Extent, and Ecological Implications of Marine Light Pollution' (2014) 12(6) Frontiers in Ecology and the Environment 347.* *[66] These guidelines recommend a long-term management plan for turtles, given the risks of artificial light, including from gas developments: Department of the Environment and Energy, Australian Government, National Light Pollution Guidelines for Wildlife: Including Marine Turtles, Seabirds and Migratory Shorebirds (Guidelines, January 2020) p. 18. See also OPP, p. 48.*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding light pollution plus the requirements to comply with recommendations under the National Light Pollution Guidelines for Wildlife and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach acknowledges the statement within Davies et al (2004) that artificial light at night is globally widespread. Davies et al (2004) also states that sources of artificial light in the marine environment vary, with shipping and light fisheries contributing as temporary sources in nearshore and offshore waters. Land-based developments such as towns, cities, and harbours are also listed as permanent sources that can increase night-time light intensities across large geographical areas. Whilst Davies et al (2004) also includes offshore oil platforms as a permanent source of light pollution, surface activities and flaring as part of the Project will be short term and temporary with no permanently lit structures installed. Section 6.3 of the OPP evaluates the impacts to the environment from light emissions resulting from activities associated with the Project. The EMBA for routine light emissions is based on the National Light Pollution Guidelines for Wildlife (the Guidelines) (DCCEEW 2023). The Guidelines recommend undertaking a light impact assessment where important habitat for listed species that are sensitive to light are located within 20 km of the light source. The 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings demonstrated to occur at 15 to 18 km and fledgling seabirds grounded in response to artificial light 15 km away (DCCEEW 2023). This 20 km light EMBA adopted is considered to be highly conservative based on a light assessment study undertaken for the Project (Xodus 2023) and a previous study undertaken for the Browse FLNG development (Woodside 2014). The National Light Pollution Guidelines for Wildlife identify marine turtles, seabirds and migratory shorebirds as potentially being impacted by artificial light to a level significant enough to require assessment within the OPP. In addition to this, impacts on fish/plankton and coastal communities are also assessed in the OPP.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		A summary of the impact assessment for light emissions from the Project are presented in Table 6-14 of the OPP. The potential consequence (residual) of light emissions is assessed as minor within the OPP. Wildlife potentially vulnerable to light (i.e. seabirds and marine turtles) are highly unlikely to be disrupted, nor displaced from important habitat and will be able to continue critical behaviours such as foraging and reproduction. In addition, Control Measure (CM) 13 (light management procedure) within the OPP states that the Mobile Offshore Drilling Unit and vessels will implement a Light Management Procedure as per the National Light Pollution Guidelines (DCCEEW 2023) for Project activities. The Light Management Procedure will detail mitigations to manage light based on the information in the Seabird Light Mitigation Toolbox and Beach Energy's Vessel Light Management Procedure Guidance (CDN/ID 19012450). Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC240 Paragraph 47	Comment: Bird strandings are more common around coastal and offshore industrial sites such as gas developments than at other locations.[67] Light pollution could cause harm to the critically endangered Orange-bellied Parrot, which is likely to migrate through the Project Area. The National Recovery Plan for this species indicates that the parrots may be killed by flying into barriers, which include "illuminated structures and illuminated boats"; both will be present in the parrot's habitat over the 30-year life of this Project.[68] [67] *See, e.g., C. Gjerdrum, 'Bird Strandings and Bright Lights at Coastal and Offshore Industrial Sites in Atlantic Canada' (2021) 16(1) Avian Conservation and Ecology 22.* [68] *Australian Government, National Recovery Plan for the Orange-bellied Parrot, Neophema chrysogaster (2016), p. 16.*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding light pollution and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. The control measures associated with industry best practice are considered appropriate to ensure the environmental impacts relating to light emissions from vessels and the Mobile Offshore Drilling Unit (MODU) and are of an acceptable level. These control/mitigation measures are provided in the OPP Table 6-15. In particular, Beach has taken into consideration the National Light Pollution Guidelines for Wildlife (DCCEEW 2023) (the Guidelines). The Guidelines recommend using Best Practice Lighting Design and undertaking an environmental risk assessment (i.e. the impact assessment within the OPP) where there is important habitat within 20 km of a project. In addition, Beach has committed to the development of a Light Management Plan that will assist in managing environmental impacts and risks of light emissions to acceptable levels and is legally required to be completed prior to commencement of activity. Beach will contract a suitably qualified specialist to develop and support the implementation of the Plan as per the Guidelines. The National Recovery Plan for the Orange-bellied parrot (DELWP 2016) identifies that the behaviour of this species may be modified by the presence of barriers such as illuminated structure and boats, with the impacts of barriers greatest where they occur on migration routes,

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		though there is little more than anecdotal evidence to support this. The Project Area, as detailed in Section 3.5 (Project Area Definition), overlaps an area of probably migration by <0.01 per cent and as such, the activities of the MODU and vessels when undertaking the petroleum activity do not present the same barrier risk as that associated with illuminated structures or illuminated boats within the migration route. Impacts associated with flaring, which will not occur within the migration route but rather may change ambient light in the area, will be temporary and of short duration. Therefore, a change in ambient light is unlikely to cause behavioural changes or result in injury/mortality to the Orange-bellied parrot. Project activities, as detailed in Section 3 (Description of the Project and Alternatives Analysis) involve seabed surveys through to decommissioning of wells and infrastructure installed as part of the Project. These activities will involve the use of either a semi-submersible or jack-up MODU and appropriate support vessels. The presence of the MODU and support vessels will be short term and temporary as detailed in Section 3.8 (Description of Activities) and will not be permanently present over the 30-year life of the project as commented. Successfully drilled wells will be tied back to existing infrastructure, which may include the existing, normally unmanned, Thylacine A platform. The Thylacine A platform is situated ~33 km from an area of probably migration according to DELWP (2016). This is greater than the 20 km threshold to undertake an environmental risk assessment (as detailed within the National Light Pollution Guidelines (DCEEW 2023) with a change of ambient light in the area of probably migration not expected. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments, <u>however references to the National Light Pollution Guidelines for Wildlife (DCCEEW 2023) have been amended throughout to ensure the correct revision is referenced</u>. *References:* *DELWP (2016). National Recovery Plan for the Orange-bellied Parrot, Neophema chrysogaster. Department of Environment, Land, Water and Planning, Canberra.* *DCCEEW (2023). National Light Pollution Guidelines for Wildlife, Department of Climate Change, Energy, the Environment and Water, Canberra, May. CC BY 4.0*

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC241 Paragraph 48	Comment: Similarly, with respect to the endangered albatross species that are likely to occur in the Project Area, the National Recovery Plan for Albatrosses and Petrels highlights the risks of artificial lighting among the threats from interactions with offshore installations and ships. After specifically noting impacts from oil and gas platforms, the Plan notes: "The response of seabirds to marine infrastructure can lead to avoidance behaviours, collisions where the bird may be killed or injured, and fallouts where the bird may be unable to return to the air without assistance."[69] [69] *Australian Government, National Recovery Plan for Albatrosses and Petrels (2022), p. 40.*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impacts to albatross and petrel species from light pollution and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Impacts to bird species from light emissions as a result of activities from the Project have been assessed in Section 6.3 (Emissions - Light). Whilst the National Recovery Plan for Albatrosses and Petrels (2022) (DCCEEW 2022a) identifies light emissions as a threat, it classifies marine infrastructure interactions including those associated with artificial light as having no risk category priority and affecting 'Nil' species in Australian jurisdiction. In addition, *The Wildlife Conservation Plan for Seabirds* (DCCEEW 2020b) lists light pollution as a threat with minor consequence (individuals affected but no population level impacts expected). For most species, the threat of light pollution relates to disturbance to critical behaviours (such as nesting or roosting) on land. Section 6.3 (Emission – Light) has assessed the impact consequence (residual) of light emissions to bird species as minor. Wildlife potentially vulnerable to light (i.e. seabirds and marine turtles), are highly unlikely to be disrupted, nor displaced from important habitat and will be able to continue critical behaviours such as foraging and reproduction. Table 6-15 of the OPP also details Control Measures to be implemented including CM12 (Mobile Offshore Drilling Unit and vessel lighting) plus CM13 (Light Management Procedure). Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments. *References:* *DCCEEW (2020a). National Recovery Plan for Albatrosses and Petrels. Commonwealth Department of Climate Change, Energy, the Environment and Water formerly DAWE* *DCCEEW (2020b). The Wildlife Conservation Plan for Seabirds. Commonwealth Department of Climate Change, Energy, the Environment and Water formerly DAWE*
PC242 Paragraph 49	Comment: There is also substantial evidence that industrial light pollution affects turtles and reduces their chance of successful nesting and survival.[70] Since artificial light can disrupt critical behaviours of turtles and	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impacts to turtle species from light pollution and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	undermine their recovery, addressing light pollution is considered an important part of the National Recovery Plan for Marine Turtles.[71] In particular, there are obligations to manage light emissions adjacent to critical habitat so marine turtles are not displaced from these habitats, and identify "the cumulative impact on turtles from multiple sources of onshore and offshore light pollution."[72] As above, two endangered turtle species (Leatherback and Loggerhead) are likely or known to occur in the Project Area itself.[73] [70] *See, e.g., R. Kamrowski et al., 'Influence of industrial light pollution on the sea-finding behaviour of flatback turtle hatchlings' (2015) 41(5) Wildlife Research 421.* [71] *Australian Government, Recovery Plan for Marine Turtles in Australia 2017-2027 (2017), pp. 38, 56.* [72] *Australian Government, Recovery Plan for Marine Turtles in Australia 2017-2027 (2017), p. 56.* [73] *OPP, Appendix A (PMST Report for the Project Area).*	Beach acknowledges that artificial light can disrupt turtle nesting and hatching behaviours and is listed as a key threat in the Recovery Plan for Marine Turtles in Australia (CoA 2017). As detailed in Section 6.3 (Emissions – Light), although listed turtle species may occur within the routine light and flaring Environments that May be Affected (EMBAs), no Biologically Important Areas (BIAs), or habitat critical to survival for marine turtles were identified (Section 4.4.9-Threatened and Migratory Species). For all species that may be present in the routine light and flaring EMBAs, nesting habitats are located significant distance away i.e. Queensland or Western Australian coastline. Consequently, population level impacts to marine turtles from routine light and flaring emissions are not predicted to occur. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments. *References:* *CoA (2017). Recovery for Marine Turtles in Australia. Commonwealth of Australia.*
PC243 Paragraph 50	Comment: The main sources of light pollution from the Project are likely to be drilling operations, vessel traffic, and flaring.	Beach Energy (Operations) Limited (Beach) agree with the statement that the main sources of artificial light emissions associated with the Otway Offshore Gas Victoria Project will be drilling and vessel operations and short-term flaring of wells. Section 6.3 of the Offshore Project Proposal (OPP) assess the potential impacts from light on the environment.
PC244 Paragraph 51	Comment: Substantial light emissions are expected during the drilling phase. The MODU drilling rig and vessels will have lighting during the night, with activities "to be conducted 24 hours a day" and operations continuing for up to 60 days per well in the initial drilling campaign. Even though the OPP states that "there are no permanent lit structures",[74] the MODU and vessel operations will continue to emit light for extremely long periods—up to a	Beach Energy (Operations) Limited (Beach) acknowledge the statement that artificial light emissions associated with the the Otway Offshore Gas Victoria Project may pose potential environmental impacts and risks to the marine environment As summarised in the introduction to this Report, the scope of the Project has been revised which is reflected throughout the OPP. In particular Chapter 3 for the description of activities is updated to for a reduction in total well number and end of field life. For clarity, Beach has amended section 6.3.1 and Table 6-14 the OPP to: "There will be no permanent lighting associated with the Project. <u>Temporary light emissions from flaring during drilling and completions and navigational lighting for support operations to comply with</u>

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	total of 107 weeks or 34 months, likely commencing in 2025.[75] [74] *OPP, p. 335.* [75] *This assumes that there will be drilling campaigns for all 17 wells; light impacts will continue "between 30-60 days per* well for MODU and vessel presence for each campaign": OPP, p. 350.	navigational and safety requirements, will be emitted during the Project when the MODU or vessels are on location in the Project Area ".
PC245 Paragraph 52	Comment: It is misleading to call this "temporary" or "short term" emissions of light.[76] In the summary of impacts, the OPP comments "The extent of the area potentially impacted by light emissions has been assessed as up to 50km for flaring and routine light for 20km, however this will only occur on a temporary basis for short periods of time and there are no permanent lit structures associated with this Project."[77] [76] *OPP, pp. 335, 350* [77] *OPP, p. 350 (emphasis added).*	For clarity, Beach has amended section 6.3.1 and Table 6-14 the OPP to: "There will be no permanent lighting associated with the Project. Temporary light emissions from flaring during drilling and completions and navigational lighting for support operations to comply with navigational and safety requirements, will be emitted during the Project when the MODU or vessels are on location in the Project Area ". As noted in responses to other comments above, the light EMBA for flaring has been remodelled based on 65mmscf and a light EMBA of 63 km - this does not change the information about the source of lighting and description as temporary and short-term
PC246 Paragraph 53	Comment: Apart from noting that vessels will be operating for "24 hours a day", the OPP does not provide the specific number and frequency of vessels that will operate during the 30-year life of the Project, so there is insufficient information to evaluate the intensity and duration of light from these vessels and the cumulative impacts on light-sensitive species.	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding vessel activity and has reviewed the Offshore Project Proposal (OPP) in response to these comments. The potential impact of light emissions on marine species is assessed in section 6.3 of the OPP. Light emissions are assessed as having a Minor (1) consequence, which is not considered as having the potential to result in serious or irreversible environmental damage and is of an acceptable level. Based on the current level of operational detail, Beach is confident that the impact assessment outcome of minor is correct. The Environment Plan(s) that will be required to authorise specific activities are intended to address environmental impacts and risks at an activity-level, which would typically be at a finer scale of detail than the OPP. For example, an EP for drilling activity would generally include information on number and type of vessel (see section 3.9.1 of the OGV Drilling and P&A Activities EP. No change is made to the OPP in response to this comment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC247 Paragraph 54	Comment: With respect to turtle species, the most significant risks from light pollution would be from vessels transiting to and from coastal areas where turtles may have nesting, internesting or other critical habitats. However, Beach excises the potentially large area where vessels will travel to and from the offshore locations from its definition of the "Project Area", on the grounds that it is "outside the scope" of the Offshore Petroleum Greenhouse Gas Storage Act 2006 (Cth) (OPGGS Act).[78] It fails to consider NOPSEMA's obligations, endorsed by the Minister for the Environment under s 146B of the EPBC Act, to assess actions that are likely to have a significant impact on Matters of National Environmental Significance (MNES). This review under the EPBC Act is not limited to Commonwealth waters; Beach as the proponent is required to consider any potentially significant impacts on MNES, which include threatened or migratory species which are protected under the EPBC Act. [78] *OPP, p. 75*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impacts to turtle species from light pollution and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach acknowledges that artificial light can disrupt turtle nesting and hatching behaviours and is listed as a key threat in the Recovery Plan for Marine Turtles in Australia (CoA 2017). As detailed in Section 6.3 (Emissions – Light), although listed turtle species may occur within the routine light and flaring Environment that May be Affected (EMBAs), no Biologically Important Areas (BIAs), or habitat critical to survival for marine turtles were identified within the Project Area (Appendix E). Consequently, population level impacts to marine turtles from routine light and flaring emissions are not predicted to occur. The OPP has been prepared by Beach to satisfy the requirements of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Environment Regulations). It has been prepared in line with the regulations and with relevant National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) guidelines including the OPP Content Requirements Guidance Note (N-04790-GN1663 A473026) and OPP assessment policy (N-04790-1650). As described in the OPP Content Requirements Guidance Note (NOPSEMA 2020), an OPP is required for most new offshore petroleum development projects in Commonwealth Waters. An 'offshore project' is defined in the Environment Regulations as 'one or more activities that are undertaken for the purpose of the recovery of petroleum, other than on an appraisal basis, including any conveyance of recovered petroleum by pipeline' (NOPSEMA 2020). Therefore, the Project constitutes an 'offshore project', and an OPP is required. The OPP Content Requirements Guidance Note also states that 'Any component of a development project that is undertaken in State or Northern Territory coastal waters or onshore would not be part of an offshore project.' (NOPSEMA 2020). As stated in Section 3.5 (Project Area Definition) of the OPP, vessels transiting to and from the offshore locations are excluded from the OPP as this is outside the scope of the OPGGS Act. Vessels transiting to or from the operational areas are operating under the Commonwealth *Navigation Act 2012* and are not considered to be performing a petroleum activity whilst outside the operational area. Impacts and risks associated with vessels operating within the operational area in Commonwealth waters are assessed throughout the OPP including Section 6.3 (Emissions – Light).

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Based on this, it is not within the scope of an OPP to describe or assess potential impacts from vessels not undertaking a petroleum activity on Matters of National Environmental Significance (MNES). Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments. *References* *NOPSEMA 2020. Offshore project proposal content requirements Guidance Note. N-04790-GN1663 A473026. August 2020. Accessed online <https://www.nopsema.gov.au/sites/default/files/documents/2021-03/A473026.pdf>*
PC248 Paragraph 55	Comment: This is a serious omission. In excluding from the definition of the Project Area the substantial areas in which vessels will transit between the port and the offshore site, the OPP neglects to evaluate not only potential harms from light pollution, but all potential environmental, social and cultural impacts from these Project activities.	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impacts to environmental, social and cultural impacts within the Project Area from light pollution and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. As stated in Section 3.5 (Project Area Definition), vessels transiting to and from the offshore locations are excluded from the OPP as this is outside the scope of the OPGGS Act. Vessels transiting to or from the operational areas are operating under the Commonwealth Navigation Act 2012 and are not considered to be performing a petroleum activity whilst outside the operational area. Impacts and risks associated with vessels operating within the operational area in Commonwealth waters are assessed throughout the OPP, including Section 6.3 (Emissions – Light). The OPP has been prepared by Beach to satisfy the requirements of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Environment Regulations). It has been prepared in line with the regulations and with relevant National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) guidelines, including the OPP Content Requirements Guidance Note (N-04790-GN1663 A473026) and OPP assessment policy (N-04790-1650). Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC249 Paragraph 56	Comment: There are also significant risks of harm from light emissions from gas flaring. Ten birds have BIAs in the Project Area, and a larger number of protected bird species are likely or known to be found in the Project Area; all of these species will be exposed to the adverse impacts of flaring.[79] Attraction to gas flares and industrial light sources may pose the "greatest risk to migrating landbirds, and some seabirds, particularly during periods of inclement weather."[80] According to the United States Fish and Wildlife Service, gas flaring poses the following risks to birds: Methane or other gas burner pipes present a hazard to birds from burning, entrapment in pipes or vents, or direct mortality from the flare flame. The flame emitted to burn off gas during a flaring event can attract birds, especially at night. Birds can fly through the superheated gas or flame resulting in feather damage grounding the bird or scalding of lungs or other tissues due to inhalation. Birds can also be killed or injured if they perch on burner pipes[81]. *[79] See OPP, p. 55 (Table 6). BIAs are defined as "spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration": OPP, p. 54.* *[80] See, e.g., R. Ronconi et al., 'Bird Interactions with Offshore Oil and Gas Platforms: Review of Impacts and Monitoring Techniques' (2015) 147 Journal of Environmental Management 34-45.* *[81] U.S. Fish and Wildlife Service, Incidental Take Beneficial Practices: Gas Flares (Web Page, 2024).*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impacts to bird species from flaring activities and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Impacts and risks to birds associated with flaring as part of the Project's activities within the Project Area are assessed in Section 6.3 (Emissions – Light). This includes terrestrial species that migrate across the area. Flaring associated with well flowback during the potential testing of the wells via the drilling rig may occur in the initial or future drilling campaigns if the base case of unloading the wells to the Otway Gas Plant is not feasible. However, the duration of flaring is only in the order of 1 to 2 days for each well. Following assessment, the Impact Consequence (residual) of light emissions to bird species was assessed as Minor in the OPP. Wildlife potentially vulnerable to light (i.e. seabirds) are highly unlikely to be disrupted, nor displaced from important habitat and will be able to continue critical behaviours such as foraging and reproduction. The comment "greatest risk to migrating landbirds, and some seabirds, particularly during periods of inclement weather" is mostly based on anecdotal evidence (Ronconi et al. 2015). Only a few studies cite weather effects related to seabird attraction. However, there has been no systematic evaluation of bird attraction in relation to specific weather variables except at one offshore wind energy platform in the German Bight (Ronconi et al. 2015). Beach has committed to develop and support the implementation of a Light Management Plan, as per the National Light Pollution Guidelines for Wildlife (DCCEEW 2023), for the activity (Control Measure CM13). Although the interactions with migrating and seabirds from the result of flaring is highly unlikely with the impact assessed as Minor (as detailed in Section 6.3 Emissions – Light), Beach will ensure that within the Light Management Plan, procedures will include that prior to the commencement of the initial flaring event at each well, the area extending from the tip of the flare will be visually confirmed clear of birds. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. However, <u>Beach has included additional detail in the OPP (Table 6-15) to Control Measure 13 (Light Management Procedure) that the plan will include prior to the commencement of an initial flaring event at each well, the area extending from the tip of the flare will be visually confirmed to be clear of birds</u>. *References:*

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		CoA (Commonwealth of Australia) (2020) National Light Pollution Guidelines. Department of the Environment and Energy, Canberra. *Ronconi RA, Allard KA and Taylor PD (2015) 'Bird Interactions with offshore oil and gas platforms: Review of impacts and monitoring techniques', Journal of environmental management, 147: 34-45.*
PC250 Paragraph 57	Comment: The OPP provides that "flaring may be required during well intervention or drilling activities" but comments that it is only "short term" (1-2 days per well). However, the duration of the activity is not the only factor which determines its potential for harm. Where there are critically endangered and endangered species occurring in the Project Area who face the risk of extinction, as is the case here, the exposure of these bird species to flaring cannot be so quickly dismissed. For example, for the critically endangered Orange-bellied Parrot, even mortality or mortal injury impacts on relatively low numbers could have population-level effects.	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impacts to bird species from flaring activities and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Impacts and risks to birds associated with the Project have been thoroughly assessed within Section 6.3 (Emissions – Light) of the OPP. This includes the use of a 63 km light Environment that May Be Affected (EMBA) for the impact assessment of flaring activities. Beach acknowledges that the National Recovery Plan for the Orange-bellied parrot, Neophema chrysogaster (DELWP 2016) details that barriers to migration and movement as a threat to the Orange-bellied parrot. It details that highly mobile species may be impacted by barriers to movement (Navarrete 2011), though there is little more than anecdotal evidence for impacts on the Orange-bellied parrot (Holdsworth 2006). In addition, it states that individuals may be killed by flying into barriers, or behaviour may be modified by the presence of barriers, leading to avoidance of some habitat. Barriers may include wind energy turbines, powerlines and associated infrastructure, aircraft including small recreational aircraft, illuminated structures, and illuminated boats. The National Recovery Plan for the Orange-bellied parrot, Neophema chrysogaster (DELWP 2016) does however assess the evidence for impact barriers to migration and movement to be weak. For the Project there will be no temporary (Mobile Offshore Drilling Unit (MODU) or support vessels) or permanent infrastructure within areas classified as the breeding range, infrequent non-breeding range, migration route or non-breeding range as defined in the National Recovery Plan for the Orange-bellied parrot, Neophema chrysogaster (DELWP 2016). The Project Area, as detailed in Section 3.5 (Project Area Definition) of the OPP, where temporary MODU or support vessel activities may occur, does overlap the area classified as probable migration. However, this overlap is <0.01 per cent and as such, the activities of the MODU and support vessels when undertaking Project activities do not present the same barrier risk as those associated with illuminated structures or illuminated boats within the migration route.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		The Flaring EMBA does not intersect areas classified as the breeding range, infrequent non-breeding range, migration route or non-breeding range as defined within the National Recovery Plan for the Orange-bellied parrot, Neophema chrysogaster (DELWP 2016). Whilst the flaring EMBA does overlap the area classified as probable migration, impacts associated with flaring will only result in a temporary and short-term change in ambient light in the probable migration area but not present a barrier or risk of collision. Therefore, a change in ambient light is unlikely to cause behavioural changes or result in injury/mortality to the Orange-bellied parrot. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments. *References.* *DELWP (2016). National Recovery Plan for the Orange-bellied Parrot (Neophema chrysogaster). Australian Government, Canberra.* *Holdsworth M. C. 2006. Reproductive success and demography of the Orange-bellied Parrot Neophema chrysogaster. Masters Thesis, University of Tasmania.* *Navarrete L. M. 2011. Behavioral effects of wind farms on wintering Sandhill Cranes (Grus Canadensis) on the Texas High Plains. Master of Science Thesis, Texas Tech University.*
PC251 Paragraph 58	Comment: Beach's self-assessment posits that the residual impacts of interaction with marine fauna will be "low" overall throughout the Project duration.[82] However, the OPP assessment does not properly account for risks of vessel strikes and collisions, which are particularly hazardous to cetacean populations that spend time near the surface to breathe or forage. [82] *OPP, p. 34.*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impacts to fauna resulting from vessel strikes and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach is confident that the risk evaluation in Section 7.2 (Physical Presence – Interaction with Marine Fauna) of the OPP provides a robust evaluation of the potential of collision with megafauna as a result of activities from the Project including identification of hazards, risk analysis, control measures. An unplanned interaction with marine fauna event, resulting in injury or mortality to an individual marine mammal, marine reptiles or seabird or shorebird, has been evaluated as a Low risk (see Table 7-8). The defined acceptable level and environmental performance outcome for the Project is no death or injury to listed threatened or migratory species (Table 7-10).

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Beach is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC252 Paragraph 59	Comment: The OPP acknowledges that "Vessel strike could cause injury or death"*[83]* and that "Collisions between vessels and cetaceans occur more frequently where high vessel traffic and cetacean habitat coincide."*[84]* It is well established that increased vessel traffic heightens the risk of vessel strikes, which can cause severe injury or death.*[85]* In this case, the most impacted marine fauna are likely to be whales and sea turtles (including endangered species) occurring in the area where vessels transit.[86] The available data usually understates the real threat; because vessel collisions often remain unseen and unreported, the danger to marine fauna can be substantially higher than the data demonstrates.[87] *[83] OPP, p. 445.* *[84] OPP, p. 446.* *[85] See, e.g., R. Schoeman et al. 'A Global Review of Vessel Collisions With Marine Animals' (2020) 7 Frontiers in Marine Science 292; Department of the Environment and Energy, Australian Government, National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (Dec. 2017), p. 4.* *[86] R. Schoeman et al. 'A Global Review of Vessel Collisions With Marine Animals' (2020) 7 Frontiers in Marine Science 292.* *[87] International Whaling Commission, 'Ship strikes: collisions between whales and vessels' (2023); F. Ritter et al. 'Collisions of Vessels With Cetaceans – The Underestimated Threat' in C. Sheppard (ed), World Seas: An Environmental Evaluation (2019).*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impacts to fauna resulting from vessel strikes and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. As referenced in the claim, Schoeman et al (2020), DoEE (2017) and the IWC (2024) highlight successful measures to mitigate collisions with marine fauna which include a reduction in vessel speed. DoEE (2017) states that large, high-speed vessels, in particular, have become a major concern as they are capable of travelling at speeds of up to 35 to 40 knots. As stated in Section 7.2 (Physical Presence – Interaction with Marine Fauna) of the OPP, vessels operating within the Project Area will be moving very slowly or be stationery, so the risk associated with fast moving vessels not credible. The lack of reporting of vessel strikes, as detailed in the claim, is likely a result of ship personnel being inexperienced with reporting procedures, fear of penalties if incidents are reported and species interactions going undetected due to large vessel size or vessel speed (Laist et al. 2001). Control Measure 14 (CM14) requires that vessel personnel are aware of and will adhere to *Environmental Protection and Biodiversity Conservation Act 1999* and Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans and vessel speeds within caution zones. In addition, vessel movements will be aligned to Objective 3 of the National Strategy for Reducing Vessel Strikes on Cetaceans and other Marine Megafauna (DoEE 2017) by: • maintaining separation of vessels and whales • maintaining slow vessel speeds • avoidance manoeuvres Commercial vessels in Commonwealth waters involved in a collision with marine fauna are required to report the incident under several acts and guidelines. These include *The Navigation Act 2012* and the *Marine Safety (Domestic Commercial Vessel) National Law Act 2012* plus reporting the incident to AMSA and the Australian Marine Mammal Centre. Details of guidelines and industry practice that support vessels will adhere to are listed in Section 7.2.3 (7.2.3 - Risk Evaluation Summary) of the OPP.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Beach is confident that the risk evaluation in Section 7.2 (Physical Presence – Interaction with Marine Fauna) of the OPP provides a robust evaluation of the potential of collision with megafauna as a result of activities from the Project. This includes Environmental Performance Outcomes (EPO's) and control measures ensuring that these impacts and risks of an acceptable level. The risk assessment (residual) assessed the consequence of an interaction as moderate but highly unlikely with a risk rating of low. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments. *References:* *CoA (2017) National Strategy for Reducing Vessel Strikes on Cetaceans and other Marine Megafauna. Department of the Environment and Energy, Canberra.* *IWC (2024) Ship Strikes: collisions between whales and vessels. International Whaling Commission. Website accessed June 2024 at < https://iwc.int/management-and-conservation/ship-strikes* *Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S. & Podesta, M. (2001) Collisions between ships and whales. Marine Mammal Science 17(1): 35-75.* *Schoeman RP, Patterson-Abrolat C and Plön S (2020) A Global Review of Vessel Collisions With Marine Animals.* Front. Mar. Sci. 7:292. doi: 10.3389/fmars.2020.00292
PC253 Paragraph 60	Comment: However, Beach downplays the risk of collision with vessels, commenting that vessels within the Project Area "will be moving very slowly or will be stationery, so the risk associated with fast moving vessels is not an issue."[88] [88] *OPP, p. 446.*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impacts to fauna resulting from vessel strikes and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach is confident that the risk evaluation in Section 7.2 (Physical Presence – Interaction with Marine Fauna) of the OPP provides a robust evaluation of the potential of collision with megafauna as a result of activities from the Project. This includes Environmental Performance Outcomes (EPO's) and control measures ensuring that these impacts and risks are of an acceptable level. The risk assessment (residual) assessed the consequence of an interaction as moderate but highly unlikely with a risk rating of low.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC254 Paragraph 61	Comment: Yet, as the OPP previously stated, it is not only the speed but the volume of vessel traffic which increases risks of strikes. As noted with respect to light pollution, this Project could involve significant vessel traffic, operating "24 hours a day" and continuing for up to 34 months, during the drilling period alone.[89] If the Project progresses to the production stage and/or if further construction is required, there will be additional traffic from pipelay and support vessels. As argued previously, the OPP fails to account for vessels transiting between the coast and the offshore sites, as these activities are not captured in the Project Area. All of these factors suggest that Beach is underestimating the risks of interactions with marine fauna, especially endangered and vulnerable whale species [89] *See OPP, p. 350.*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impacts to fauna resulting from vessel strikes and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach is confident that the risk evaluation in Section 7.2 (Physical Presence – Interaction with Marine Fauna) of the OPP provides a robust evaluation of the potential of collision with megafauna as a result of activities from the Project. This includes Environmental Performance Outcomes (EPOs) and control measures ensuring that these impacts and risks are of an acceptable level. The risk of an unplanned interaction with marine fauna event has been evaluated to be Low. Low risks are considered lower-order risks that is acceptable with the application of good industry practice. As provided in comment and response (PC247), Section 3.5 (Project Area Definition) of the OPP, vessels transiting to and from the offshore locations are excluded from the OPP as this is outside the scope of the OPGGS Act. Vessels transiting to or from the operational areas are operating under the Commonwealth *Navigation Act 2012* and are not considered to be performing a petroleum activity whilst outside the operational area. Impacts and risks associated with vessels operating within the operational area in Commonwealth waters are assessed throughout the OPP. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC255 Paragraph 62	Comment: The Project poses significant risks to the marine environment	Beach Energy (Operations) Limited (Beach) acknowledges comments of risks to the marine environment and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach is confident that the OPP provides a robust evaluation of the potential impact and risks to ecological and social receptors. In accordance with Environment Performance Outcomes (EPOs) and control measures set out within the OPP, the Project will be managed so that the potential

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		impacts and risks will be mitigated to acceptable levels in accordance with environmental regulatory requirements. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC256 Paragraph 63	Comment: Risks from planned toxic discharges The OPP identifies numerous planned toxic discharges to the marine environment: drill cuttings and drilling fluids, cement, and commissioning and operational fluids, and routine operational wastes from vessels. It concludes that all impacts from these discharges are minor and acceptable.[90] However, for the following reasons, the OPP fails to support these conclusions.	Beach Energy (Operations) Limited (Beach) acknowledges comments of risks from planned discharges and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. This is a general statement with specific comments about carbon budgets are addressed throughout this public comment report (see PC 257 to 260).
PC257 Paragraph 64	Comment: Drill cuttings and drilling fluids The OPP provides that discharges of drill cuttings and drilling and completion fluids will occur throughout the life of the Project.[91]	Beach Energy (Operations) Limited (Beach) acknowledges comments concerning planned discharges and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach rejects the comment that Table 6-47 of the OPP (reference 91) provides that "discharges of drill cuttings and drilling and completion fluids will occur throughout the life of the Project". Tables 6-47 and 6-48 (in section 6.7.2) of the OPP describes total expected volumes of drill cuttings and fluids discharged for discrete activities within the Project. Beach has considered these comments and is satisfied that the comment has no merit and no changes have been made to the OPP in response to these comments.
PC258 Paragraph 65a	Comment: Risks from planned toxic discharges Drill cuttings and drilling fluids Although the OPP acknowledges that discharges of drill cuttings and fluids may cause changes in water quality, sediment quality, and habitat, potentially resulting in injury and mortality to fauna,[92] it fails to adequately	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding drill cuttings and drilling fluids and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. As described in the comment, the OPP provides a description of drill cuttings and drilling fluid discharges in the following sections: • Section 3.8.3 describes the type of fluids to be used during drilling and expected discharge volumes per well.

ID	Summary of comments received	Beach’s assessment of merit of comment(s) and response(s) to comments and/or objections
	support its conclusion that the impacts will be minor and acceptable: a. The OPP fails to identify which substances will be discharged, their chemical composition, concentration, or toxicity. It only lists a range of substances which the discharges “can include” or “are estimated to consist of”, and many of these substances can cause harm to the marine environment. For example: i. Drilling fluids “are planned to be” water based (WBDF), which uses “pre-hydrated bentonite gel sweeps and will be discharged directly to the seabed with cuttings. The seawater may be treated with caustic soda (NaOH) and/or soda ash (Na2CO3) to increase pH and alkalinity.”[93] ii. Synthetic based drilling fluids (SBDF) will be used “where technical requirements preclude the use of WBDF” and “assessed should their use be required.” The base fluid is “typically a hydrocarbon, ether, ester, or acetal,” and additives include organophilic clays, barite, lime, aqueous chloride, rheology modifiers fluid loss control agents, and emulsifiers.[94] iii. Drill cuttings can “contain toxic materials, such as heavy metals, that can leach into the water and harm marine life.”[95] iv. Completions fluids “can include” chlorides, bromides, hydrate inhibitors [monoethylene glycol] (MEG), biocides, oxygen scavengers, viscosifiers, and surfactants, as well as produced/formation water.[96] v. Suspension fluids “are estimated to consist of” corrosion inhibitor (soluble oil) and suspension fluid (treated with dilute oxygen scavenger, preservative (glutaraldehyde), and caustic soda). Well annular fluids may include small amounts of hydrocarbons.[97] [92] *OPP, p. 415.* [93] *OPP, p. 412.*	• Section 3.8.4 describes well completion fluid discharges. • Section 3.8.4 describes well P&A during decommissioning, which includes the discharge of annulus fluid. Potential impacts from these discharges are collectively assessed in Section 6.7 (Planned Discharge – Drill Cuttings and Fluids). The impact assessment is based on the current level of planning, which in this case means the type of expected volume of fluids, however details such as specific chemical composition, concentrations, dilutions and frequency of discharges are operational details which are determined much closer to the start of the activity. Subsequently, the OPP relies upon an understanding of what is typical in the industry. Throughout the impact assessment, peer-reviewed literature is cited to support the assessment of potential consequences. Justification is provided throughout as to why these literature sources are considered relevant to the Project, for example comparison in location and water depth or composition of discharge is provided. Through this process, Beach is able to confidently provide an assessment of impacts without refining the specifics of the planned discharges at this early stage. In response to specific points in the comment: i) Water based drilling fluids (WBDF) will be used exclusively for the initial drilling campaign. WBDF will be discharged directly to the seabed during top-hole drilling, and then from the MODU once the riser has been installed. WBDF composition will be industry standard. ii) For future drilling campaigns, it is possible that operational requirements will mean that synthetic-based drilling fluids (SBDF) will be used. Typically SBDF are only used for the bottom-hole / reservoir section of the well. There will be no bulk discharge of SBDF; instead all SBDF remaining at the end of the well either being reused on the next well, passed onto the next operator or returned to the vendor for reprocessing or appropriate disposal. This will be detailed in the relevant activity specific Environment Plans. iii) It is accurate to state that drill cuttings can contain toxic materials, which can harm marine life. However, WBDF which will be used for the majority of drilling activities have very low toxicity, and are generally composed of low impact / PLONOR chemicals. iv) Completion fluids can include the chemicals listed; however these are typically in very small concentrations. The majority of completion fluid is brine. Completion fluids are pumped into the wellbore during completions and clean-up, with all returns processed through the on-board package on the MODU prior to discharge.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	[94] *OPP, pp. 412, 422.* [95] *OPP, p. 411.* [96] *OPP, pp. 89, 412-413.* [97] *OPP, p. 413.*	v) Suspended fluids are those retained in the wellbore while the well is suspended, and will be discharged during P&A when the wellhead is removed. Volumes of discharge will be low (approx. 100 m^3 per well) and will mostly consist of brine with some additives (as listed). All chemicals used during the Project which have the potential for planned discharge to the marine environment are assessed using the Beach chemical selection process (CM29). Beach will provide full details of the Beach Hazardous Chemicals Management Procedure and Hazardous Materials Risk Assessment which will be used to assess all chemicals used as part of the Project in the associated EPs. The procedure considers aquatic toxicity, bioaccumulation, and persistence data for each chemical, along with the discharge concentration, duration, frequency, rate, and volume to assess chemicals that may or will be discharged to the marine environment. This approach aligns with international industry best practise for chemical assessment and will ensure that discharges to the marine environment are of an acceptable level. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC259 Paragraph 65b	b. Instead of providing adequate information to support its conclusion, the OPP states there will be a process for chemical selection to ensure chemicals are "environmentally acceptable"98 – without indicating what that means for each potentially-impacted species and ecosystem. The OPP also assumes discharges will have low or no toxicity, and low bioaccumulation.[99] However, many of the substances listed above can be toxic (for example, MEG and biocides are toxic,[100](discussed below)), and also have bioaccumulation potential (for example, heavy metals and petroleum hydrocarbons101). [98] *OPP, p. 422.* [99] *OPP, pp. 416-420.* [100] *Department of Climate Change, Energy, the Environment and Water, Ethylene glycol (1,2-ethanediol) (Web Page, 30 June 2022) (noting that ethylene glycol (1,2-*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding drill cuttings and drilling fluids and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Unlike an Environment Plan (EP), an OPP is not required to provide details of the implementation strategy i.e. arrangements which are in place to ensure that control measures are met, planned and unplanned emissions and discharges are recorded etc. Beach has provided detail of their Environmental Management System (Section 9) which provides a high-level overview of Beach's approach to implementation and a summary of the systems, practices and procedures used to ensure implementation of activities in accordance with the OPP. Regarding chemical assessment, Beach will provide full details of the Beach Hazardous Chemicals Management Procedure and Hazardous Materials Risk Assessment which will be used to assess all chemicals used as part of the Project in the associated EPs. The procedure considers aquatic toxicity, bioaccumulation, and persistence data for each chemical, along with the discharge concentration, duration, frequency, rate, and volume to assess chemicals that may or will be discharged to the marine environment. This approach aligns with international industry best

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	ethanediol) is a synonym for "monoethylene glycol"); United States Environment Protection Agency, Reregistration eligibility decision for alkyl dimethyl benzyl ammonium chloride (ADBAC) (3 August 2006), p. 45. *101 Several scientific studies have shown for over a decade that petroleum hydrocarbons bioaccumulate in a range of species, including aquatic worms and oysters. B. Muijs et al., 'A Closer Look at Bioaccumulation of Petroleum Hydrocarbon Mixtures in Aquatic Worms' (2010) 29(9) Environmental Toxicology and Chemistry 1943; N. Gan et al., 'Impact of Polycyclic Aromatic Hydrocarbon Accumulation on Oyster Health' (2021) 12 Frontiers in Physiology.*	practise for chemical assessment and will ensure that discharges to the marine environment are of an acceptable level. Regarding toxicity and bioaccumulation, these factors are integral in the Beach Hazardous Chemicals Management Procedure and Hazardous Materials Risk Assessment. Where chemicals are proposed for use which do not meet the criteria for discharge, as described in the chemical assessment process, Beach will follow the plan to identify alternative chemicals or adjust the dosage and / or discharge volume until discharges meet the criteria required. Chemicals will not be discharged if they do not meet discharge criteria. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC260 Paragraph 65c	c. Further, the OPP provides no detail about the chemical composition of the formation water that will be discharged or the basis on which to conclude its impact will be minor, although produced/formation water can include toxic contaminants.[102] It also contains no assessment of the potential impacts of heavy metals in the discharges, despite acknowledging that drill cuttings and drilling fluids may contain heavy metals such as mercury and cadmium.[103] [102] *J. Beyer et al., 'Environmental effects of offshore produced water discharges: A review focused on the Norwegian continental shelf' (2020) 162 Marine Environmental Research 105155.* [103] *OPP, pp. 411, 422.*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding formation water discharges and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Sections 3.8.3 (Drilling) and 3.8.4 (Completions) of the OPP explains the formation water will only be discharged during drilling and completions as part of completion fluids discharges. There will be no ongoing discharge of produced formation water as part of the project. Completion fluids consist of completion brine, and any formation water or condensate in the well bore. Total discharge volume of completion fluids from well completion, unloading and testing will be up to approximately 300 m^3. Approximately 100 bbls (16 m^3) of produced water may be generated and discharged per well. Completion fluids will be treated to reduce the oil in water content to below 30 ppm prior to overboard discharge. Fluid not meeting this criterion will be stored in tanks for later onshore disposal. This low volume of 16m3 is due to the low formation water content in formation gas. The chemical composition of formation water discharged together with completion fluids depends on the formation and well construction process. To prevent uncertainty of impacts from unknown chemical composition of completion fluids, Beach is committed to test and treat completion fluids prior to discharge to ensure minor impacts to the environment. Section 6.7 details the impact analysis and evaluation which concludes discharge of drill cutting and fluids (including completion fluids) will result in reduction in water quality in the near vicinity of the discharge. The temporary,

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		low volume discharges of completion fluids will be diluted and dispersed by wave action and local currents which will reduce contaminant concentrations to levels below which could possibly result in acute or chronic toxic effects. As a result, there is little or no risk of bioaccumulation, bioconcentration or trophic transfer of chemicals. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC261 Paragraph 65d	d. The OPP's conclusions as to minor impacts rely on general data about settling, dispersion, and dilution of discharges. It does not provide modelling specific to the discharges that would take into account – for example – concentrations, dilution, period and frequency of the discharges, ocean conditions, and currents.	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impact assessment of drill cuttings and fluids and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Section 6.7 of the OPP provides a detailed assessment of planned discharges of drill cuttings and fluids. The impact assessment is based on the current level of planning, which in this case means the type of expected volume of fluids, however details such as specific chemical composition, concentrations, dilutions and frequency of discharges (as mentioned in the comment) are operational details which are determined much closer to the start of the activity. Subsequently, the OPP relies upon an understanding of what is typical in the industry. Throughout the impact assessment, peer-reviewed literature is cited to support the assessment of potential consequences. Justification is provided throughout as to why these literature sources are considered relevant to the Project, for example comparison in location and water depth or composition of discharge is provided. Through this process, Beach is able to confidently provide an assessment of impacts without refining the specifics of the planned discharges at this early stage. Beach has a high level of certainty on the predicted impacts from drill cuttings and fluids. Potential impacts from planned discharges of drill cuttings and fluids have been evaluated to result in Minor (I) consequences. Minor consequences are considered lower-order impacts that is acceptable with the application of good industry practice (Table 6-49). Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC262 Paragraph 65e	e. The OPP uses its unsupported conclusion that discharges will have negligible impact on fish, marine mammals, and marine reptiles as the basis for not further evaluating impacts.[104] However, as noted above, the conclusion is based on unsupported assertions regarding toxicity, bioaccumulation, and dispersion of contaminants, as well as unsupported statements about the transience of species in the region. This is despite several species, such as the blue whale and southern right whale, identified as threatened by chronic and acute chemical discharges.[105] [104] *OPP, p. 420.* [105] *OPP, p. 420.*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impact assessment of drill cuttings and fluids and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. As stated in the comment, several categories of receptor are scoped out of the assessment on the basis that impacts will be negligible. Fish, marine mammals and marine reptiles (as listed in the comment) are all species which live in the water column and are therefore potentially affected by changes in water quality. As described in the OPP (Section 6.7.3.1.1), a change in water quality is expected to be localised and temporary. This is based upon the current understanding of the nature of discharges (such as the type of fluids which will be used and expected volumes discharged), and peer-reviewed literature. Literature is selected where the discharge parameters or receiving environment is comparable to the Project and therefore can be used as a direct example of what the consequences from the Project will be. Impacts to water quality from planned discharges of drill cuttings and fluids are assesses as minor and will be controlled through implementation of industry best practise control measures. Motile fauna actively avoid discharge plumes and turbidity within the water column, reducing exposure time and therefore preventing acute and chronic consequence to receptors. Based on the assessment of minor impacts to water quality, the potential impact of these minor changes in water quality to individuals which will actively avoid area of disturbance is assessed to be below minor i.e. negligible. The comment refers to threats to marine mammal species from chronic and acute chemical discharges. The Conservation Management Plans for the Blue Whale (CoA, 2015b) and Southern Right Whale (DSEWPaC, 2012a) identify acute and chronic chemical discharges as a threat mainly in relation to hydrocarbon spills and bioaccumulation of pollutants. As bioaccumulation is not expected (based on the implementation of the chemical risk assessment) and hydrocarbons are not present in drill fluids and cuttings, acute and chronic chemical exposure are not predicted. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC263 Paragraph 65f	f. In assessing impacts on benthic communities, the OPP fails to account for accretion of sediments over time resulting from the multiple discharges over the life of the Project or to assess how the temporal aspect of sedimentation occurring multiple times can harm benthic communities. This is despite the OPP assuming a 2 km exposure radius for drilling discharges on the seabed.[106] [106] *OPP, p. 418.*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding impact assessment of drill cuttings and fluids and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Section 6.7.3.1.2 describes the changes in sediment quality from drill cuttings and fluids discharged during drilling operations. The deposition of sediments is expected to be highly localised around the well site. A study by Terrens et al (1998) of drilling impacts in the Bass Strait, described in Section 6.7.3.1.2, found after 11 months from drilling synthetic based drilling fluids were not detectable in the sediments indicating recovery of the seabed, and after one to two years recolonisation of benthic infauna and epifauna was observed. Section 6.7.3.1.3 also describes that the studies reviewed by Jones et al (2012) indicate that benthic infauna and epifauna recover relatively quickly after impacts from discharges of drill cuttings and fluids. Studies (Balcom et al., 2012; IOGP, 2016) have concluded that impacts to benthic habitats and communities as a result of drill cuttings and fluids discharges are minimal, resulting in highly localised impacts with benthic environments rapidly recovering to post-drilling conditions. A change in benthic habitats and communities as a result of planned discharges of drill cuttings and fluids is unlikely. Given that epifaunal communities are likely well represented in the region and that the footprint of the potential impact is small in comparison with the spatial extent of these communities in the Southeast Marine Region, there is a high level of confidence that drill cuttings and fluids will not destroy, fragment or isolate these communities nor modify or disturb substantial areas of habitat. Section 8 details the cumulative impact assessment method. As part of CIA scoping it is highlighted that "key environmental matters that could be materially affected by the cumulative impacts of the project and other reasonably foreseeable future projects and require a detailed CIA." Details of CIA scoping assessment Table 8-2 assessed cumulative impacts on benthic habitat and did not identify impacts that would warrant further detailed assessment for cumulative impact assessment outcomes. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC264 Paragraph 66	Comment: Commissioning and operational fluids Fluids associated with commissioning and operations will be discharged to the marine environment throughout the life of the Project, during drilling, installation, operations, and decommissioning: a. Hydraulic control fluids will be released during blow-out preventer functioning and pressure testing. Function tests are generally undertaken every 7 days and will release ~2200L of potable water with 1-3% water-soluble control fluids. Pressure tests are generally undertaken every 21 days and may release small volumes of water-soluble fluids. In addition, blow-out preventer fluids are released whenever the riser is unlatched.[107] b. Hydrotesting will result in the release of inhibited/treated seawater to the marine environment. Chemicals "may include" biocides, dyes, corrosion inhibitors, and scale inhibitors.[108] [107] *OPP, p. 429.* [108] *OPP, p. 429.*	Beach Energy (Operations) Limited (Beach) acknowledges this statement regarding commissioning and operational fluids and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to the statement. Beach confirms that the quoted sections of the activity description are correct. Hydraulic control fluid and hydrotest fluid are industry standard fluids used during all phases of an offshore development project. Hydraulic control fluid discharges occur as a result of safety critical testing, whilst hydrotesting (and subsequent discharge of hydrotest fluid) is an essential part of installation and commissioning which ensures that new infrastructure is successfully connected, reducing the likelihood of unplanned releases of fluid or reservoir hydrocarbons. No changes are required in response to this statement.
PC265 Paragraph 67	Comment: Although the OPP acknowledges that discharges of commissioning and operational fluids may cause localised changes to water quality that may impact the marine environment,[109] it fails to adequately support its conclusion that the impacts will be minor and acceptable: a. The OPP does not identify which chemicals will be used in hydrotesting, in what concentration and level of toxicity, and how often these discharges will occur. Without this information, the OPP cannot support its conclusions that chemicals will not persist in the environment or	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding discharges of commissioning and operational fluids and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. A description of fluids used and discharged during the Project is provided in Section 3.8 of the OPP, and a detailed assessment of planned discharges of commissioning and operational fluids is provided in Section 6.9. Chemicals used and discharged during the Project. In response to specific points raised in the comment: a. Specific fluids to be used for treating seawater during hydrotesting will be finalised and assessed in detail in the activity-specific EP. At this early stage, the assessment is based on typical chemicals expected to be used, i.e. Hydrosure 0-3670R as described in Appendix M of

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	bioaccumulate, and that any impacts on the marine environment will be minor. b. For example, the OPP fails to specify the biocide to be used. The modelling report commissioned by Beach (Appendix L to the OPP) assumes the use of Hydrosure 0-3670R, with an impact threshold of 1 ppm (equivalent to 1 mg/L), based on an assumption that concentrations below this level would not result in significant environmental impact.[110] It is from this assumption that conclusions about the minor significance of impacts from discharges is based. However, we understand that the biocide in Hydrosure is alkyl dimethyl benzyl ammonium chloride (ADBAC),[111] which the United States EPA has categorised as "highly toxic to fish" and "very highly toxic to aquatic invertebrates … on an acute exposure basis."[112] Even relatively low levels of ADBAC in treated seawater can be lethal at very short time periods; studies have found ADBAC is lethal to aquatic invertebrates over 48 hours with a no observable concentration level as low as 0.006 mg/L.[113] c. In any event, the modelling report indicates that chemicals within the discharge plume could well be at concentrations above the 1 mg/L threshold over a range of distances from the release point,[114] which may result in harm to species including plankton, benthic communities, and motile animals passing through the plume. d. Despite the frequency of discharges of hydraulic control fluids, the OPP does not identify the components of these fluids, model their dispersion, or provide any support for its conclusion that the fluid discharges will result in minor impacts. *[109] OPP, p. 429.* *[110] OPP, pp. 430, 1263 (Appendix L).*	the OPP. The exact discharge location, volume and duration will depend on the final flowline layout. b. Hydrosure 0-3670R is included as a typical biocide used in the offshore industry during hydrotest, and therefore a good proxy for the assessment at this early stage when chemical selection has not been finalised. Biocide is essential during hydrotest, as it aids in leak detection. As stated in the OPP, and in the Crux OPP (as referenced in the OPP), an impact threshold of 1 ppm of biocide was defined, which is consistent with published acute toxicity test data for aquatic species for typical biocides that may be used. The metrics typically used to measure toxicity are LC50 – the lethal concentration required to kill 50% of a population in the given time; and EC50 - the concentration at which 50% immobilisation of the test organism is observed in the given time. The Safety Data Sheet for Hydrosure 0-3670R states the 96-hour LC50 as 3.09 mg/L (3.09 ppm) for fish in marine waters, with a 48-hour EC50 of 5.66 mg/L (5.66 ppm) for aquatic invertebrates. Both of these levels are above the impact threshold set of 1ppm, meaning that the modelling is conducted to a conservative level. The OPP also notes that ecotoxicological studies are typically undertaken using constant doses for periods ranging from 24 to 96 hours under controlled conditions. This approach is in contrast to the natural environment, where the concentration and exposure durations can vary widely. c. The modelling replicates the behaviour of planned discharges in a range of environmental conditions (such as currents) and provides a prediction as to the area where exposure will be above the impact threshold of 1ppm. The far-field modelling results indicate that for the 99th and 100th percentile analysis (i.e. 99% and 100% of the time), the maximum distances from the Release Location to the predicted dilutions of 1:550 (i.e. 1 mg/L which represents the impact threshold concentration/trigger value) contour were 20m and 156 m, respectively. This is to say, it is predicted that the plume of fluid where biocide concentration will be above 1ppm is 20-156 m from the release location. Receptors within this boundary would be exposed to higher concentrations of the treatment chemicals (including biocide), however the high energy marine environment means that discharges will quickly dissipate on completion of hydrotest discharges. Effect concentrations and lethal concentrations are based on extended exposure (i.e. LC50 is measured after 96 hours of exposure, EC50 after 48-hours of exposure), which is not expected to occur as a result of hydrotest discharges. Subsequently, even concentrations above the impact threshold are not expected to result in measurable impacts to sensitive receptors, meaning that minor impacts are concluded to occur. d. Hydraulic control fluids are water-based, low toxicity and readily biodegradable (Section 6.9.2.1 of the OPP). This means that their discharge into the marine environment will inherently have a minor impact to receptors, as any exposure will be short-lived and non-toxic, and chemicals will disperse quickly in the marine environment meaning that the potential

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	[111] *See Santos, Barossa gas export pipeline installation environment plan (27 Oct. 2023, rev. 3.4), Table 5-24 (p. 247).* [112] *United States Environment Protection Agency, Reregistration eligibility decision for alkyl dimethyl benzyl ammonium chloride (ADBAC) (3 Aug. 2006), p. 45.* [113] *Toxicology Regulatory Services, Inc., Alkyldimethylbenzylammonuim Chloride (ADBAC) Category* *High Production Volume (HPV) Chemicals Challenge Final Test Status and Data Review (1 Mar. 2011), Table 3 (p. 22).* [114] *OPP, pp. 1250, 1267-1279 (Appendix L).*	timeframe for exposure will be short. Section 6.9 of the OPP has been updated to clearly provide justification for the consequence evaluation outcomes for hydraulic control fluids. Having considered these comments, Beach Energy has updated the OPP as described above.
PC266 Paragraph 68	Comment: Routine operational wastes from vessels The routine operational waste discharges will contribute to general water pollution in a marine area that is important to numerous species and ecosystems. The OPP acknowledges that these discharges may include sewage, grey water, putrescible waste, bilge water, deck drainage, cooling water, and desalination unit waste, and contaminants may include hydrocarbons, oil, grease, solvents, chemicals, detergents, drilling fluids, biocides, and any other chemical used in the daily operations of the facility.[115] [115] *OPP, pp. 435-437.*	Beach Energy (Operations) Limited (Beach) acknowledges the comment that routine operational wastes from vessels will contribute to general water pollution in the marine area and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this comment. As mentioned in Section 6.10.3.1, these discharges are intermittent, low volume, low toxicity and on release to the environment will rapidly dilute resulting in only localised and temporary impacts to water quality. Section 6.10.1 highlights that these discharges are subject to IMO regulations so most will undergo treatment prior to discharge. The temporary presence of routine discharges in the marine environment will prevent chronic exposure to marine fauna species and ecosystems and therefore injury, mortality or change to marine fauna species populations and ecosystems are not predicted. Section 6.10.3. has been updated to include the following text: "These discharges are intermittent, low volume, low toxicity and on release to the environment will rapidly dilute by prevailing waves and currents to below no effect levels, resulting in only localised and temporary impacts to water quality. The maximum extent of potential impact to water quality is conservatively predicted to be within 500 m of the MODU or vessels ~~and~~ resulting in a Minor (1) consequence.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		As described in Section 4.6, Sea Country connection extends far beyond the current coastline and includes the Project Area. These discharges will be intermittent, localised and without any long-term impacts to sediment or water quality. In addition, impacts to marine fauna (including eels and southern right whales) that have cultural value to First Nations people are not predicted. Discharges to the seabed has the potential to interfere with First Nations submerged cultural heritage. The implementation of underwater cultural heritage assessments within potential areas of disturbance in the Project area (CM11) will ensure any cultural heritage values are not impacted. Thus the consequence is assessed as Minor (1) to water quality and ecological receptors and therefore is assessed as Minor (1) for associated cultural values." Beach has considered these comments and updates have been made to the OPP as outlined above.
PC267 Paragraph 69	Comment: The OPP dismisses the potential impact of these discharges as minor with a "[l]ow level decrease in water quality in the near vicinity of the discharge" with impacts felt up to 500 m of the discharge.[116] However, similarly to its assessment of other types of discharges (discussed above), it ignores the potential harmful and toxic impacts of these discharges on individual species and ecosystems over the life of the project and fails to support the conclusion with adequate information. [116] *OPP, p. 437.*	Beach Energy (Operations) Limited (Beach) acknowledges the comment that routine operational wastes from vessels are potentially harmful and toxic to individual species and ecosystems and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this comment. As mentioned in Section 6.10.3, these discharges are intermittent, low volume, low toxicity and on release to the environment will rapidly dilute resulting in only localised and temporary impacts to water quality and are subject to IMO regulations so most will undergo treatment prior to discharge. The temporary presence of routine discharges in the marine environment will prevent chronic exposure to marine fauna species and ecosystems and therefore injury, mortality or change to marine fauna species populations and ecosystems are not predicted. <u>Section 6.10.3 has been updated to include the following text:</u> "...discharges are subject to IMO regulations so most will undergo treatment prior to discharge. On release to the environment, they will rapidly dilute resulting in only localised and temporary impacts <u>water quality</u>." Beach has considered these comments and updates have been made to the OPP as outlined above.
PC268	Comment: Finally, in relation to all types of planned discharges, there is no cumulative impact assessment. As	Beach Energy (Operations) Limited (Beach) acknowledges the comment that there is no cumulative impact assessment in relation to all types of planned discharges and has reviewed the Otway

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
Paragraph 70	the OPP acknowledges, the objectives of the Project include to "[u]tilise and extend existing infrastructure in the Otway Basin."[117] There is already operating offshore gas infrastructure in the Otway Basin in the Planning Area, as well as Beach infrastructure in the Project Area.[118] Many of the conclusions about the significance of the impact of planned discharges rely on volume, concentration, and dispersion of these discharges. However, because these discharges are not happening in isolation, but rather in the context of other offshore gas operations in the region, the OPP must undertake a cumulative impact assessment. [117] *OPP, p. 41.* [118] *OPP, pp. 74-76, 78-79, 264.*	Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this comment. Section 8 details the cumulative impact assessment method. As part of CIA scoping it is highlighted that "key environmental matters that could be materially affected by the cumulative impacts of the project and other reasonably foreseeable future projects and require a detailed CIA." Details of CIA scoping assessment Table 8-2 did not identify planned discharges (in combination with other aspects) to have the potential to cause material affects to key environmental matters (receptors), therefore planned discharges was not put forward for detailed assessment for cumulative impact assessment outcomes). The context of other offshore operations in the region have also been assessed in detail in Table 8-1 of Section 8 of the cumulative impact assessment. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC269 Paragraph 71	Comment: Culturally important species affected by hydrocarbon spills Hydrocarbon spills threaten Nyamat Mirring[119] in several ways, including posing risks of dissolved oil exposure for the entirety of the Gundatjmara coastal Country stretching from Discovery Bay to the West to Hopkins River mouth/Warnmambool in the East,[120] entrained oil exposure along the coast and Nyamat Mirring,[121] and shoreline oiling approaching or overlapping with the Hopkins River mouth/Warnmambool.122 [119] *Gunditjmara Sea Country includes the coastal land and water from Bocara (Glenelg River) in the West to the Hopkins River in the East (emptying out near Warnmambool), and extends out to sea into Discovery Bay, Portland Bay surrounding Deen Maar Island: see Gunditjmara Nyamat Mirring Plan, p. 11.* [120] *See, for example, OPP, p. 490, Figure 130 (modelled during summer).*	Beach Energy (Operations) Limited (Beach) acknowledges the comment that hydrocarbon spills threaten Gundatjmara Nyamat Mirring and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this comment. Beach has provided details on condensate spill exposure evaluations (Tables 7-24, 7-25) to First Nations Sea Country. The condensate spill exposure evaluations have been updated to specify that Gunditjmara Sea Country is predicted to be exposed to in-water and surface hydrocarbons in the event of a condensate spill. Dissolved hydrocarbon exposure extent for First Nations Sea Country evaluation in Table 7-25 has been updated as follows: "In-water exposure to hydrocarbons is predicted along ~~the Victorian~~ coastal First Nations Sea Country including Victorian coastal waters stretching from Discovery Bay to the west to Hopkins River mouth/Warnambool in the east. Sea Country predicted to be exposed to in-water exposure to hydrocarbons is adjacent to the Eastern Maar Native Title determination (Tribunal File No. VCD2023/001), Gunditjmara Native Title determination (Tribunal File No. VCD2007/001) and Preminghana Indigenous Protected Area. ~~within the planning area which is Sea Country for a~~

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	[121] *OPP, p. 492, Figures 132-3.* [122] *OPP, p. 489, Figure 129.*	~~number of First Nations groups and is adjacent to the Eastern Maar Native Title comment and Preminghana Indigenous Protected Area~~." Shoreline hydrocarbon exposure extent for First Nations Sea Country evaluation in Table 7-24 has been updated as follows: "Marine pollution can result in reduced visual aesthetic. The modelling predicts shoreline exposure at the low threshold within Victorian First Nations areas of ~~Eastern Maar Aboriginal Corporation (and Native Title comment)~~ Eastern Maar Native Title determination (Tribunal File No. VCD2023/001), Gunditjmara Native Title determination (Tribunal File No. VCD2007/001), and Bunurong Land Council Aboriginal Corporation. The modelling predicts shoreline exposure at the low threshold, with some limited areas of moderate threshold, on the western side of King Island. Beach have updated the OPP to reflect changes as shown above in Tables 7-24 and 7-25.
PC270 Paragraph 72	Comment: The Planning Area encompasses the environment that may be affected by a potential hydrocarbon spill.[123] Within the Planning Area, the PMST Report finds that the critically endangered King Island Brown Thornbill, King Island Scrubtit, Curlew Sandpiper, Great Knot, Swift Parrot, Orange-bellied Parrot, Eastern Curlew, Southern Bent-wing Bat are known to occur, and the critically endangered Regent Honeyeater and Plains-wanderer bird species are likely to occur in the area. [123] *"The outer boundary of the Planning Area is the worst-case and largest spatial extent where unplanned hydrocarbon releases from Project activities could have an environmental consequence": OPP, p. 26.*	Beach Energy (Operations) Limited (Beach) acknowledges the comment that the mentioned critically endangered species identified by the Protected Matters Search Tool (PMST) as likely or known to occur within the Planning Area and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this comment. The OPP Description of Environment (Section 4) includes all species with an *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) listing that have a presence in the Project or Planning Area, as identified in the PMST Report. As described in OPP Section 4.4.9. (Threatened and Migratory Species), species listed as threatened or migratory under the EPBC Act and known or likely to occur in the Project or Planning Areas and/or have an intercepting BIA with the Project or Planning Areas are discussed in more detail. The description of environment is the basis for the impact and risk assessment. Species with higher status of protection, or those engaging in biologically important behaviours, are assessed in the greatest detail to account for nature and scale of impacts. The PMST detects all EPBC Act listed species with an occurrence in the area. Due to the grid sizes used in the PMST, species outside of the actual search area can be detected, including terrestrial species. Species that only occur in terrestrial habitats are not included in the OPP as they do not have potential to be impacted by the activities.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		The southern bent-wing bat (EPBC Act listed as critically endangered) was identified by the PMST as breeding known to occur within the Planning Area (Appendix B). However, this species was not detailed further in the OPP due to its terrestrial ecology. The southern bent-wing bat is an obligate cave-dwelling species which roosts underground in limestone caves, crevices and manmade tunnels and is understood to forage along forested ridgelines, pastures, wetlands and swamps. Southern bent-wing bats feed primarily on moths and foraging occurs primarily in open spaces via fast, direct flight patterns (DELWP 2020). Additionally, no threats directly relevant to the Project were identified in either the Conservation Advice (TSSC 2021) or National Recovery Plan for the species (DELWP 2020). As such, this species is not included in the OPP as it does not have the potential to be impacted by the Project. The following EPBC listed critically endangered terrestrial bird species are identified in the PMST and listed in Table 4-22 of the OPP: • King Island brown thornbill • King Island scrubtit • Plains-wanderer • Regent honeyeater • Swift parrot These species occur in terrestrial habitats and thus do not have the potential to be impacted by a hydrocarbon spill and are not discussed further (DCCEEW 2024a). The following EPBC listed critically endangered bird species which are known to utilise coastal habitats are identified in the PMST and listed in Table 4-22 of the OPP: • Curlew sandpiper • Eastern curlew • Great knot • Orange-bellied parrot The curlew sandpiper, eastern curlew and great knot are described further in Section 4.4.9.4.6 of the OPP and the orange-bellied parrot is described further in Section 4.4.9.4.4. These species are known to occur in coastal habitats and thus have potential to be impacted by a hydrocarbon spill. Seabirds are evaluated against impact and risk aspects for floating oil exposure in Section 7.4.2.4

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		of the OPP. The environmental impact summary tables of the OPP have been updated as follows to include exposure and consequence evaluations against impacts to shorebirds and seabirds from shoreline hydrocarbon exposure. Table 7-21 of the OPP has been updated to include an additional row for seabirds and shorebirds for MDO shoreline exposure: "Exposure evaluation (Column 4)" The modelling predicts potential shoreline exposure at the moderate threshold at Cape Otway West and Moonlight Head from MDO release at the north release location. The moderate threshold is not predicted to be reached based on MDO release at the TW1 release location. Several listed threatened, migratory and/or listed marine seabird and shorebird species have the potential to be foraging at these locations. Shorelines at the Otway coast with the potential to be exposed to moderate hydrocarbon thresholds overlap a foraging BIA and a breeding BIA and therefore may expose birds to shoreline hydrocarbons for the short-tailed and wedge-tailed shearwater at Muttonbird Island. "Consequence evaluation (Column 5)" Shorebird species foraging for invertebrates in intertidal feeding habitats, such as exposed sand and mud flats at lower tides, will be at potential risk of both direct impacts through contamination of individual birds (ingestion or soiling of feathers) and indirect impacts through the contamination of foraging areas that may result in a reduction in available prey items (Clarke 2010). Any direct impact of oil on terrestrial habitats has the potential to contaminate seabirds present at the breeding sites (Clarke 2010). Bird eggs may also be damaged if an oiled adult sits on the nest. Fresh crude was shown to be more toxic than weathered crude, which had a medial lethal dose of 21.3 mg/egg (Clarke 2010). Studies of contamination of duck eggs by small quantities of crude oil, mimicking the effect of oil transfer by parent birds, have been shown to result in mortality of developing embryos (French-McCay 2009). Shoreline accumulation will be concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA 1995). As breeding activities of shorebirds and seabirds generally occurs above the high tide mark, exposure to hydrocarbons is considered unlikely to occur.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		However, oiled bird species may track oil into their nests, which may then have subsequent impacts on any eggs present. The little penguin would be the highest-risk species, as they have to traverse through the intertidal area to reach nesting sites. Based on the worst-case scenario, the modelling predicted the maximum probability of shoreline accumulation at, or above, the moderate (100 g/m^2) threshold from MDO release at the northern release location to occur at Cape Otway West (6% probability) with the minimum time for shoreline contact predicted as 6.8 days with a peak volume ashore of 4.46 m^3 and Moonlight Head (2% probability) with the minimum time for shoreline contact predicted as 7.7 days with a peak volume ashore of 2.45 m^3 (RPS 2024). Acute or chronic toxicity impacts (death or long-term poor health) to seabirds and shorebirds is possible, however, with the minimum time for shoreline contact predicted as 6-7 days, potential contamination of nests and eggs from oiled parent bird species is limited to weathered MDO. The Otway coast, including Cape Otway West and Moonlight Head, is exposed to substantial wave action that would further break down any shoreline hydrocarbons. The limited exposure to shoreline hydrocarbons will prevent potential death or long-term poor health to seabirds and shorebirds over multiple breeding seasons, therefore it is expected that shoreline hydrocarbons will only impact a single breeding season at most. Consequently, the potential consequence is considered to be **Serious (3)**, as they could be expected to result in serious impact on valued species or habitat." Table 7-24 of the OPP has been updated to include an additional row for seabirds and shorebirds for condensate shoreline exposure: "Exposure evaluation (Column 4)" The modelling predicts potential shoreline exposure at or above the moderate threshold only along the Otway coast from LOWC condensate release at the northern location. No shoreline exposure at, or above, the moderate threshold was predicted for the southern release locations. Several listed Threatened, Migratory and/or listed marine bird species have the potential to be foraging or nesting at these locations. Shorelines exposed at or above moderate hydrocarbon thresholds include a breeding BIA for the wedge-tailed shearwater as well as breeding BIAs and surrounding foraging BIAs for the black-faced cormorant, common diving-petrel, little penguin and short-tailed shearwater. "Consequence evaluation (Column 5)'

ID	Summary of comments received	Beach’s assessment of merit of comment(s) and response(s) to comments and/or objections
		Shorebird species foraging for invertebrates in intertidal feeding habitats, such as exposed sand and mud flats at lower tides, will be at potential risk of both direct impacts through contamination of individual birds (ingestion or soiling of feathers) and indirect impacts through the contamination of foraging areas that may result in a reduction in available prey items (Clarke 2010). Any direct impact of oil on terrestrial habitats has the potential to contaminate seabirds present at the breeding sites (Clarke 2010). Bird eggs may also be damaged if an oiled adult sits on the nest. Fresh crude was shown to be more toxic than weathered crude, which had a medial lethal dose of 21.3 mg/egg (Clarke 2010). Studies of contamination of duck eggs by small quantities of crude oil, mimicking the effect of oil transfer by parent birds, have been shown to result in mortality of developing embryos (French-McCay, 2009). Shoreline accumulation will be concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA, 1995). As breeding activities of shorebirds and seabirds generally occurs above the high tide mark, exposure to hydrocarbons is considered unlikely to occur. However, oiled bird species may track oil into their nests, which may then have subsequent impacts on any eggs present. The little penguin would be the highest-risk species, as they have to traverse through the intertidal area to reach nesting sites. Based on the worst-case scenario, the modelling predicted the maximum probability of shoreline accumulation at, or above, the moderate (100 g/m^2) threshold from a LOWC condensate release at the Northern location at Cape Otway West (34%), followed by Moonlight Head (11%), Point Hicks (10%) and Port Campbell (1%). The minimum time to shore was at Cape Otway West (9 days), followed by Moonlight Head and Port Campbell (both 18 days), then Point Hicks (46 days). Cape Otway West had the maximum peak volume ashore predicted (6.6 m^3), followed by Point Hicks (5.56 m^3), Moonlight Head (4.39 m^3), and Port Campbell (1.76 m^3). The modelling predicted no shoreline accumulation at, or above, the moderate (100 g/m^2) threshold to occur from the southern spill release location. Acute or chronic toxicity impacts (death or long-term poor health) to seabirds and shorebirds is possible, however, with the minimum time for shoreline contact predicted as 9-46 days, potential contamination of nests and eggs from oiled parent bird species is limited to weathered condensate. Also, given the predicted minimum time for oil to reach shorelines within breeding

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		BIAs is 9-46 days. The majority of condensate at sea is likely to have dissipated during that time. The Cape Otway coast is exposed to wave and tidal action that would further breakdown any shoreline hydrocarbons. The limited exposure to shoreline hydrocarbons will prevent potential death or long-term poor health to seabirds and shorebirds over multiple breeding seasons, therefore it is expected that shoreline hydrocarbons will only impact a single breeding season at most. Consequently, the potential consequence is considered to be **Serious (3)**, as they could be expected to result in serious impact on valued species or habitat." Beach has considered these comments and updates have been made to the OPP as outlined above. *References:* *Clarke RH (2010). The Status of Seabirds and Shorebirds at Ashmore Reef and Cartier and Browse Islands: Monitoring program for the Montara Well release - Pre-impact Assessment and First Post-impact Field Survey. Prepared on behalf of PTTEP Australasia and the Department of the Environment, Water, Heritage and the Arts, Australia.* *DCCEEW (2024a). Species Profile and Threats Database- SPRAT Profile. Department of Climate Change, Energy, the Environment and Water. Accessed May 2024 at: https://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.* *DELWP (2020). National Recovery Plan for the Southern Bent-wing Bat Miniopterus orianae bassani. The State of Victoria Department of Environment, Land, Water and Planning. Retrieved from: https://www.dcceew.gov.au/sites/default/files/documents/recovery-plan-southern-bent-wing-bat.pdf* *French-McCay DP (2009). State-of-the-Art and Research Needs for Oil Spill Impact Assessment Modelling. Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response. 2.* *IPIECA (1995). Biological Impacts of Oil Pollution: Rocky Shores. IPIECA. London.* *RPS (2024). Offshore Gas Victoria Oil Spill Modelling GOC365512). August 2024. Report for Beach Energy.* *TSSC (2021). Conservation Advice: Miniopterus orianae bassani Southern Bent-wing Bat. Threatened Species Scientific Committee established under the Environment Protection and Biodiversity Conservation* Act 1999. Retrieved from:

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		http://www.environment.gov.au/biodiversity/threatened/species/pubs/87645-conservation-advice-14062021.pdf
PC271 Paragraph 80	Comment: Environmental impact thresholds are not best available science Beach uses thresholds for environmental impacts that rely on outdated science and are not in accord with recent findings since the Deepwater Horizon disaster. Beach's hydrocarbon model relies on studies from 1996 and 2009 to determine that environmental impacts "occur at 10 g/m2 (a film thickness of approximately 10 µm or 0.01 mm)" of hydrocarbon sheens.[144] Deepwater Horizon showed species' mortality rates occurring from sheens as thin as 1 µm.[145] Mortality from thin sheens of 1 µm occurred at rates of 34% even where exposure was limited to 24 hours.[146] The oil spill model assessment is not acceptable until it is re-done with impact assumed to occur at levels of 1 µm. [144] *OPP, Appendix M, p. 32.* [145] *"When exposed to the integrated average dose of UV light in the Gulf of Mexico over the course of the spill, the toxicity (percent mortality) of thin surface sheens to red snapper (embryo), bay anchovy (embryo), spotted seatrout (embryo), and mysid shrimp (juvenile) is 85, 89, 100, and 100 percent mortality, respectively" where thin sheens were defined as 1 µm thick: Deepwater Horizon EIS, pp. 4-169.* [146] *"The results of these studies demonstrated that exposure to even thin sheens of oil were extremely toxic to developing fish. The longer organisms spent in contact with the oil sheen, the more likely they were to die. For example, red drum embryos exposed to sheens made with weathered oil (Slick A) for 24, 48, or 60 hours experienced an average of 34, 68, or 74 percent mortality in excess of controls, respectively": Deepwater Horizon EIS, pp. 4-169.*	Beach Energy (Operations) Limited (Beach) acknowledges the claim that hydrocarbons thresholds used are not in accordance with findings from Deepwater Horizon disaster studies and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this claim. The hydrocarbon exposure thresholds used for the spill modelling and OPP risk analysis and evaluation are based on the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) Bulletin: Oil Spill Modelling (NOPSEMA 2019). The oil spill modelling NOPSEMA Bulletin (2019) was developed after publication of the Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement (Westerholm and Rauch 2016) and includes French McCay (2016) references of potential effects thresholds for oil spill risk assessments based on findings from the Deepwater Horizon oil spill. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments. *References* *Westerholm, David A. and Rauch, Samuel Dean, III, 1966- (2016). Deepwater Horizon oil spill : final programmatic damage assessment and restoration plan and final programmatic environmental impact statement. National Oceanic and Atmospheric Administration.* *French McCay, D. (2016). Potential Effects Thresholds for Oil Spill Risk Assessments, Proceedings of the 39th AMOP Technical Seminar, Environment and Climate Change Canada, Ottawa, ON, pp. 285-303.* *NOPSEMA (2019). Environmental Bulletin: Oil Spill Modelling. Document number: A652993. April 2019. National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/sites/*default/files/documents/2021-04/A652993.pdf

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC272 Paragraph 81	Comment: No modelling of routine operational spills Beach assesses impacts of routine discharges from vessels and operations, but the hazards of routine operations do not include hydrocarbons routinely spilled from vessel traffic or other offshore operations.[147] Routine discharge of hydrocarbons can result in chronic exposure for species, and chronic effects can begin at concentrations as low as 7 µg/L total petroleum hydrocarbons (TPH).[148] The amounts of routine spills must be quantified and their impacts assessed. [147] *OPP, p. 435.* [148] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, *Oils and petroleum hydrocarbons in freshwater and marine water* (October 2000).	Beach Energy (Operations) Limited (Beach) acknowledges the claim that hazards of routine operations do not include routine spills from other offshore operations and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this claim. Accidental discharge of small quantities of hydrocarbons, hydraulic oils/fluids and lubricants plus hydrocarbon-contaminated materials (e.g., oily rags, pipe dope, oil filters) are assessed within Section 7.3 (Accidental Discharge – Hazardous and Non-Hazardous Materials) of the OPP. The risk assessment (residual) within Section 7.3 (Table 17-12) of an unplanned loss of hazardous or non-hazardous materials to marine environment from Project activities has been assessed as having a risk rating of Low (Consequence – Minor; Likelihood – Unlikely). In addition, Section 8 details the cumulative impact assessment (CIA) method. As part of CIA scoping it is highlighted that "key environmental matters that could be materially affected by the cumulative impacts of the project and other reasonably foreseeable future projects and require a detailed CIA." Details of CIA scoping assessment Table 8-2 did not identify planned discharges (in combination with other aspects) to have the potential to cause material affects to key environmental matters (receptors), therefore planned discharges was not put forward for detailed assessment for cumulative impact assessment outcomes. The context of other offshore operations in the region have also been assessed in detail in Table 8-1 of Section 8 of the cumulative impact assessment. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC273 Paragraph 82	Comment: Details of oil spill response must be disclosed because the plan may cause significant harm Beach does not appear to have completed its oil spill response plan for the project, stating that "Oil spill response arrangements associated with the Project will be detailed in the relevant Offshore Oil Pollution Emergency Plan (OPEP)."[149] Beach must disclose the details of its OPEP since oil spill response plans can cause additional	Beach Energy (Operations) Limited (Beach) acknowledges the claim that oil spill arrangements have not been assessed and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this claim. Unlike an Environment Plan (EP), an OPP is not required to provide details of the implementation strategy. Under the OPGGS (Environment) Regulations, an Oil Pollution Emergency Plan (OPEP) is required as part of the implementation strategy for the activity-specific EP. Beach will provide a full risk analysis and evaluation of feasible oil spill response options in the associated EPs. Not all response options and tactics are appropriate for every oil spill, such as those oil spill responses

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	environmental harms, which have not been assessed. For example: a. Dispersants used in oil spill response plans are chemicals that can be lethal to marine organisms on their own.[150] In response to the Deepwater Horizon incident, 1.84 million gallons of two dispersants—Corexit 9500A and Corexit 9527A—were applied that "raised concerns about the potential for toxic effects of dispersed oil in the water column, as well as the potential for hypoxia due to bacterial consumption of dispersed oil."[151] b. Synthetic-based muds used in attempts to kill a well blowout can contain petroleum-based chemicals and barium sulphate, which can smother biota on the sea floor when released in sufficient quantity.[152] c. Controlled burns can result in enormous amounts of atmospheric pollution. In response to Deepwater Horizon, personnel conducted 411 controlled burns of surface oil slick that were unprecedented in U.S. history, exceeding any previous in situ burn in both duration and magnitude. Plumes of smoke from burning oil primarily consisted of aerosolised black carbon soot that increased air pollution.[153] [148] *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Oils and petroleum hydrocarbons in freshwater and marine water (October 2000).* [149] *OPP, p. 543.* [150] *Deepwater Horizon EIS, pp. 4-115.* [151] *Deepwater Horizon EIS, pp. 2-11.* [152] *Deepwater Horizon EIS, pp. 2-11.* [153] *Deepwater Horizon EIS, pp. 2-12.*	listed in points a, b and c. In each associated EP under this OPP, a response option assessment will be undertaken to identify suitable and recommended oil spill responses to be adopted in the event of a spill. In the OPP, Beach has provided detail of their Environmental Management System (Section 9) which provides a high-level overview of Beach's approach to implementation and a summary of the systems, practices and procedures used to ensure implementation of activities. The OPP includes a commitment that accepted EPs will have an OPEP and Operational and Scientific Monitoring Plan (OSMP) in place relevant to the activity and oil spills will be responded to in accordance with the plans. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC274	Comment: There are several culturally important species for Gunditjmara that are also found in the Planning Area,	Beach Energy (Operations) Limited (Beach) acknowledges the comment that hydrocarbon spills threaten Gunditjmara Nyamat Mirring and culturally relevant species and has reviewed the Otway

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
Paragraph 73	including Kooyang (Eels), which have been a valuable resource for thousands of years.[124] Eels at sea may be particularly vulnerable to hydrocarbon spills.[125] Risks of spills and accidents from the Project on Gunditjmara Country and culturally relevant species should be modelled using worst case scenarios (as below) [124] *Gunditjmara Nyamat Mirring Plan, p. 17.* [125] *NWF Blog, Dead Eel found in BP Oil Slick, (May 2010); Japan Times, Sea life around Mauritius dying as Japanese ship oil spill spreads (August 2020).*	Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this comment. Beach have provided details on marine diesel oil (MDO) and condensate spill consequence evaluations (MDO Tables 7-20 to 7-22 and condensate Table 7-23 to 7-25) to First Nations Sea Country. The MDO and condensate spill consequence evaluations have been updated to describe potential impacts to culturally important species for First Nations people in the event of an MDO or condensate spill, namely eels and whales as specified in Sections 4.6.3.4.2 and 4.6.3.4.3. Table 7-20 has been updated as follows, based on potential risk to whales from floating oil exposure: "Consequence Evaluation - Beach understands that First nations people are linked to the marine environment and may be affected by a change in the environment. Although no long term or permanent changes to marine environment are expected it is considered that the visual presence of floating oil may impact Sea Country at a spiritual level (ie rituals, songlines, totem species culturally important species) and could affect culturally important activities such as mutton birding or affect ~~totem fauna~~ culturally important species including whales. There may be short-term and localised consequences, which are ranked as Moderate (2). Refer also to: cetaceans (whales) exposure and consequence evaluation ecological receptors above." Table 7-21 has been updated as follows, based on no risk to eels and whales from shoreline hydrocarbons: "Beach understands that First nations people are linked to the marine environment and may be affected by a change in the environment. Although no long term or permanent changes to marine environment are expected it is considered that the visual presence of shoreline oil may impact Sea Country at a spiritual level (ie rituals, songlines, ~~totem species~~) and could affect culturally important activities such as mutton birding ~~or affect totem fauna~~ The predicted minimum time for oil to reach a shoreline means it is likely to have dissipated during that time. Both Cape Otway and the west side of King Island are exposed to substantial wave action that would further breakdown any shoreline hydrocarbons. The relatively low volume means there may be short-term and localised consequences, which are ranked as Moderate (2)"

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Table 7-22 has been updated as follows, based on potential risk to eels and whales from in-water hydrocarbon exposure: "Section 4 details the connection First Nations people have to Sea Country which could be potentially impacted by in-water exposure to hydrocarbons. The relatively low volume means there may be short-term and localised consequences. Although no long term or permanent changes to marine environment are expected the short-term contamination of Sea Country may result in impacts associated at a spiritual level (ie rituals, songlines, culturally important species) and could affect culturally important activities such as mutton birding or affect culturally important species including eels and whales. The potential short-term and localised consequences are ranked as Moderate (2). Refer also to: fish (including eels) and cetaceans (whales) exposure and consequence evaluations above." Table 7-23 has been updated as follows, based on potential risk to whales from floating oil exposure: "Visible surface hydrocarbons (i.e. a rainbow sheen) have the potential to reduce the visual amenity of the areas of Sea Country. The distance from shore means there may be minor consequences and some impact. Beach understands that First nations people are linked to the marine environment and may be affected by a change in the environment. Although no long term or permanent changes to marine environment are expected it is considered that the visual presence of floating oil may impact Sea Country at a spiritual level (ie rituals, songlines, culturally important species) and could affect culturally important activities such as mutton birding or affect culturally important species including whales. There may be short-term and localised consequences, which are ranked as Moderate (2). Refer also to: cetaceans (whales) exposure and consequence evaluation above." Table 7-24 has been updated as follows, based on no risk to eels and whales from shoreline hydrocarbons: "Visible shoreline hydrocarbons has the potential to reduce the visual amenity of Sea Country. The predicted minimum time for oil to reach a shoreline is 6.54 days for the Victorian coast, 6.92 days for King Island and 33 days for north-west Tasmania and it is likely to have dissipated during that time due to substantial wave action that would breakdown any shoreline hydrocarbons. Although

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		no long term or permanent changes to marine environment are expected it is considered that the visual presence of shoreline oil may impact Sea Country at a spiritual level (ie rituals, songlines) and could affect culturally important activities such as mutton birding. The relatively localised extent and low volume means there may be short-term and localised consequences, which are ranked as Moderate (2)." Table 7-25 has been updated as follows, based on potential risk to eels and whales from in-water hydrocarbon exposure: "Section 4 details the connection First Nations people have to Sea Country which could be potentially impacted by in-water exposure to hydrocarbons. Although no long term or permanent changes to marine environment are expected the short-term contamination of Sea Country may result in impacts associated at a spiritual level (ie rituals, songlines, culturally important species) and could affect culturally important activities such as mutton birding or affect culturally important species including eels and whales. The potential short-term and localised consequences are ranked as Moderate (2). Refer also to: fish (including eels) and cetaceans (whales) exposure and consequence evaluations above. ~~There may be short-term and localised consequences, which are ranked as Moderate (2)~~" Beach has considered these comments and updates have been made to the OPP as outlined above.
PC275 Paragraph 74	Comment: No justification of the probability or likelihood of a spill Beach assumes that the risk of a marine diesel oil spill from vessels is "Highly Unlikely" and a condensate spill is "Remote."[126] Beach provides no information to justify either conclusion. Beach confesses to significant hydrocarbon spills in the Otway basin as recently as Fiscal Year 2021 and 2015;[127] in addition, there are likely ongoing oil spills from maritime vessels in the area.[128] Beach discloses no summary of all incident reports in the Otway basin that would inform an assessment of the likelihood of spills based on these historical numbers, and	Beach Energy (Operations) Limited (Beach) acknowledges the comment that no detailed information has been provided to justify the highly unlikely and remote likelihoods of marine diesel oil (MDO) and condensate spills, respectively, and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this comment. Section 7.4.3 has been updated to include additional information on oil spill incidents in the Otway Basin: Historical LOWC incidents listed in the IOGP Risk Assessment Data Directory (2019) found blowout events during development drilling for a gas well to be at a frequency of 4.2 x 10-5 per drilled well; for development drilling operations on deep, normal wells of North Sea standard (IOGP, 2019). This frequency is based on two blowout incidents occurring in the UK between 1980 and 2014

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	performs no analysis as to how climate change will increase intensity of storms that are likely to increase the risk of collisions or spills. Both NOPSEMA and Beach should provide the public with a list of all hydrocarbon spills in the Otway Basin for the last 30 years and the amounts spilled to inform an assessment of how likely future spills would be over the next 30 years of the life of the project. [126] *OPP, p. 518.* [127] *Beach, Otway Basin Update, (9 Dec. 2021) p. 5.* [128] *See, e.g., Dianne Padley, University of Adelaide, Petroleum Geochemistry of the Otway Basin and the Significance of Coastal Bitumen Strandings on Adjacent Southern Australian Beaches (1995), section 9.2 (analysing bulk composition and alkane parameters of crude oils in oil slicks in Otway Basin to determine that many oil slicks in the area dating back to the 1980s are a "result of maritime pollution").*	during development drilling (IOGP, 2019); and represents the frequency of the cause (i.e. LOWC) that results in the worst-case consequence. Review of Australian Transport Safety Bureau vessel collision type marine investigations in Victorian waters between found only two vessel collision incidents both between container ship and fishing vessel (ATSB 2024). Both collisions did not result in loss of hydrocarbons. To date no incidents relating to LOWC or vessel collision events have occurred during Beach operations in Australia including in the Otway basin. Future spills from LOWC or vessel collision events are considered remote and highly unlikely events based on history of no known MDO or condensate spills in southern Australia from LOWC or vessel collision events. Beach has reviewed the reference 127 (Otway Basin Update of 9 December 2021) and the comment of significant hydrocarbon spills in the Otway Basin. The reference is from a presentation on (onshore) Otway Basin activities in South Australia which included a high-level summary of Beach's Corporate Health, Safety and Environment Performance for the period FY15 to FY22 across its portfolio. As Beach acquired its interest in the Offshore Otway Basin in the beginning of FY18 (1 July 2017) the hydrocarbon spills recorded in Beach's portfolio in FY15 does not relate to the offshore Otway Basin. In FY21, a spill occurred in the offshore environment with the discharge of drilling fluid. Beach complies with its requirements to notify of incidents Under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023. Beach also reports annual on environmental performance, including spills, in its Sustainability Report (publicly available on Beach's website). Beach have reviewed the study conducted by Padley (1995) and will not include findings/reference into the OPP. Padley (1995) does not highlight loss of MDO from vessel collision or Loss of well control (LOWC) as incidents resulting in the bitumen strandings found in southern Australian waters in 1986, 1990 and 1991 Padley (1995) states the sources of waxy bitumen strandings in southern Australian waters are believed to be the result of either accidental discharge or deliberate pumping of oil from tankers and cargo vessels after tank cleaning operations; recreational and commercial fishing boats with fuel leaks or pumped out dirty bilge water; illegal dumping of sludge from bunker fuel tanks and slop tanks; the pumping of dirty bilge and ballast water; or tanker-cleaning operations. Specifically, Section 9.2 of Padley, 1995, highlights those investigations into the geochemistry of oil slicks found the sources to be from maritime oil pollution incidents from: • Spills of mixed marine and terrestrial crude oils from tankers enriched in waxes

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		• Unlawful discharge of oil to sea from MV Arthur Phillip • Natural fractionation of petroleum seeping from submarine reservoirs, followed by long-distance ocean transport • Surfboard wax or residues of tanker cleaning operations Padley (1995) also mentions that crude oils spilled from ships in southern Australian waters, or the last surviving relics of oils that have been transported around Australia by ocean currents may also be sources of bitumen strandings in southern Australian beaches in 1086, 1990 and 1991. Given the sources of bitumen strandings were not found to be the result of LOWC or vessel collision events, Padley (1995) will not be cited in the OPP. Having considered these comments, Beach has included additional information in the OPP as described above. *References* *IOGP (2019). Risk Assessment Data Directory of Blowout Frequencies. Available online https://www.iogp.org/bookstore/product/risk-assessment-data-directory-blowout-frequencies/* *Australian Transport Safety Bureau [ATSB] (2024). Marine investigations database. https://www.atsb.gov.au/marine-investigation-reports*
PC276 Paragraph 75	Comment: Beach did not provide sufficient information to establish that it has modelled the worst case scenario for the following reasons	Beach Energy (Operations) Limited (Beach) acknowledge the statement about modelling of worst case scenario for hydrocarbon spills for the Otway Offshore Gas Victoria Project. This is a general statement with specific comments about hydrocarbon spills summarised and addressed in this public comment report (see PC277 to PC286).
PC277 Paragraph 76	Comment: First, Beach did not justify why the chosen locations for the well blowouts would cause a worst-case scenario. The locations selected for the hydrocarbon spill model were selected for their northern and most southern positions,[129] not on whether these locations would cause the worst case of environmental harm. For example, there is no description as to why these two locations would generate a worst-case hydrocarbon spill for any sensitive species or ecosystem. The methodology section of the hydrocarbon spill model describes no process that went	Beach Energy (Operations) Limited (Beach) notes the comment about modelling of worst case scenario for hydrocarbon spills for the Otway Offshore Gas Victoria Project. As summarised in the introduction to this Report, new quantitative spill modelling was undertaken to model the loss of well control in the southern well location to replace T/30P well location (now outside the Project Area) with Thylacine West 1 location (within the Project Area) (see Appendix M, Figure 7-1 and Table 7-17 of OPP). National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) Guidance Note on Oil Pollution Risk Management set out the requirement for establishing the context of oil pollution risk. In this context, the worst case scenario or discharge is based on the

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	into selecting the spill sites.[130] A "range of environmental receptors and shorelines were assessed," not for determining which site would cause a worst case hydrocarbon spill, but for how a release of hydrocarbons from chosen sites would impact those receptors.[131] [129] *OPP, p. 457 ("Two release locations for both the MDO and condensate spill scenarios within the Project Area were selected to ensure a conservative assessment. Release Location North is the most northerly potential well location, and nearest to the Victorian coast, and Release Location South is the most southerly well location, nearest to the Tasmanian Coast (King Island) and Zeehan AMP").* [130] *OPP, Appendix M, pp. 1-5.* [131] *OPP, Appendix M, p. 43.*	activity, location, reservoir characteristics and hydrocarbon properties. As stated in section 7.4.1 of the OPP, *Guidance on the identification of worst-case credible spill scenarios is given in AMSA's Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities (AMSA 2015) and Technical Report on Calculation of Worst-Case Discharge (SPE 2016)*. These documents were used to identify the potential significant and credible loss of containment scenarios associated with the Project as detailed in Table 7-16. For the condensate loss of containment scenarios, Beach has a high degree of confidence in the estimated release rates and timing used for the modelling as they are based on known reservoir properties and flow rates. The spill modelling for the release location north and south of the Project Area is based on the reservoir properties of a wells drilled and produced in the Otway Basin. Sensitivities were tested as well to evaluate the worst-case discharge. For example, Condensate Gas Ratio (CGR) is one of the main factors that drives the worst-case discharge result. Beach had modelled this using the highest known CGR and field condensate value of the Otway field to best knowledge which results in the largest condensate discharge and is carried as the worst-case discharge scenario for these wells within the Release Location North and South. Sensitivity analysis was also performed using different combination of OGIP, pressure, IPR, CGR, and worst case was selected. This is in line with the workflow suggested in the *Technical Report on Calculation of Worst-Case Discharge (SPE 2016)*. Beach selected worst case scenarios to model for a hydrocarbon spill for the Project as a loss of containment from a well during the drilling phase, the marine diesel oil spill (at northern and southern location within the Project Area) was modelled but remained within the spill are of the loss of containment scenario. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC278 Paragraph 77	Comment: There are several other proposed well locations for the project whose locations appear to be undisclosed, and no analysis has been done regarding whether they might cause an even worst case scenario. The map of the Project Area shows only the proposed well at La Bella 2, suspended wells at Artisan 1 and Geographe and existing wells;[132] it does not show the "five additional exploration	Beach Energy (Operations) Limited (Beach) notes the comment about modelling of worst case scenario for hydrocarbon spills for the Otway Offshore Gas Victoria Project. The Offshore Project Proposal (OPP) considers the whole life cycle of the Project. Project stages are defined to include an initial exploration and appraisal drilling campaign and future drilling campaign(s). For the OPP the well locations for spill modelling are based on north and south location (corresponding to

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	and appraisal wells drilled and completed (in success case) from a portfolio of prospects in the Project Area" in the initial drilling campaign, nor the 10 additional wells for future tie-backs.[133] Without information on the locations of the total 17 wells, it is unclear whether they would create an even worst case scenario for sensitive receptors. *[132] As shown in OPP, p. 76 (Figure 2).* *[133] OPP, p. 25.*	Thylacine West location – formerly T/30P well location) within the Project Area (see Figure 7-1 and Table 7-17). Based on the current level of operational detail, Beach is confident that the assessment represents the worst case scenario. For each activity, Beach will be required to submit an Environment Plan (EP). Further information about well locations and respective spill models will be assessed in the EPs which must be assessed and accepted by NOPSEMA prior to the commencement of activity. Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to this comment.
PC279 Paragraph 78	Comment: Second, Beach does not use a worst-case scenario for flow or release rate. Beach estimates 7,547 STB/day and 6,813 STB/day of condensate at Release Location South and North, respectively.[134] This is far short of what government agencies in other jurisdictions recommend in modelling worst case discharge rates of condensate. For example, in modelling of South Louisiana condensate spill from a well blowout for the Central Gulf of Mexico planning area, the U.S. Department of the Interior Bureau of Safety and Environmental Enforcement suggests using a 26,400 bbl/day worst case daily flow rate.[135] The South Louisiana condensate model was based off depths much shallower (42 feet) than those proposed by Beach (155 meters, or ~509 ft), and thus pressures and flow rates from Beach's proposed wells are likely to be higher. Beach provides no information as to why its maximum condensate flow rates in a worst-case scenario should be significantly less than worst-case estimates elsewhere. Beach also fails to provide technical information supporting the flow rate it chose, as flow rates from nearby existing wells have not been provided, nor other information used in calculating condensate worst-case	Beach Energy (Operations) Limited (Beach) notes the comment about hydrocarbon spills for the Otway Offshore Gas Victoria Project. The worst case scenarios for a hydrocarbon spill are summarised in section 7.4 of the OPP. For the OPP the well locations for spill modelling are based on north and south location (corresponding to Thylacine West location – formerly T/30P well location) within the Project Area (see Figure 7-1 and Table 7-17). The worst-case discharge modelling is developed using several inputs such as reservoir depth, reservoir temperature, gas in place, inflow performance, casing sizes, condensate to gas ratio (CGR). In general, the worst-case discharge numbers increases when the numbers of these respective inputs increase. While water depths are also considered in the worst case modelling, Beach does not agree with the comment that applying the Otway water depth (155 meters) to South Louisiana condensate model is an accurate representation of the worst case scenario for the Offshore Project Proposal (OPP). Further, from publicly available resources a field in South Louisiana has reservoir depth double the depth of the proposed wells in the Otway Basin, along with that the gas in place is estimated to be many times more with a much higher CGR. Therefore, it is expected that the worst-case discharge of the South Louisiana condensate spill will be much higher than planned wells in the Otway Basin. The spill modelling for the release location north and south of the Project Area is based on the reservoir properties of a wells drilled and produced in the Otway Basin. Sensitivities were tested as well to evaluate the worst-case discharge. CGR is one of the main factors that drives the worst-case discharge result. Beach had modelled this using the highest known CGR and field condensate

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	flow rates, such as sufficient information on geology, pressure, and sub-surface well-depth.[136] [134] *OPP, Appendix M, p. 30.* [135] *U.S. Department of the Interior Bureau of Safety and Environmental Enforcement, Task 1: Worst Case Discharge Analysis (Volume 1) (2016), p. 55 (modelling a very similar condensate, South Louisiana Condensate, that is a "nonpersistent oil that is very light and thus, tends to evaporate and dissipate quickly").* [136] *U.S. Department of the Interior Bureau of Safety and Environmental Enforcement, Task 1: Worst Case Discharge Analysis (Volume 1) (2016), Section 2.2. See also U.S. Department of Energy, Methods For Determining Vented Volumes During Gas-Condensate and Oil Well Blowouts (1981).*	value of the Otway field to best knowledge which results in the largest condensate discharge and is carried as the worst-case discharge scenario for these wells within the release locations north and south of the Project Area. Sensitivity analysis was also performed using different combination of OGIP, pressure, IPR, CGR, and worst case was selected. This is in line with the workflow suggested in the *Technical Report on Calculation of Worst-Case Discharge (SPE 2016).* For the condensate loss of containment scenarios, Beach has a high degree of confidence in the estimated release rates and timing used for the modelling as they are based on known reservoir properties and flow rates of suitable analogues for all potential new fields within the Project Area of the Otway Basin (e.g. Thylacine well). The hydrocarbon properties of Thylacine condensate are used for modelling (see section 7.4.3.2 and Table 7-18) and discharge volumes (Table 7-17). Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to this comment.
PC280 Paragraph 79	Comment: Third, Beach does not justify why its maximum duration for a spill in the event of loss of well control is a worst-case scenario in light of the harsh weather that could further delay the time to stop a release. Beach estimates a maximum duration of a spill would be 86 days from loss of well control.[137] This is analogous to the Deepwater Horizon spill that lasted 87 days.[138] No storms or rough seas caused the delay of stopping the Deepwater Horizon spill, as delays were due to technical failures.[139] Colder Antarctic temperatures[140] and rough seas *can make spill recovery more difficult and require different containment technologies.[141] The Otway Basin is located in seas that require "harsh environment" equipment,[142] and experience frequent high winds and intense storms and up to 10 m wave heights.[143] Given the difference in conditions, it is not*	Beach Energy (Operations) Limited (Beach) notes the comment about hydrocarbon spills for the Otway Offshore Gas Victoria Project. The comment specifically refers to Appendix M (Oil Spill Modelling Report by RPS Group) models hydrocarbon spill for 86 days. Beach confirms that 86 days is appropriate length of time to mobilise a rig and drill the relief well. Rig broker reports are used to monitor the rig market monthly, if required, assist in sourcing and contracting suitable MODU. The rig broker can be contracted to identify and contract a suitably specified rig (including Australian Safety Case status) within 14 days. The memorandum of understanding in place between the operators in Australia to assist in an emergency well control situation. A MODU mobilised from North West Shelf or Singapore is likely to take 35 days. These periods have been factored into the relief well schedule within the well specific relief well plans. Once a MODU is on location, it is estimated that drilling a relief well will take approximately 21 days, dependent on the intersection point and homing-in method selected. No changes have been made to the OPP in response to this comment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	appropriate for Beach to rely on the maximum duration in Deepwater Horizon. [137] *OPP, Appendix M, p. xviii.* [138] *The Macondo release "led to 87 days of continuous uncontrolled oil and natural gas discharge into the northern Gulf of Mexico," and the release of 3.19 million barrels of oil and 7.7 billion standard cubic feet of natural gas: Deepwater Horizon Natural Resource Damage Assessment Trustees, Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement (2016) (Deepwater Horizon EIS), pp. 2-8.* [139] *Deepwater Horizon EIS, pp. 2-4.* [140] *U.S. Department of the Interior Bureau of Safety and Environmental Enforcement, Task 1: Worst Case Discharge Analysis (Volume I), p. 15 (2016) (colder temperatures could be associated with higher rates of human error and can affect ways in which equipment and metal components handle).* [141] *See, for example, U.S. Environmental Protection Agency, Understanding Oil Spills And Oil Spill Response, p. 8-10 (1999).* [142] *OPP, p. 37.* [143] *OPP, Section 4.3.2.1 ("Otway is a high-energy environment exposed to frequent storms and significant wave heights. Winds in the area generally exceed 13 knots (23.4km/h) for more than 50% of the time contributing to the moderate to high wave-energy environment" and "is highly exposed to swell from the Southern Ocean. Wave heights generally range from 1.5m to 2m. Waves up to 10m can occur during winter storm events").*	

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC281 Paragraph 83	Comment: The Hybrid Coordinate Ocean Model has not been validated, which is key to understanding where hydrocarbon spills will have shoreline impacts To construct its hydrocarbon spill model, Beach relied on the Hybrid Coordinate Ocean Model (HYCOM), which contains data describing the flow of ocean currents.[154] It appears that this model has not been validated. Academics have shown that HYCOM can lead to inaccurate understandings of ocean currents, and therefore oil spill impacts. For example, researchers assessing the reliability of HYCOM against other models for studying the Agulhas current found that HYCOM predicted "more early retroflections than are observed which have resulted in its mean eastward location" and "largely overestimate[d] the magnitude of its southwestward flow" because of the model's "misrepresentation of the Current's vertical structure."[155] Predictions of shoreline accumulation of hydrocarbons were substantially less reliable as a result. For this reason, oil spill modellers must validate HYCOM models with local real-world observations before relying on it. [154] *OPP, Appendix M, p. 9.* [155] *Cristina Serena Russo, Jennifer Veitch, Matthew Carr, Giles Fearon, and Christo Whittle, 'An Intercomparison of Global Reanalysis Products for Southern Africa's Major Oceanographic Features' (11 March 2022) 9 Frontiers in Marine Science 837906.*	Beach Energy (Operations) Limited (Beach) acknowledges the comment that Hybrid Coordinate Ocean Model (HYCOM) can lead to inaccurate understandings of ocean currents and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this comment. RPS (2024) have specified that to accurately describe the variability in currents between the inshore and offshore region, a hybrid regional dataset was developed by combining deep ocean predictions obtained from HYCOM with surface tidal currents developed by RPS. Therefore, inshore and offshore currents have been represented by a hybrid regional dataset, not by HYCOM alone. The combination of HYCOM ocean data and HYDROMAP tidal data from 2010 to 2019 ensures reliability of current data used in RPS (2024) spill modelling. Russo et al (2022) highlights that HYCOM's representation of sea surface temperatures are misrepresented. As a result, RPS's use of HYCOM for only deep ocean predictions counters the sea surface misrepresentations by using HYDROMAP for surface tidal currents in the inshore and offshore region for the Otway (RPS 2024). Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC282 Paragraph 84	Comment: Reliance on outdated studies, including those from the 1980s that assume cetaceans are not impacted by hydrocarbon spills Beach's assessment of impacts from hydrocarbon spills on sensitive environmental receptors contains many flawed assumptions, only a few of which are highlighted here.	Beach Energy (Operations) Limited (Beach) acknowledges the comment that outdated studies have been used to describe hydrocarbon impacts and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this comment.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	Firstly, in assessing impacts from marine diesel oil in the event of a vessel collision, Beach states, "Geraci (1988) found little evidence of cetacean mortality from hydrocarbon spills; however, some behaviour disturbance (including avoidance of the area) may occur."[156] Oil and gas development in the U.S. Gulf of Mexico is recognised as a primary threat to the continued existence of Rice's whale, now at the brink of extinction.[157] Beach also assumes dolphins would not be impacted for their tough skin.[158] However, after Deepwater Horizon, researchers "documented a series of injuries to bottlenose dolphins in oiled areas that were not observed in unoiled reference locations."[159] The project must commit, at a minimum, to pausing activities during the presence of migrating cetaceans to avoid significant impacts. [156] OPP, *p. 473.* [157] *NOAA, Endangered and Threatened Wildlife and Plants: Notice of 12-Month Finding on a Petition To List the Gulf of Mexico Bryde's Whale as Endangered Under the Endangered Species Act (ESA), 81 Fed. Reg. 88,639, at 88,641 (6 December 2016); NOAA, Recovery Outline, Rice's Whale (Sept. 2020). See also NPR, Only 51 of these U.S. whales remain. Little has been done to prevent their extinction (16 November 2023); Yasmin Dahnoun, 'Rare whales face extinction due to oil extraction', Ecologist (14 October 2022).* [158] *"Direct surface hydrocarbon contact may pose little problem to dolphins due to their extraordinarily thick epidermal layer which is effective as a barrier to the substances found in hydrocarbons (Geraci and St. Aubin, 1990; Volkman et al., 1994)": see OPP, p. 474.* [159] *Deepwater Horizon EIS, pp. 4-6.*	Beach has reviewed and updated Section 7.4.2 with additional contemporary references as shown below, however, notes that these additional literature sources do not result in a change in overall impact consequence. Table 7-20 and 7-23 have been updated with the following text: *Consequence Evaluation for cetaceans (whales):* Geraci (1988) found little evidence of cetacean mortality from hydrocarbon spills; however, some behaviour disturbance (including avoidance of the area) may occur. However, observations during spills have recorded whales and dolphins traveling through and feeding in oil slicks. During the Deepwater Horizon spill cetaceans were routinely seen swimming in surface slicks offshore (and nearshore) (Aichinger Dias et al. 2017). Cetaceans observed during the spill response for the Montara oil spill included oceanic species such as false killer whales, bottlenose dolphins, spotted dolphins and spinner dolphins (Watson et al. 2009). Cetaceans exposed to surface hydrocarbons above moderate exposure thresholds may suffer external oiling, ingestion of oil and inhalation of toxic vapours (Deepwater Horizon Natural Resource Damage Assessment Trustees 2016). Table 7-22 and 7-25 have been updated with the following text: *Consequence evaluation for fish:* Environmental monitoring of pelagic and demersal fishes immediately following the Montara oil spill indicated that fish were exposed to hydrocarbons, although no adverse effects were detected (Gagnon and Rawson 2012, 2011). Further sampling and testing over time indicated that fish captured in close proximity to the Montara wellhead were comparable to those collected from reference sites (Gagnon and Rawson 2012, 2011). Beach has considered these comments and updates have been made to the OPP as outlined above.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC283 Paragraph 85	Comment: Secondly, the impact assessment makes a common mistake in assuming that harm will be mitigated by species avoiding the area, without analysing how avoidance of key foraging areas can cause harm. For example, Beach relies on another outdated study to conclude that "Dolphins are highly mobile and are considered to have some ability to detect and avoid oil slicks (Geraci and St. Aubin, 1988; Smith et al, 1983)."[160] [160] *OPP, p. 474.*	Beach Energy (Operations) Limited (Beach) acknowledges the claim regarding key dolphin foraging areas and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this claim. Table 4-25 of the OPP identifies *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed cetacean species of dolphin which may occur or are likely to occur within the Project Area and Planning Area according to the Protected Matters Search Tool (PMST) Reports (Appendix A and Appendix B). Only one of these species, the dusky dolphin, is EPBC listed as migratory. No dolphin BIAs have been identified within the Project or Planning Areas. As a result, foraging is not expected to be an important behaviour for dolphins within the area and avoidance of key foraging areas for dolphins is not relevant to the Project and associated impacts are not predicted. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments. *References:* *DCCEEW (2024). National Conservation Values Atlas. http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf*
PC284 Paragraph 86	Comment: No impact analysis for habitat critical to the survival of a species The environmental receptors to assess impacts of floating oil, shoreline accumulation and water column included categories such as biologically important areas, marine marks, and key ecological features.[161] These list of receptors do not include a category for habitat critical to the survival of a species that may be impacted. Albatross Island, which is critical habitat for the Shy Albatross,[162] is located within the low risk threshold area for the release of condensate from the Release Location South during summer and winter conditions,[163] and is within the area that may be affected by dissolved[164] and entrained[165] hydrocarbon exposure, but there was no impact	Beach Energy (Operations) Limited (Beach) acknowledges the claim regarding Albatross Island and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this claim. Albatross Island is classified as habitat critical to the survival of the shy albatross, an *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed threatened and migratory species and is located within the Planning Area. Further detail regarding habitat critical to the survival of a species is provided in Section 4.4.9.2 of the OPP and further detail about Albatross Island is provided in Section 4.4.9.4.1. As summarised in the introduction to this Report, new quantitative spill modelling was undertaken to model the loss of well control in the southern well location to replace T/30P well location (now outside the Project Area) with Thylacine West 1 location (within the Project Area) (see Appendix M,

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	assessment on how a hydrocarbon spill would affect this critical habitat. [161] *OPP, Appendix M, p. 43, Table 10-1.* [162] *Department of Climate Change, Energy, the Environment and Water, Listed Critical Habitat, Thalassarche cauta (Shy Albatross) - Albatross Island, The Mewstone, Pedra Branca (Web Page, 01 Jul 2002).* [163] *OPP, Appendix M, p. 57, Figure 11-1.* [164] *OPP, Appendix M, p. 73.* *P, Appendix M, p. 88.*	Figure 7-1 and Table 7-17 of OPP). Revision of the OPP scope and change to the spill modelling mean that Albatross Island is no longer in the Planning Area. Table 7-19 of the OPP lists the exposure and contact threshold values used for the spill modelling study which are based on the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) Bulletin: Oil Spill Modelling (NOPSEMA 2019). The moderate exposure threshold is considered to be the approximate lower limit for harmful exposures to biological receptors such as birds, marine mammals and other sensitive species. The environmental impact summary tables of the OPP have been updated where necessary to include exposure and consequence evaluations against impacts to seabirds (including relevant BIAs and habitats critical) from in-water hydrocarbon exposure. Table 7-25 of the OPP has been updated to include an additional row for seabirds and shorebirds for condensate spill in-water hydrocarbon exposure: "Exposure evaluation" The extent of in-water hydrocarbons at the moderate threshold from a LOWC overlaps foraging BIAs for several seabird species, including various albatross species (i.e. antipodean, black-browed, Bullers, Campbell, Indian-yellow-nosed, shy and wandering), petrels (common-diving, soft-plumaged and white-face storm), shearwaters (short-tailed and wedge-tailed), In-water hydrocarbons at low threshold were predicted to overlap the breeding BIA for the little penguin (at Phillip Island and the buffer around Christmas Island).. "Consequence evaluation" Seabirds could be impacted by in-water hydrocarbon exposure directly (i.e., whilst diving through the water column foraging) or indirectly (i.e. by consuming hydrocarbon-tainted fish, resulting in sub-lethal or toxic impacts). Penguins may be especially vulnerable to oil because they spend a high portion of their time in the water and readily lose insulation and buoyancy if their feathers are oiled. The Iron Baron vessel spill, of 325 tonnes of bunker fuel in Tasmania in 1995, is estimated to have resulted in the death of up to 20,000 penguins (Hook et al. 2016). As seabirds are top order predators, any impact on other marine life (e.g., pelagic fish) from hydrocarbon exposure may disrupt and limit food supply both for the maintenance of adults and the provisioning of young.

ID	Summary of comments received	Beach’s assessment of merit of comment(s) and response(s) to comments and/or objections
		Furthermore, the foraging BIAs are typical over relatively extensive areas, therefore, impacts are not anticipated at a population level due to the localised and temporary exposure of moderate levels of surface hydrocarbons. Breeding shy albatrosses and little penguins oiled by in-water hydrocarbons during foraging may contaminate nests and eggs from oil transfer by parent birds (Clarke 2010). Bird eggs may become damaged from oil contamination if an oiled adult sits on the nest. Fresh crude was found to be more toxic than weathered crude, which had a median lethal dose of 21.3 mg/egg (Clarke 2010). Studies of contamination of duck eggs by small quantities of crude oil, mimicking the effect of oil transfer by parent birds, have been shown to result in mortality of developing embryos (French-McCay 2009). Acute or chronic toxicity impacts (death or long-term poor health) to seabirds is possible, however, the presence of birds within areas exposed to moderate threshold levels is expected to be limited, due to the transitory nature of foraging individuals, and temporary presence of in-water hydrocarbons in waters surrounding breeding BIAs (moderate dissolved hydrocarbon exposure at Albatross Island maximum residence time is less than 1 day). However, due to the anticipated hydrocarbon weathering and fate of the condensate, the majority is expected to have either evaporated or entrained during that time. Modelling predicted between approximately 69.4% to 82.5% of the volume to evaporate and up to approximately 22.1% to entrain within the first 24 hours, depending on the wind conditions (RPS 2024). Furthermore, tidal and wave action within the area is anticipated to breakdown any shoreline hydrocarbons. Consequently, the potential consequence to seabirds and shorebirds is considered to be Moderate (2), as they could be expected to result in minor, short-term impact to species of recognised conservation value.” For consistency, Table 7-22 has also been updated with the following text: “Exposure evaluation The extent of in-water hydrocarbons at the moderate threshold from a MDO release overlaps foraging BIAs for several seabird species, including various albatross species (i.e. antipodean, black-browed, Bullers, Campbell, Indian-yellow-nosed, shy and wandering), petrels (common-diving and white-face storm) and shearwaters (short-tailed and wedge-tailed). Consequence evaluation:

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Seabirds could be impacted by in-water hydrocarbon exposure directly (i.e., whilst diving through the water column foraging) or indirectly (i.e. by consuming hydrocarbon-tainted fish, resulting in sub-lethal or toxic impacts). As seabirds are top order predators, any impact on other marine life (e.g., pelagic fish) from hydrocarbon exposure may disrupt and limit food supply both for the maintenance of adults and the provisioning of young. Furthermore, the foraging BIAs are typical over relatively extensive areas, therefore, impacts are not anticipated at a population level due to the localised and temporary exposure of moderate levels of surface hydrocarbons. Acute or chronic toxicity impacts (death or long-term poor health) to seabirds is possible, however, the presence of birds within areas exposed to moderate threshold levels is expected to be limited, due to the transitory nature of foraging individuals, and given the absence of offshore aggregation areas in the area. However, due to the anticipated hydrocarbon weathering and fate of the MDO, the majority is expected to have either evaporated or entrained during that time. Modelling predicted between approximately 38% of the volume to evaporate and up to approximately 60% to entrain within the first 24 hours, depending on the wind conditions (RPS 2024). Furthermore, tidal and wave action within the area is anticipated to breakdown any shoreline hydrocarbons. Consequently, the potential consequence to seabirds and shorebirds is considered to be Moderate (2), as they could be expected to result in minor, short-term impact to species of recognised conservation value." *References:* *Clarke RH (2010). The Status of Seabirds and Shorebirds at Ashmore Reef and Cartier and Browse Islands: Monitoring program for the Montara Well release - Pre-impact Assessment and First Post-impact Field Survey. Prepared on behalf of PTTEP Australasia and the Department of the Environment, Water, Heritage and the Arts, Australia.* *CoA (2002). Habitat critical to the survival of Shy Albatross. Commonwealth of Australia, June 2002. Retrieved from: https://www.dcceew.gov.au/sites/default/files/env/pages/e106adc1-c4fb-4321-85e0-ed36b485051c/files/3-albatross-map.pdf*

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		DCCEEW (2024a). Species Profile and Threats Database- SPRAT Profile. Department of Climate Change, Energy, the Environment and Water. Accessed May 2024 at: https://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. *French-McCay DP (2009). State-of-the-Art and Research Needs for Oil Spill Impact Assessment Modelling. Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response. 2.* *Hook S, Batley G, Holloway M, Irving P and Ross A. (eds) (2016). Oil Spill Monitoring Handbook. CSIRO Publishing, Australia.* *NOPSEMA (2019). Environmental Bulletin: Oil Spill Modelling. Document number: A652993. April 2019. National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/sites/default/files/documents/2021-04/A652993.pdf* *RPS (2024). Offshore Gas Victoria Oil Spill Modelling (GOC365512). August 2024. Report for Beach Energy.*
PC285 Paragraph 87	Comment: Inadequate assessment of toxic impacts of unplanned releases of monoethylene glycol Beach did not study impacts associated with the accidental release of an estimated 400m3 of monoethylene glycol (MEG) because it did not believe it posed a risk.[166] These assumptions contradict an assessment of the Department of Climate Change, Energy, the Environment and Water of the toxicity of large releases of MEG. [167] Additionally, Beach's assessment fails to acknowledge how MEG depresses dissolved oxygen,[168] which would pose "a threat risk to aquatic ecosystems,"[169] and that is exacerbated by climate change as warmer ocean temperatures can hold less dissolved oxygen.[170] Lastly, MEG also degrades into acids, including acetic acids,[171] that can be harmful to aquatic life.[172] For all these reasons, Beach must model and assess how MEG may impact sensitive environmental receptors before it assumes it will not pose a direct or cumulative harm. [166] *OPP, p. 457.*	Beach Energy (Operations) Limited (Beach) acknowledges the claim regarding the assessment of monoethylene glycol (MEG) release and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this claim. The maximum credible spill volume of MEG, as described in Table 7-16 of the OPP, is 400 m^3 from a loss of containment of an umbilical. Loss of containment from an umbilical from the subsea facilities could occur as a result of erosion, corrosion, or external forces (e.g. dropped object; fishing vessel interactions). As described in Section 7.4.2, MEG is an 'E' category OCNS chemical with no substitution warning, readily biodegradable with a low potential for bioaccumulation. This means that any discharges, even a credible worst-case of 400 m^3, would not be expected to result in environment impacts to receptors greater than a Minor consequence. Beach acknowledge that despite the very low aquatic toxicity of MEG there is potential for the chemical to contribute to hypoxic conditions within the water column (ANZG 2018). However, due to the metocean conditions within the Otway region, which facilitate the rapid dispersion of the discharge throughout the marine environment, it is not anticipated that there would be a noticeable change in dissolved oxygen concentrations to an extent that would result impacts to marine fauna. Beach has updated section 7.4.3.1 of the OPP to include this text.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	[167] *Department of Climate Change, Energy, the Environment and Water, Ethylene glycol (1,2-ethanediol), ("The immediate effects of exposure to high concentrations (e.g. resulting from a major spill) of ethylene glycol can mean death of animals, birds or fish and death or low growth rate in plants. Long-term effects on animal life are shortened lifespan, reproductive problems, lower fertility and changes in appearance or behaviour. Ethylene glycol has moderate toxicity to aquatic life on both a short term and long term basis").* [168] *Australian and New Zealand Guidelines for Fresh & Marine Water Quality, Ethylene glycol in freshwater and marine water (October 2000).* [169] *Department of Climate Change, Energy, the Environment and Water, The impacts of low-oxygen water.* [170] *CSIRO, Even temporary global warming above 2℃ will affect life in the oceans for centuries (10 October 2023).* [171] *Hydratech U.K., Ethylene Glycol (Web Page, Undated).* [172] *Department of Climate Change, Energy, the Environment and Water, Acetic acid (Web Page, 30 June 2022).*	Beach has reviewed the various references provided as evidence of the toxicity of MEG. On balance there is no new references to indicate that the MEG release at the indicated volumes and the Otway metocean conditions that would justify further assessment of impacts to receptors.
PC286 Paragraph 88	Comment: Unclear if the spill analysis covers all Project activities Finally, it is unclear from the OPP whether the assessment of hydrocarbon spills covers production activities within the Project scope. Beach should assess whether and to what extent impacts may be more significant during production operations compared to drilling. Further, the OPP fails to assess the risks of a more extensive hydrocarbon spill if poor installation at the subsea infrastructure installation phase led to rupture and an accidental release of gas and condensate products in the	Beach Energy (Operations) Limited (Beach) notes the comment about hydrocarbon spills for the Otway Offshore Gas Victoria Project (the Project). The scenarios for a hydrocarbon spill are summarised in section 7.4 (Table 7-16) of the OPP and include several scenarios associated with stages of the Project. Credible spill scenarios include loss of containment from flowline (Table 7-16). The worst case scenarios modelled for a hydrocarbon spill for Project are a loss of containment from a well during the drilling phase and marine diesel oil spill (at northern and southern location). The loss of containment from a well while drilling is the source of the largest volume of hydrocarbon.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	production phase. As global incidents such as Deepwater Horizon demonstrate, proper installation of risers and other subsea infrastructure is important for reducing subsequent spill risks which could otherwise be devastating to the marine environment	Beach has production operations in the Otway Basin and an accepted Environment Plan. The Otway Offshore Operations EP provides worst case oil spills scenarios that cover a comparatively similar but smaller planning area than the worst case spill scenario provided in the OPP. Subsequent EPs for specific activities such as subsea installations, and production operations will include worst case scenarios for spills as a result of these activities which may include rupture of flowline and accidental release of gas and condensate products. No change is made to the OPP in response to this comment.
PC287 Paragraph 89	Comment: Australian and state marine parks The proposed Project is inconsistent with national and international standards, since it intersects with an Australian Marine Park which is classified as a Marine Protected Area under the International Union for Conservation of Nature (IUCN) system. The OPP states that the "Project Area has been designed to not include the deeper waters off the continental shelf and to avoid potential overlap with the Zeehan Marine Park with a minimum 1km buffer applied."[173] The OPP acknowledges that Zeehan Australian Marine Park (AMP) was identified within the Project Area according to the Commonwealth government's PMST Report, but then denies the result.[174] [173] *OPP, p. 75 (emphasis added).* [174] *"However this is due to the size of the grids used in the PMST and does not actually intersect the Project Area": OPP, p. 110.*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding Australian Marine Parks (AMP) and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. The Project Area was originally designed to avoid potential overlap with the Zeehan Marine Park with a minimum 1km buffer applied. As described in the introduction to this Report, the revised Planning Area overlaps two Australian Marine Parks (Zeehan and Apollo) with the Zeehan Marine Park a distance of 58 km from the Project Area. As stated in the OPP (section 4.2.2), PMST Reports may identify AMPs within the Planning Area due to the size of the grids, while further assessment indicates the AMP does not intersect the Planning Area. This applies to Franklin Marine Park (see Table 4-2 and Figure 4-2). Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC288 Paragraph 90	Comment: Even though the artificial boundary of the Project Area "avoids" Zeehan AMP, it appears that there are Project activities that would directly overlap with this protected area. Beach has title to permit area T/30P, which appears to intersect with part of Zeehan AMP.[175] The Project description confirms that Beach intends to drill up to 2 wells within the T/30P permit area in the initial drilling	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding Australian Marine Parks (AMP) and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. As described in the introduction to this Report, the revised scope of the OPP removes development in T/30P. The Zeehan Marine Park is is now a distance of 58 km from the Project

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	campaign, and up to 4 additional wells in the same permit area in future drilling campaigns covered by the Project scope. This means that there are up to six gas prospects that could be drilled, appraised, and developed within Zeehan AMP. It is therefore not possible for Beach to assert that a "1km buffer" has been applied. Additionally, Beach acknowledges that hydrocarbon spills may impact Zeehan AMP, along with several other sites of environmental importance.[176] [175] *OPP, p. 76 (Figure 2).* [176] *"[F]loating oil exposure above the low threshold was predicted at the Zeehan AMP (38% summer and 39% winter": OPP, Appendix M, p. 101*	Area. The Zeehan Marine Park is within the Planning Area which may be affected by an unplanned hydrocarbon spill. Beach has assessed the risk of a spill event in Section 7.4 (Loss of Containment – Hydrocarbons and Chemicals) of the OPP. Spill modelling conducted for the Project showed that the Zeehan AMP may be exposed to hydrocarbons at the low (condensate) to moderate (MDO) _ thresholds within the upper 0 -10 m of the water column. The Zeehan AMP is located in waters 50 m to 3,000 m deep and thus conservation values such as ecosystems, habitats and communities associated with the Tasmania Province, the West Tasmania Transition and the Western Bass Strait Shelf Transition and associated with the seafloor features are not predicted to be impacted. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC289 Paragraph 91	Comment: Further, Beach has misinterpreted the scope of activities allowed in Marine Protected Areas which have been classified under the IUCN system. The OPP notes that Zeehan AMP is classified as IUCN Category VI,[177] but then incorrectly states that this category "allows for limited mining and low-level extraction of natural resources."[178] The latest guidelines from IUCN indicate that industrial activities including gas extraction "are not compatible with" Marine Protected Areas. Mining (including oil and gas extraction) is explicitly "not permitted" in Category VI areas.[179] Beach thus proposes to undertake extractive activities in a Marine Protected Area, Zeehan AMP, in violation of IUCN guidelines. The assertion in the OPP that "Project activities are not within an AMP"180 is evidently false. [177] *This is correctly stated at OPP, p. 110. Note that Zeehan AMP is mistakenly referred to as category "VII" (which does not exist under the IUCN system) at OPP, p. 55.* [178] *OPP, p. 110.*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding Australian Marine Parks (AMPs) and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach acknowledges that for Zeehan AMP, the IUCN Category Number has, in some instances, been incorrectly labelled as IUCN VII. The Project Area was originally designed to avoid potential overlap with the Zeehan Marine Park with a minimum 1km buffer applied. As described in the introduction to this Report, the revised Planning Area overlaps two Australian Marine Parks (Zeehan and Apollo) with the Zeehan Marine Park a distance of 58 km from the Project Area. IUCN (International Union for the Conservation of Nature) Categories are the internationally recognised set of seven protected area management categories. Within the Guidelines for applying the IUCN protected area management categories to marine protected areas (Day 2019) prohibited activities for IUCN VI states "Industrial fishing, industrial-scale aquaculture, untreated waste discharge, mining and habitation not permitted" as per the comment. However, the IUCN categories are further defined in the Australian IUCN reserve management principles in Schedule 8 of the Environmental Protection and Biodiversity Conservation Regulations 2000. Within the Guide

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	[179] *Only sustainable, low-level and non-industrial use of natural resources is regarded as compatible with protection: Jon Day et al., IUCN, Guidelines for applying the IUCN protected area management categories to marine protected areas (2nd edition, 2019), pp. 8, 10.* [180] *OPP, p. 55.*	for users of the south-east Commonwealth marine reserves network (DNP 2013), the Zeehan AMP has two IUCN listings as detailed in Figure 4-2 of the OPP. These are: • Special Purpose Zone (IUCN VI) • Multiple Use Zone (IUCN VI). (Closest section to Project Area) Within DNP (2013), Multiple Use Zone (IUCN VI) states for mining that "activity is allowable in accordance with a class approval from the Director of National Parks". In preparation of the OPP, Beach consulted with the Director of National Parks (DNP) in accordance with National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA's) guidance note (NOPSEMA and Parks Australia Petroleum Activities and Australian Marine Parks June 2023). Further consultation with DNP will be undertake as part of preparation of future Environment Plan(s). Beach would again like to highlight that the Project Area does not overlap the Zeehan and therefore no activities will be undertaken within the Zeehan AMP. Beach rejects the comment that Project activities will occur within the Zeehan AMP as detailed above and as a result. Beach rejects that the activity limitations for the Multiple Use Zone (IUCN VI) have been incorrectly listed as Section 4.2.2 provides a summary of limitations as detailed in DNP (2013) and as a result, no changes have been made to the OPP in response to these comments. Beach acknowledges the IUCN Category Number has, in some instances, been incorrectly labelled as IUCN VII with reference to these AMPs and has updated to IUCN VI throughout the OPP. *References:* *Day, J., Dudley, N., Hockings, M., Holmes, G., Laffoley, D., Stolton, S., Wells, S. and Wenzel, L. (eds.) (2019). Guidelines for applying the IUCN protected area management categories to marine protected areas. Second edition. Gland. Switzerland: IUCN.* *DNP (2013). Guidelines for applying the IUCN protected area management categories to marine protected areas. Commonwealth Marine Reserves. Director of National Parks. Accessed at <https://parksaustralia.gov.au/marine/pub/factsheets/south-east-users-guide.pdf >*
PC290 Paragraph 92	Comment: World Heritage sites and Ramsar wetlands The internationally recognised Tasmanian Wilderness World Heritage Area falls within the Planning Area.[181] The OPP indicates that shoreline loading of oils along the	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding the Tasmanian World Heritage Area and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	Tasmanian Wilderness coastline in the case of a spill could exceed 10 g/m^2 (10 µm).[182] This is significant because mortality can begin for some marine species at 1 µm (as noted above). [181] *OPP, p. 26.* [182] *OPP, p. 109 (Figure 16)*	As summarised in the introduction of this Report, revisions to the scope of the Otway Gas Victoria (OGV) Project mean that the Tasmania World Heritage Wilderness is no longer within the Planning Area of the Project. The Tasmanian World Heritage Area is not at risk of being exposed to hydrocarbons at any of the modelled thresholds.
PC291 Paragraph 93	Comment: Further, the OPP confirms that entrained oil may reach towards the Tasmanian Wilderness,[183] and the area may be impacted by a spill.[184] As discussed above, there are issues with the OPP spill analysis which suggest that potential impacts on this World Heritage site could be more significant than stated. Considering the potential impacts of hydrocarbon spills to seagrass beds, giant kelp forests, and seabirds,[185] the OPP must model and assess the potential impacts of species likely to occur in the Tasmanian Wilderness, including long-term and cumulative impacts from normal operations and worst-case scenarios.186 Australia should also inform the World Heritage Committee of this proposal as it "may affect" the Outstanding Universal Value of the Tasmanian Wilderness.[187] [183] *OPP, p. 471 (Figure 125).* [184] *See for example, Appendix M, Figures 11-1, 11-8, 11-9, 11-19.* [185] *OPP, pp. 472, 481, 482, 500, 510, 511.* [186] *See also UNESCO, Operational guidelines for the implementation of the World Heritage Convention (WHC.23.01, 2023), para. 118bis ("States Parties shall ensure that Environmental Impact Assessments … be carried out as a pre-requisite for development projects and activities that are planned for implementation within or around a World Heritage property.").*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding the Tasmanian World Heritage Area and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. As summarised in the introduction of this Report, revisions to the scope of the Otway Gas Victoria (OGV) Project mean that the Tasmania World Heritage Wilderness is no longer within the Planning Area of the OPP. The Tasmanian World Heritage Area is not at risk of being exposed to hydrocarbons at any of the modelled thresholds.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	[187] *UNESCO, Operational guidelines for the implementation of the World Heritage Convention (WHC.23.01, 2023), para. 172*	
PC292 Paragraph 94	Comment: The Budj Bim Cultural Landscape is one of the oldest and most extensive aquaculture systems in the world.188 Developed over a period of at least 6,600 years by the Gunditjmara, the World Heritage property is dependent on the migration of kooyang (short-finned eel) for its operation.[189] UNESCO's declaration of the cultural landscape as a World Heritage property was dependent on it being an "outstanding representative example of human interaction with the environment".[190] This interaction was described by UNESCO as the Gunditjmara "creating, modifying and maintaining an extensive hydrological engineering system that manipulated water flow in order to trap, store and harvest kooyang that migrate seasonally through the [aquaculture] system."[191] The "life cycle of kooyang" is described by the World Heritage Committee as a key element of this system.[192] [188] *UNESCO World Heritage Convention, Decision 43 COM 8B.14 Budj Bim Cultural Landscape (Australia) <https://whc.unesco.org/en/decisions/7371>.* [189] *Ibid.* [190] *Ibid, criterion (v).* [191] *Ibid* [192] *UNESCO's decision to declare the site as a World Heritage property stated that the site satisfied Criterion (v) as a continuing cultural landscape by Gunditjmara people by their "creating, modifying and maintaining an extensive hydrological engineering system that manipulated water flow in order trap, store and harvest kooyang that migrate seasonally through the system. The key elements of this system are the interconnected clusters of constructed and*	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding the Budj Bim Cultural Landscape and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Beach acknowledges that Budj Bim cultural landscape and eels are of cultural significance to the Gunditjmara, however, the Planning Area (and Project Area) does not overlap with the UNESCO World Heritage Listed Budj Bim Cultural Landscape as confirmed by the Protected Matters Search Tool (PMST) Report and additional analysis of publicly available special data in response to this comment. As the area is outside of the Planning area it is outside of the scope of the OPP. Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	modified water channels, weirs, dams, ponds and sinkholes in combination with the lava flow, water flow and ecology and life-cycle of kooyang."	
PC293 Paragraph 95	Comment: As part of their life-cycle, kooyang have been shown to migrate to their spawning grounds in the Coral Sea near New Caledonia by travelling from freshwater systems such as those contained in the Budj Bim Cultural Landscape, to the Southern Ocean and then either directly through the Bass Strait or by circumnavigating Tasmania.[193] Once adult kooyang breed, they die and then their larval offspring make the journey back to Victorian waters and into the same freshwater systems as their parents, to begin the life-cycle again.[194] [193] *Wayne M. Koster, Kim Aarestrup, Kim Birnie-Gauvin, Ben Church, David Dawson, Jarod Lyon, Justin O'Connor, David Righton, Denis Rose, Hakan Westerberg, Ivor Stuart, 'First tracking of the oceanic spawning migrations of Australasian short-finned eels (Anguilla australis)' (2021) Scientific Reports 11:22976 p 4.* [194] *Victorian Fisheries Authority, "Short-finned eel". Online. 12 October 2022, <https://vfa.vic.gov.au/education/fishspecies/short-finned-eel>*	Beach Energy (Operations) Limited (Beach) acknowledges the statement regarding the Budj Bim Cultural Landscape and kooyang and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this statement. Beach recognises the presence of eels in the existing environment and the cultural significance of eels for First Nations Groups. Section 4.4.9.3.2 of the OPP assesses eels their ecology and biology, migration and spawning, eel fishery and first nations connections to eels As no additional information not already included in the OPP is presented, no change to the OPP has been made in response to this comment.
PC294 Paragraph 96	Comment: While the Budj Bim Cultural Landscape sits outside of the Project and Planning Areas of the OPP, the OPP acknowledges that migratory pathways of kooyang may intersect with them,[195] and as such, intersect with potential hydrocarbon spill. There appears to be no discussion in the OPP on the impacts of hydrocarbon spill on eels at different stages of the species' life cycle, particularly in their juvenile forms as larvae and glass eels, when they are likely to travel through the OPP's Project and Planning Areas. There is no discussion in the OPP on how the impacts of an adverse event on kooyang would consequently impact the Budj Bim Cultural Landscape.	Beach Energy (Operations) Limited (Beach) acknowledges the comments regarding the Budj Bim Cultural Landscape and kooyang and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this statement. Section 7.4.4 of the OPP details that free-swimming fish (i.e. kooyang) are unlikely to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons in-water are not expected to be sufficient to cause harm (ITOPF 2011). Subsurface hydrocarbons could potentially result in acute exposure to marine biota such as juvenile fish, larvae, and planktonic organisms, although impacts are not expected cause population-level impacts. Impacts on fish eggs and larvae (i.e. glass eels) entrained in the upper water column are not expected to be significant given the temporary nature of the resulting change in water quality. As egg/larvae dispersal is widely distributed in the upper layers of the water column it is expected that current induced drift will

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	[195] *OPP, pp 373, 366*	rapidly replace any oil affected populations. As such, impacts to the Budj Bim Cultural Landscape via an adverse event on kooyang are not expected. Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments. Beach Energy notes that, in response to a separate comment, <u>Section 7.4.2 (Tables 7-22 and 7-25) is updated to refer to "fish (including eels)" to ensure inclusion of eels is clearly stated.</u> *References:* *ITOPF (2011). Effects of Oil Pollution on the Marine Environment. Technical Information Paper 13. The International Tanker Owners Pollution Federation Ltd. London*.
PC295 Paragraph 97	Comment: Adverse impacts on kooyang populations as a result of possible hydrocarbon spill could have serious repercussions on the function of the Budj Bim World Heritage site and affect the landscape's recognised Outstanding Universal Value. Australia should also inform the World Heritage Committee of this proposal as it may also affect the Outstanding Universal Value of the Budj Bim Cultural Landscape	Beach Energy (Operations) Limited (Beach) acknowledges the comment regarding the Budj Bim Cultural Landscape and kooyang and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to this statement. Section 7.4.2.4 of the OPP details that free-swimming fish (i.e. kooyang) are unlikely to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons in-water are not expected to be sufficient to cause harm (ITOPF 2011). Subsurface hydrocarbons could potentially result in acute exposure to marine biota such as juvenile fish, larvae, and planktonic organisms, although impacts are not expected cause population-level impacts. Impacts on fish eggs and larvae (i.e. glass eels) entrained in the upper water column are not expected to be significant given the temporary nature of the resulting change in water quality. As egg/larvae (i.e. glass eel) dispersal is widely distributed in the upper layers of the water column it is expected that current induced drift will rapidly replace any oil affected populations. As such, impacts to the Outstanding Universal Value of the Budj Bim Cultural Landscape via an adverse event on kooyang are not expected. The Operational Guidelines for the Implementation of the World Heritage Convention states in Paragraph 172: *"The World Heritage Committee invites the States Parties to the Convention to inform the Committee, through the Secretariat, of their intention to undertake or to authorize in an area protected under the Convention major restorations or new constructions which may affect the Outstanding Universal Value of the property. Notice should be given as soon as possible (for instance, before drafting basic documents for specific projects) and before making any decisions that would be difficult to reverse, so*

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		that the Committee may assist in seeking appropriate solutions to ensure that the Outstanding Universal Value of the property is fully preserved." World Heritage properties in Australia are bilaterally managed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) as a Matters of National Environmental Significance (MNES). As per the above, significant impacts to this MNES are not expected based on the Significant Impact Guidelines. Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments. *References:* *ITOPF (2011). Effects of Oil Pollution on the Marine Environment. Technical Information Paper 13. The International Tanker Owners Pollution Federation Ltd. London.* *CoA (2013). Matters of National Environmental Significance: Significant Impact Guidelines 1.1. Commonwealth of Australia. Retrieved from: https://www.dcceew.gov.au/sites/default/files/documents/nes-guidelines_1.pdf* *World Heritage Centre (2023). The Operational Guidelines for the Implementation of the World Heritage Convention. UNESCO World Heritage Centre.*
PC296 Paragraph 98	Comment: Finally, the OPP notes that the PMST identified seven Ramsar-listed wetlands of international importance within the Planning Area, although it excludes three of these sites from its definition of the Planning Area.[196] The OPP indicates that a hydrocarbon spill may impact Ramsar wetlands, including Lavinia and Port Phillip Bay. Although hydrocarbon spills can cause significant harm to wetlands and species that rely on wetlands, the OPP fails to assess such impacts specific to the Ramsar sites. [196] *"The remaining intersections in the PMST Report are due to the size of the grids used in the PMST": OPP, p. 119*	Beach Energy (Operations) Limited acknowledges the comment regarding impacts to Ramsar-listed wetlands in the Planning Area and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. Revision to the scope of the Otway Gas Victoria (OGV) Project mean that one wetland of international importance (Ramsar wetland) is identified within the Planning Area – the Livina wetland located north-east coast of King Island. As stated in the OPP (section 4.2.6), four Ramsar-listed wetlands were identified within the Planning Area according to the Protected Matters Search Tool (PMST) Report, however only the Lavina wetland overlaps the Planning Area. This is due to the size of the analysis grids used in the PMST system which can be up to 32 km by 32 km. Due to the large grid size it is possible for both the Planning Area and a Ramsar-listed wetland to intersect the same analysis grid but not actually intersect each-other.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Beach conducts additional analysis using publicly available spatial data to confirm the presence or absence of sensitive areas, such as Ramsar-listed wetlands within the Project and Planning Areas. OPP Figure 4-5 (Wetlands of International Importance (Ramsar) and Table 4-4 within the Planning Area) shows that one Ramsar-listed wetlands overlap the Planning Area (and with a coastal component) may be potentially exposed to a hydrocarbon spill event. However, as detailed in Appendix M of the OPP, no Ramsar-listed wetlands are exposed to moderate threshold levels in the event of a loss of well control (LOWC) or marine diesel oil (MDO) hydrocarbon spill event based on the detailed oil spill modelling study. As a result, impacts to Ramsar-listed wetlands due to hydrocarbon exposure are not expected, and subsequently have not been assessed in the OPP. Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
3.8 Submitter No. 11		
PC342 Climate Action	Comment: [Name] has functions, interests and activities related to climate protection. Any fossil fuel expansion is inconsistent with Australia's commitment to the Paris agreement and limiting global temperature increases to 1.5 degrees celsius. Further, the International Energy Agency has affirmed that no new oil, gas and coal projects can be built if the energy sector is to reach net-zero emissions by 2050. Beach energy should abandon this project and seek more responsible investments.	Beach Energy (Operations) Limited (Beach) recognises that action to address climate change is necessary and that all energy systems must contribute to meet the targets set out in the Paris Agreement. As an energy company, Beach must play a role in managing our carbon emissions. Beach aspires to reach net zero Scope 1 and 2 emissions by 2050. Beach has an equity emissions reduction target to reduce its Scope 1 and 2 emissions intensity by 35 per cent by 2030. This is aligned with the Australian Government's target of a 43 per cent reduction in carbon emissions from a 2005 base. The emissions reduction is measured against a 2018 baseline, when Beach materially expanded its portfolio through the acquisition of Lattice Energy. The proposed management of the impact is aligned with the Beach Environment Policy, Climate Change Policy, Sustainability Policy, Risk Management Standard, Environment Management Standard and Sustainability Standard as detailed in Section 6.6.3.3 (part 6) of the Offshore Project Proposal (OPP) (Table 6-43). Gas and condensate from OGP is supplied into the domestic Australian market. The scope 3 emissions associated with the transmission/transport and end use of the gas and condensation will occur within Australian Commonwealth jurisdiction. Therefore, the scope 3 emissions will be managed in accordance with Australia's regulatory regime including NGER and the Safeguard

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
		Mechanism, which is designed "to deliver emissions reductions consistent with Australia's [NDC] under the Paris Agreement" (DCCEEW, 2023i) and the *Climate Change Act 2022*. As part of the commitment to the Paris Agreement, Australia has an emissions budget for the 2021-2030 decade of 4,353 MtCO2-e. The Project emissions (including all scopes) during this period is ~ 0.1% of this carbon budget. Beach has calculated the carbon budget for the period of the Project (2025 to 2049) of 6,729 MtCO2-e . The Project emissions (including all scopes) during this period is 0.19% of this carbon budget. The evaluation of GHG emissions confirm the Project is consistent with Australia's commitments under the Paris Agreement. Beach has considered this comment and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no change has been made to the OPP in response to this comment.
PC333 Threat to Tasmania Wilderness World Heritage Area.	Comment: [Name] does not consider oil and gas drilling, associated vessel movement and other activities in such close proximity to the Tasmanian Wilderness World Heritage Area coastline acceptable. Risk of a spill would have a disastrous impact on the unique and recognised world heritage values of this area.	Beach Energy (Operations) Limited (Beach) acknowledges comments regarding the Tasmanian World Heritage Area* and has reviewed the Otway Offshore Gas Victoria Project (the Project) Offshore Project Proposal (OPP) in response to these comments. As summarised in the introduction of this Report, revisions to the scope of the Otway Gas Victoria (OGV) Project mean that the Tasmania World Heritage Wilderness is no longer within the Planning Area of the OPP. Therefore, the Tasmanian World Heritage Area is not at risk of being exposed to hydrocarbons at any of the modelled scenarios (including vessel spill or loss of well control). Beach has considered these comments and is satisfied that the concerns raised have been adequately addressed in the OPP, for the reasons outlined above. As a result, no changes have been made to the OPP in response to these comments.
PC334 Decommissioning	Comment: [Name] has been advocating with oil and gas companies and regulators for a number of years in relation to decommissioning obligations. Given the growing evidence of oil and gas industry failure to decommission, the [Name] expects NOPSEMA to increase regulator oversight of preparation and planning for	The Offshore Project Proposal (OPP) for the Otway Offshore Gas Victoria Project (the Project) summarises the decommissioning phase of the Project (sections 3.8.5 and 9.4). This includes Beach Energy (Operations) Limited's (Beach) responsibility to remove all structures, equipment and property for the title area in accordance with sections 572(3) and 270(3) of the Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act).

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	decommissioning right from the initiation of any new proposal, including this one. Projects should not be approved unless it is absolutely clear that the company has thoroughly planned how and when full removal will occur.	For the Project decommissioning will require plug and abandonment of wells and decommissioning of subsea infrastructure. Beach has reviewed the OPP considering this comment and is satisfied it adequately addresses the decommissioning requirements of the OPGGS Act and Environment Regulations. No change has been made to the OPP in response to this comment.
PC335 Decommissioning	Comment: [Name] expects NOPSEMA will require progressive decommissioning throughout the life of fields to ensure decommissioning occurs as soon as possible and is not left until years in the future when the costs will be higher, environmental impacts and risks greater and there is an increased likelihood of companies cutting and running.	The Offshore Project Proposal (OPP) for the Otway Offshore Gas Victoria Project (the Project) summarises the decommissioning phase of the Project (Sections 3.8.5 and 9.4). This includes Beach Energy (Operations) Limited's (Beach) responsibility to remove all structures, equipment and property for the title area in accordance with sections 572(3) and 270(3) of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act). For the Project, decommissioning will require plug and abandonment of wells and decommissioning of subsea infrastructure. Beach acknowledges the concerns about the cost of decommissioning and ensuring the financial liability for decommissioning is borne by the petroleum industry and does not become the responsibility of government and taxpayers. The OPGGS Act was amended in 2021 to include new provisions referred to as 'trailing liability' for decommissioning of offshore oil and gas infrastructure to ensure the titleholders (current and former as well as related entities) are liable for decommissioning. Beach has reviewed the OPP considering this comment and is satisfied it adequately addresses the decommissioning requirements of the OPGGS Act and Environment Regulations.
PC336 Decommissioning	Comment: Australia has obligations under international law, including as a signatory to The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter of 1972 (the London Convention) and the subsequent modernised version, the London Protocol, relating to preventing pollution in the sea. Flowing from these international treaties, Australia is bound by International Maritime Organisation guidelines. In particular, IMO guideline 3.13 requests that no installation or structure installed after 1998 should be placed on any	Beach Energy (Operations) Limited (Beach) acknowledges the comment about complying with all relevant environment and marine legislation and regulations for its offshore activities. Sections 2.5 to 2.7 of the Offshore Project Proposal (OPP) summarises the state and federal laws and international agreements that may be applicable to the proposed Otway Offshore Gas Victoria Project (the Project), including the London Convention and London Protocol ratified in the amended *Environment Protection (Sea Dumping) Act 1981*. Beach is cognisant of its requirement to remove all structures, equipment, and property for the title area in accordance with Section 572(3) of the *Offshore Petroleum and Greenhouse Gas Storage*

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
	continental shelf or in any exclusive economic zone unless the design and construction of the installation or structure is such that entire removal upon abandonment or permanent disuse would be feasible. Beach Energy must ensure these activities do not proceed unless entire removal is possible.	*Act 2006* (OPGGS Act). For the Project, decommissioning will require plug and abandonment of wells and decommissioning of subsea infrastructure. Beach has reviewed the OPP considering this comment and is satisfied it adequately addresses the decommissioning requirements of the OPGGS Act and Environment Regulations.
PC337 Decommissioning	Comment: [Name] does not consider it acceptable that "Decommissioning of wells and infrastructure installed as part of this Project will occur at the end of field life." We request Beach to properly and genuinely plan for progressive decommissioning and that NOPSEMA should not accept this environment plan until this is the case.	The Offshore Project Proposal (OPP) for the Otway Offshore Gas Victoria Project (the Project) summarises the decommissioning phase of the Project (sections 3.8.5 and 9.4). This includes Beach Energy (Operations) Limited's (Beach) responsibility to remove all structures, equipment and property for the title area in accordance with sections 572(3) and 270(3) of *the Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act). For the Project, decommissioning will require plug and abandonment of wells and decommissioning of subsea infrastructure. Beach considers it is reasonable to describe decommissioning to occur at the end of field life, meaning once production for a field has ceased and well(s) are shut-in. Updates of OPP in subsequent revisions clarifies that decommissioning will be managed in compliance with Sections 572(3) and 270 of the OPGGS Act (unless alternative arrangements are accepted) – (See Table 0-3 and Table 3-2).
PC338 Decommissioning	Comment: We are also concerned by the statement in the Environment Plan that decommissioning "will occur as either a standalone campaign or as part of a wider decommissioning campaign." This suggests Beach Energy has not genuinely planned for decommissioning. We are concerned that decommissioning left very late, and potentially lumped together with other decommissioning activities that may be even later, creates an unacceptable risk to the delivery of decommissioning obligations by Beach Energy.	The Offshore Project Proposal (OPP) for the Otway Offshore Gas Victoria Project (the Project) summarises the decommissioning phase of the Project (sections 3.8.5 and 9.4). This includes Beach Energy (Operations) Limited's (Beach) responsibility to remove all structures, equipment, and property for the title area in accordance with sections 572(3) and 270(3) of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act). For the Project, decommissioning will require plug and abandonment of wells and decommissioning of subsea infrastructure. Beach considers that it is reasonable to describe decommissioning to occur as either a standalone campaign or as part of a wider decommissioning campaign. Beach has reviewed the OPP considering this comment and is satisfied it adequately addresses the decommissioning requirements of the OPGGS Act and Environment Regulations.

ID	Summary of comments received	Beach's assessment of merit of comment(s) and response(s) to comments and/or objections
PC339 Wilderness Society – Environmental Impacts	Comment: [Name] also holds significant concerns that proposed activities will have an unacceptable impact on: • Biologically important areas for 18 species within the planning area • Protected species, including 45 fish species, 122 bird species, 32 cetacean species, 4 pinniped species and 3 marine turtle species within the planning area • 32 species of cetacean that are are or can be found in the project/planning area • 4 Ramsar wetlands that over the planning area • Marine parks that overlap the planning area. In particular, the proposed drilling just 1km from the Zeehan marine park is unacceptable and should be excluded from these activities	Beach Energy (Operations) Limited (Beach) agrees that threatened and migratory species listed under the *Environmental Protection and Biodiversity Conservation Act 1999* may be present within the Planning Area of the Otway Offshore Gas Victoria Project (the Project). Biologically Important Areas (BIAs), wetlands of international importance (Ramsar wetlands) and Australian Marine Parks may also overlap the Planning Area. As summarised in the Introduction of this Report, revisions to the scope of the Otway Gas Victoria Project mean that the threatened, migratory, marine or cetacean species protected under the EPBC Act identified within the Project Area and revised Planning Area, now include: • 12 fishes (including sharks) (9 within the Project Area and another 3 within the Planning Area beyond the Project Area) • 111 birds (33 within the Project Area and another 78 within the Planning Area beyond the Project Area) • 34 marine mammals (29 within the Project Area and another 5 within the Planning Area beyond the Project Area) • 3 marine reptiles (within both the Project Area and Planning Area beyond the Project Area) The revised Planning Area overlaps one 1 Ramsar wetland (Lavinia) and two Australian Marine Parks (Zeehan and Apollo Marine Parks) The Offshore Project Proposal (OPP) provides an assessment of the existing environment (including listed threatened and migratory species and ecosystems) in Section 4 of the OPP. Beach has assessed the impacts and risks to these environmental receptors presented in Sections 6 and 7 of the OPP and has demonstrated the acceptability of the impacts in relation to the acceptable levels defined in Table 5-4 of the OPP. As the comment does not contain any new information about the content of the OPP, no change is made to the OPP.