Environment Plan

Otway Offshore Operations

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
9	21/10/2020	Issued for use	ACU, OW, FGR, TFL	ACU	FGR
10	17/12/2020	Issued for use	NBU, ACU, TFL	NBU	FGR
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12	10/03/2022	Update NOPSEMA OMR	PWE, ACU, KGA	Xodus, PWE	KGA
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Review due	Review frequency
1/08/2027	5 year/s

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

1 Acronyms

Terms/acronym	Definition/Expansion
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
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
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
DAFF	Department of Agriculture, Fisheries and Forestry formerly part of DAWE
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water formerly DAWE
DELWP	Victorian Department of Environment, Land, Water and Planning
DIIS	Department of Industry, Innovation and Science
DISER	Department of Industry, Science, Energy and Resources
DJPR	Victorian Department of Jobs, Precincts and Regions
DJPR: ERR	Victorian Department of Jobs, Precincts and Regions: Earth Resources Regulation
DNP	Commonwealth Director of National Parks
DO	Dissolved Oxygen
DotEE	Commonwealth Department of the Environment and Energy now Department of Agriculture, Water and Environment

Terms/acronym	Definition/Expansion
DP	Dynamic Positioning
DPIPWE	Tasmanian Department of Primary Industries, Parks, Water and Environment
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
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
EPO	Environment Performance Outcome
EPS	Environment Performance Standard
ERT	Emergency Response Team
ESD	Ecologically Sustainable Development
ETBF	Eastern Tuna and Billfish Fishery
FFG	Flora and Fauna Guarantee Act
GHG	Greenhouse gases
H_2S	Hydrogen Sulphide
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
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

Terms/acronym	Definition/Expansion
IUCN	International Union for Conservation of Nature
JRCC	Joint Rescue Coordination Centre
KEF	Key Ecological Feature
Lattice	Lattice Energy Limited
LOWC	Loss of Well Control
LOC	Loss of Containment
LPG	Liquefied Petroleum Gas
MARPOL	International Convention for The Prevention of Pollution from Ships
MC	Measurement Criteria
MCS	Master Control Station
MDO	Marine Diesel Oil
MEG	Monoethylene Glycol
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
NEBA	Net Environmental Benefit Analysis
NGER	National Greenhouse and Energy Reporting
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NORMs	Naturally Occurring Radioactive Materials
NO_2	Nitrogen dioxide
NPI	National Pollution Inventory
NSW	New South Wales
O_3	Ozone
OEMS	Operations Excellence Management System
OGUK	Oil and Gas UK
OPEP	Oil Pollution Emergency Plan
OPGGS Act	Offshore Petroleum and Greenhouse Gas Storage Act 2006

Terms/acronym	Definition/Expansion
OPGGS Regulations (Vic)	Victorian Offshore Petroleum and Greenhouse Gas Storage Regulations 2011
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
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
Pb	Lead
PCM	Pipeline Corrosion Monitor
PFC	Perfluorocarbons
POLREP	Marine Pollution Report
POWBONS Act	Pollution of Waters by Oil and Noxious Substances Act 1986
ppm	Parts Per Million
PSZ	Petroleum Safety Zone
PTS	Permanent Threshold Shift
ROV	Remotely Operated Vehicle
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
SESSF	Southern and Eastern Scalefish And Shark Fishery
SETFIA	South East Trawl Fishing Industry Association
SF6	Sulfur 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

Terms/acronym	Definition/Expansion
SMS	Short Message Service
SO_2	Sulfur dioxide
SPCU	Subsea Power and Control Unit
SPF	Small Pelagic Fishery
SPL	Sound Pressure Level
SST	Sea surface temperature
SVS	Subsea Valve 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
VLSFO	Very Low Sulphur Fuel Oil
VWMS	Victorian Waterway Management Strategy
WBDF	Water-Based Drilling Fluid
WECS	Well Engineering and Construction Management System
WOMP	Well Operations Management Plan
Woodside	Woodside Petroleum Ltd
WRSSV	Wireline Retrievable Subsurface Safety Valve

2 Overview of the Activity

Beach Energy (Operations) Limited (Beach) is the part owner and nominated operator of the Otway Gas Development. The development consists of offshore and onshore infrastructure necessary for the commercialisation of gas and liquids in the Geographe and Thylacine fields off the coast of Victoria.

Development of the gas fields commenced in 2004 by Woodside Petroleum Ltd under a joint venture arrangement, with first production in mid-2007.

The Artisan field is located offshore approximately 32 km to the south of Port Campbell, the Geographe field is located offshore approximately 55 km to the south of Port Campbell and the Thylacine field is located a further 15 km south of the Geographe field.

The scope of this Environment Plan (EP), is the operation, inspection, maintenance, and repair (and associated activities) of the offshore assets associated with the Otway Gas Development (Figure 2-1):

- Thylacine-A well head platform with four production wells.
- Three subsea Geographe production wells (Geographe 2, Geographe 4, Geographe 5) and associated subsea infrastructure.
- Four subsea suspended wells (Artisan1, Geographe 1, Geographe 3, Thylacine1).
- Otway Pipeline System consists of two subsea pipelines – the Otway Gas Pipeline and the piggybacked MEG pipeline.

The onshore assets, which are not covered by this EP, include the Otway Gas Plant approximately 7 km north-east of Port Campbell, the onshore section of the Otway Gas Pipeline from the shore crossing to the Otway Gas Plant, the Halladale Black Watch Speculant wellsite located near Nirranda South, and the Halladale Black Watch Speculant gas pipeline to the Otway Gas Plant. The Otway Gas Plant produces gas, condensate and liquefied petroleum gas (LPG) from these gas fields.

The following assets/activities are not included in the scope of this EP:

- The Halladale Black Watch Speculant wellsite and gas pipeline which are covered by the Halladale Black Watch Speculant Well Site Environmental Management Plan (CDN/ID 8255348) and the Halladale Black Watch Speculant Pipeline PL006009 Environment Management Plan (CDN/ID 8198931), respectively.
- Onshore section of the Otway Gas Pipeline which is covered by the Otway Onshore Pipeline PL250 Environmental Management Plan (CDN/ID 3977303).
- Otway Gas Plant which is covered by the Otway Gas Plant Environmental Management Plan (CDN/ID 8027333).
- Exploration, appraisal and drilling activities are covered by activity specific EPs as necessary.
- Well intervention, wireline or slickline campaigns on subsea production or suspended wells are covered by activity specific EPs as necessary.
- Decommissioning of any assets/facilities which will be covered by specific EPs as necessary.

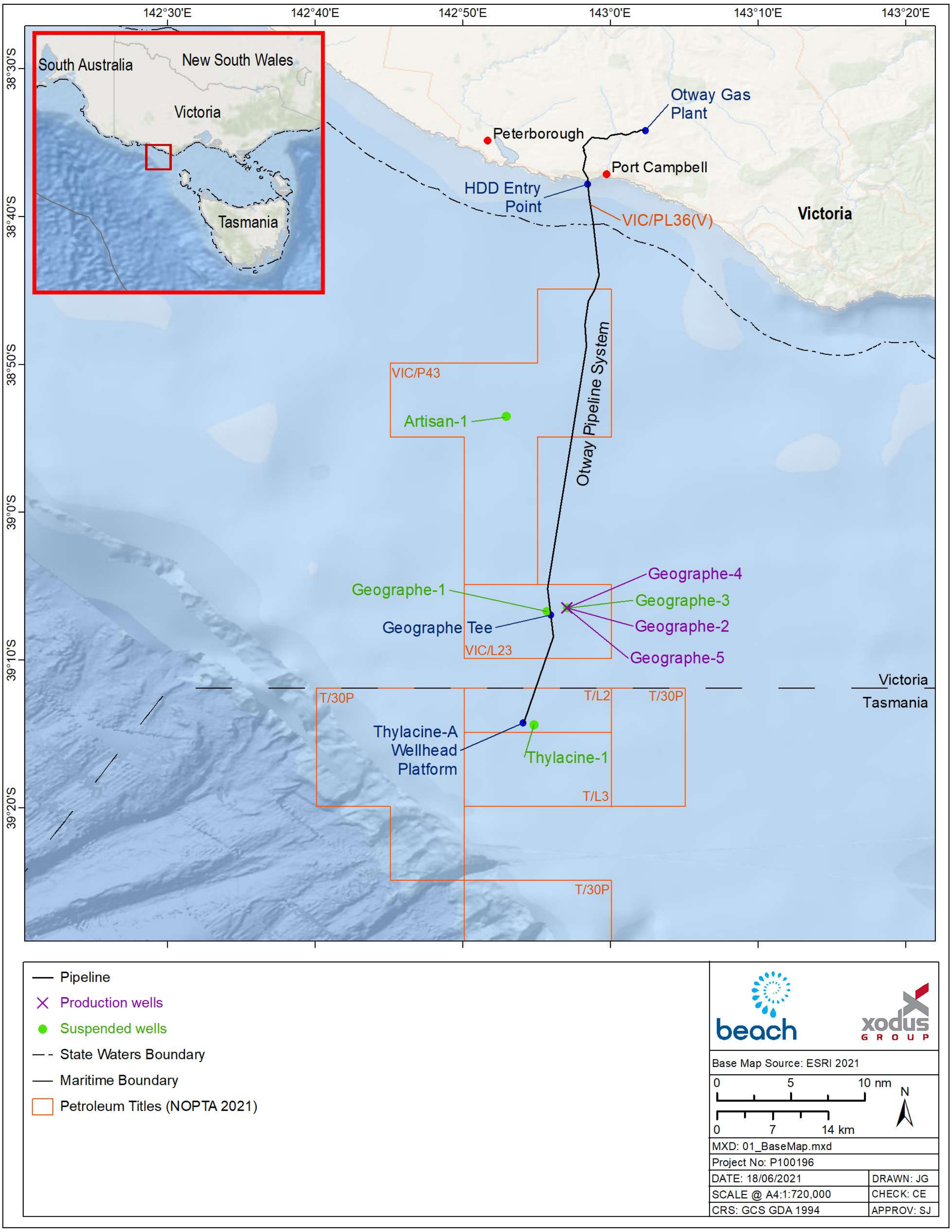


Figure 2-1: Otway Offshore Operations permits and well locations

2.1 Environment Plan Summary

This Otway Offshore Operations EP Summary has been prepared from material provided in this EP. The summary consists of the following (Table 2-1) as required by Regulation 11(4) of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R) and the Victorian Offshore Petroleum and Greenhouse Gas Storage Regulations 2011 (OPGGS Regulations (Vic)).

Table 2-1: EP Summary of material requirements

EP Summary Material Requirement	Relevant Section of EP Containing EP Summary Material
The location of the activity	Section 4.1
A description of the receiving environment	Section 5
A description of the activity	Section 4
Details of the environmental impacts and risks	Section 7
A summary of the control measures for the activity	Section 7.18
A summary of the arrangements for ongoing monitoring of the titleholder's environmental performance	Section 8
A summary of the response arrangements in the oil pollution emergency plan	Refer to OPEP
Details of consultation already undertaken and plans for ongoing consultation	Section 8.12.9
Details of the titleholders nominated liaison person for the activity	Section 2.2

2.2 Titleholder and Liaison Person Details

The operator of the Otway Gas Development is Beach Energy (Operations) Limited, a company wholly owned by Beach Energy Limited (Beach). Table 2-2 details the titleholder and the liaison person for the title applicable to the activity.

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

Beach's asset portfolio includes ownership interests in strategic oil and gas infrastructure, as well as a suite of high potential exploration prospects. Beach's gas exploration and production portfolio includes acreage in the Otway, Bass, Cooper/Eromanga, Perth, Browse and Bonaparte basins in Australia, as well as the Taranaki and Canterbury basins in New Zealand (Figure 2-2).

Beach will notify National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) and Department of Jobs, Precincts and Regions: Earth Resources Regulation (DJPR (ERR)) of any change in titleholder, a change in the titleholder's nominated liaison person, or a change in the contact details for either the titleholder or the liaison person as soon as practicable after such a change takes place.

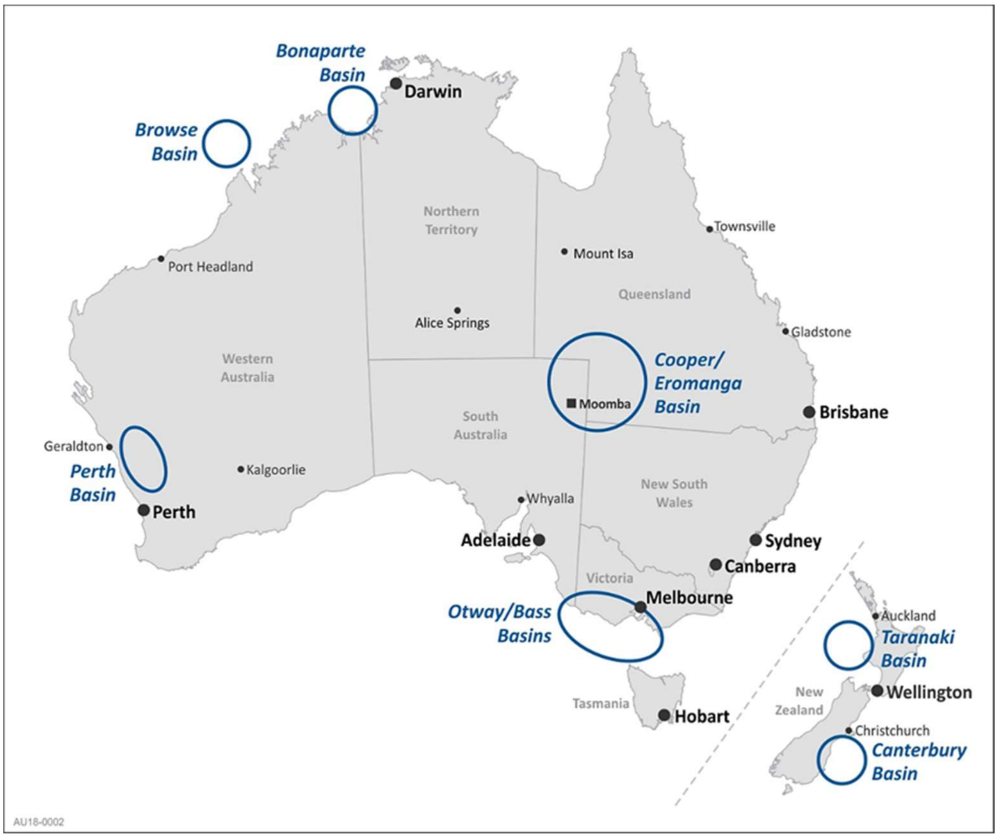


Figure 2-2: Beach operations

Table 2-2: Details of titleholder and liaison person.

Petroleum Title	**Details**	
T/L2, T/L3, T/PL3, VIC/L23, VIC/P43, VIC/PL36, VIC/PL36(V)	Titleholder	Beach Energy (Operations) Limited – Operator Beach Energy (Otway) Limited OGOG (Otway) Pty Ltd
	Business address	Level 8 80 Flinders Street Adelaide South Australia 5000
	Telephone number	(08) 8338 2833
	Fax number	(08) 8338 2336
	Email address	info@beachenergy.com.au
	Australian Company Number	ACN: 007 845 338
Titleholder Liaison Person		
Mr David Ross General Manager Victoria	Business address	Level 15 150 Lonsdale Street Melbourne Victoria 3000
	Telephone number	(08) 8338 2833
	Fax number	(08) 8338 2336
	Email address	info@beachenergy.com.au

3 Applicable Requirements

This section provides information on the requirements that apply to the activity, in accordance with Regulation 13(4) of the OPGGS(E)R and Regulation 15 (3)(a) and 15 (3)(b) of the OPGGS Regulations (Vic). Requirements include relevant laws, codes, other approvals and conditions, standards, agreements, treaties, conventions or practices (in whole or part) that apply to the jurisdiction that the activity takes place in.

The proposed activity is located within Commonwealth and Victorian State waters. Relevant Commonwealth requirements are summarised in Table 3-2 and relevant Victorian requirements are described in Table 3-3. On the basis that a worst-case credible oil spill has the potential to intersect Tasmanian waters, relevant Tasmanian requirements are described in Table 3-4.

3.1 EPBC Act Primary Approval

Woodside Petroleum Ltd (Woodside), as the original operator of the Otway Development, submitted an Environmental Impact Statement (EIS) under the Environment Protection and Biodiversity Conservation (EPBC) Act for the Otway Development which was approved by the Minister of the Environment in 2004 (EPBC 2002/621). In March 2010, Origin Energy Resources Ltd purchased the Otway Development from Woodside and commenced operatorship of the development (later changing its name to Lattice Energy Limited (Lattice)). In February 2018, Beach acquired Lattice, which included the acquisition of the Otway Development.

The EIS preferred development concept consisted of:

- Production from the Thylacine unmanned platform consisting of dry well heads and telecommunication control links to the onshore gas processing plant.
- Subsea well heads and infrastructure at the Geographe field.
- Subsea tie-ins consisting of the construction and operation of subsea wells, flowlines and other related infrastructure within the development area for the purpose of extracting gas from the Thylacine and Geographe gas discoveries.
- Subsea pipeline to bring gas from the Thylacine and Geographe fields to the onshore gas processing plant.
- Separation of produced water and compression of gas at the onshore gas processing plant.

To date the Otway Development consists of:

- Four production wells (dry wells) at the Thylacine-A Wellhead Platform and telecommunication control links to the Otway Gas Plant.
- Three subsea production wells (G-2, G-4, G-5) and the G-3 well that was constructed and never operated, at the Geographe field.
- Subsea tie-in, flowlines and other related infrastructure for the purpose of extracting gas from the Geographe gas discoveries.

- Subsea pipeline to bring gas from the Thylacine and Geographe fields to the Otway Gas Plant.
- Separation of produced water and compression of gas at the onshore Otway Gas Plant.

The scope of this EP consists of:

- Operations of the Otway Offshore Operations, including:
  - Production from the Thylacine field.
  - Production from the Geographe field.

The operation of the Otway Offshore project described in this EP forms part of the Otway Development and was approved by the Minister (EPBC (2002/621). A separate Offshore Project Proposal is not therefore required (Regulation 5A(2) OPGGS(E)R). The activity approved by the Minister included:

- Gas production, subsea manifolds and flowlines and the possibility of an offshore platform at either Thylacine or Geographe and is therefore equivalent with the description of activity within this EP.
- The location of the development in the Geographe and Thylacine fields are the same as those described within the EIS and approved under EPBC (2002/621).
- The wells, Thylacine-A Wellhead Platform and subsea infrastructure are located in the same petroleum titles as those described within the EIS and approved under EPBC (2002/621).
- The environment that may be affected by the operations is the same as that previously considered during the development of the EIS.
- The environmental impact assessment within the EIS considered similar aspects and cause effect pathways to similar receptors as those detailed within this EP, although the EP includes a greater level of detail consistent with the requirements of regulation 13 (3) of the OPGGS(E) Regs 2009.
- The consequence evaluation for environmental impacts associated with the operations of the Thylacine and Geographe fields is consistent with those described within the EIS.
- As such, the proposed activity does not trigger a requirement for further approval under the EPBC Act (as would be met though an offshore project proposal) given the Environment Minister has approved, under Part 9 of the EPBC Act the taking of an action that includes the activity via the existing approval EPBC (2002/621) which is consistent with regulation 9(3)(b)(iii) of the OPGGS(E) Regulations 2009.

Conditions relating to the EPBC Act approval that are considered relevant to the scope of this EP are detailed in Table 3-1. Conditions are based on those in the Variation to Conditions Attached to Approval issued on the 22 June 2015.

3.2 EPBC Act Requirements

This EP considers the impacts to matters of national environmental significance (MNES) protected under Part 3 of the EPBC Act. Relevant requirements associated with the EPBC Act, related policies, guidelines, plans of management, recovery plans, threat abatement plans, and other relevant advice issued by Department of Climate Change, Energy, the Environment and Water (DCCEEW), are detailed in the applicable sections within Section 4.7 as part of the description of the existing environment.

Recovery plans, threat abatement plans and species conservation advice applicable to species identified in Section 5.6.7 are detailed in Table 3-5.

On 28 February 2014, following Australian Government decisions under the EPBC Act, the process for streamlined environmental approvals for offshore petroleum and greenhouse gas storage activities in Commonwealth waters came into effect.

Following a strategic assessment of NOPSEMA's environmental management authorisation process under the EPBC Act, the Federal Minister for the Environment endorsed NOPSEMA's process as a Program (the Program) that meets the requirements of Part 10 of the EPBC Act. Subsequently, the Minister also approved a class of actions which, if undertaken in accordance with the endorsed Program, will not require separate referral, assessment and approval under the EPBC Act.

Key regulatory elements of the endorsed Program consist of the OPGGS(E)R and NOPSEMA's Program commitments in the Program Report - Streamlining Offshore Petroleum Environmental Approvals, Program Report February 2014.

In the preparation of this EP, Beach have had regard to relevant policy documents, guidelines, Statements of Outstanding Universal Value and plans of management as per the requirement of the Program.

Table 3-1: Conditions from the Otway Development (2002/621) applicable to the Otway Offshore Operations

Condition No.	Condition	Relevant Section of EP
8	If the person taking the action proposes to undertake any subsea tie-in not included in approved plans pursuant to conditions 1, 3, 4 and 5, the person taking the action must revise such plans or submit a new plan or plans so as to address the activities associated with, and potential environmental impacts of, the subsea tie-in. Activities associated with subsea tie-ins may not be commenced until each such plan or revised plan has been approved by the Minister. Each plan or revised plan that has been approved by the Minister must be implemented. Note: subsea tie-in is not defined in the conditions dated 22 June 2015. The definition in conditions dated 13 April 2004 is "the construction and operation of eight subsea wells, flowlines and other related infrastructure within the development area for the purpose of extracting gas from the Thylacine and Geographe discoveries." Conditions dated 22 June 2015 do not have conditions 3 or 4.	This EP.
11	A plan required by condition 1, 3, 5, 8 or 9 is automatically deemed to have been submitted to, and approved by, the Minister if the	This EP.

Condition No.	Condition	Relevant Section of EP
	measures (as specified in the relevant condition) are included in an environment plan (or environment plans) relating to the taking of the action that: a) was submitted to NOPSEMA after 27 February 2014; b) either: (i) is in force under the OPGGS(E)R; or (ii) has ended in accordance with regulation 25A of the OPGGS(E)R.	
11B	Where an environment plan which includes measures specified in the conditions referred to in conditions 11 is in force under the OPGGS(E)R that relates to the taking of the action, the person taking the action must comply with those measures as specified in that environment plan.	This EP. Section 7.18 Environmental Performance Outcomes, Standards and Measurement Criteria Section 7 – Implementation Strategy

Table 3-2: Commonwealth environmental legislation relevant to the Otway Offshore Operations

Legislation	Scope	Related International Conventions	Administering Authority
Australian Ballast Water Management Requirements (Commonwealth of Australia, 2020)	The Australian Ballast Water Management Requirements set out the obligations on vessel operators with regards to the management of ballast water and ballast tank sediment when operating within Australian seas. **Application to activity**: Provides requirements on how vessel operators should manage ballast water when operating within Australian seas to comply with the Biosecurity Act. Section 7.10 details these requirements in relation to the management of ballast water.	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)
Australia Biofouling Management Requirements (DAWE 2022)	The Australian biofouling management requirements set out vessel operator obligations for the management of biofouling when operating vessels under biosecurity control within Australian territorial seas. **Application to activity**: Provides requirements on how vessel operators should manage biofouling when operating within Australian seas to comply with the Biosecurity Act. Section 7.10 details these requirements in relation to the management of biofouling.	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)	DAFF
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 effected through Australian Maritime Safety Authority (AMSA) who administers the National Plan for Maritime Environmental Emergencies (NatPlan). **Application to activity**: AMSA is the designated Control Agency for oil spills from vessels in Commonwealth waters. These arrangements are detailed in the OPEP.	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	Australian Maritime Safety Authority (AMSA)

Legislation	Scope	Related International Conventions	Administering Authority
		Articles 198 and 221 of the United Nations Convention on the Law of the Sea 1982	
Biosecurity Act 2015 Biosecurity Regulations 2016 Biosecurity Amendment (Biofouling Management) Regulations 2021	This Act 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; (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. **Application to activity**: The Biosecurity Act and regulations apply to 'Australian territory' which is the airspace over and the coastal seas out to 12 m from the coastline. For the activity the Act and regulations regulates vessels entering Australian territory regarding ballast water and hull fouling. Biosecurity risks associated with the activity are detailed in Section 7.10.	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)	DAFF
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 under international agreements • nuclear actions • Commonwealth marine environment • Great Barrier Reef Marine Park	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	Department of Climate Change, Energy, the Environment and Water (DCCEEW)

Legislation	Scope	Related International Conventions	Administering Authority
	• water trigger for coal seam gas and coal mining developments **Application to activity**: Petroleum activities are excluded from within the boundaries of a World Heritage Area (Sub regulation 10A(f)). The activity is not within a World Heritage Area. The EP must describe matters protected under Part 3 of the EPBC Act and assess any impacts and risks to these. Section 4.7 describes matters protected under Part 3 of the EPBC Act. The EP must assess any actual or potential impacts or risks to MNES from the activity. Section 7 provides an assessment of the impacts and risks from the activity to matters protected under Part 3 of the EPBC Act.	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) International Convention for the Regulation of Whaling 1946 Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979	
Environment Protection and Biodiversity Conservation Regulations 2000	Part 8 of the regulations provide distances and actions to be taken when interacting with cetaceans. **Application to activity**: The interaction requirements are applicable to the activity in the event that a cetacean is sighted. Section 7 details how these requirements will be applied.	-	DCCEEW
Marine Pest Plan 2018–2023: National Strategic Plan for Marine Pest Biosecurity	Australia's national strategic plan for marine pest biosecurity. It outlines a coordinated approach to building Australia's capabilities to manage the threat of marine pests over the next five years. It represents agreed priorities and actions of governments, marine industries, and other stakeholders to achieve a common purpose: to manage the risks posed by marine pests and minimise their potential harm to marine industries, communities and the environment.	-	DAFF

Legislation	Scope	Related International Conventions	Administering Authority
	Application to activity: Applying the recommendations within this document and implementing effective biofouling controls can reduce the risk of the introduction of an introduced marine species Section 7.10 details how these requirements will be applied.		
National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry 2009	The guidance document provides recommendations for the management of biofouling risks by the petroleum industry. **Application to activity**: Applying the recommendations within this document and implementing effective biofouling controls can reduce the risk of the introduction of an introduced marine species. Section 7 details the requirements applicable to vessel activities.	Certain sections of International Convention for The Prevention of Pollution from Ships (MARPOL) International Convention for the Safety of Life at Sea 1974 Convention on the International Regulations for Preventing Collisions at Sea (COLREG) 1972	DAFF
National Greenhouse and Energy Reporting Act 2007 (NGER Act) National Greenhouse and Energy Reporting Regulations 2008 National Greenhouse and Energy Reporting (Measurement) Determination 2008 National Greenhouse and Energy Reporting (Audit) Determination 2009	Establishes the legislative framework for the NGER Scheme which is a national framework for reporting greenhouse gas emissions, greenhouse gas projects and energy consumption and production by corporations in Australia. **Application to activity**: Reporting requirements under the NGER Act and associated regulations are detail in Section 7.3	United Nations Framework Convention on Climate Change 1992.	Clean Energy Regulator

Legislation	Scope	Related International Conventions	Administering Authority
National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015			
National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds and migratory shorebirds (CoA 2020)	The Guidelines outline the process to be followed where there is the potential for artificial lighting to affect wildlife. **Application to activity**: Applying the recommendations within this document and implementing effective controls can reduce the impact of light to sensitive receptors. Section 7.2 details the requirements applicable to the activity.	-	DCCEEW
National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (Commonwealth of Australia, 2017a)	The overarching goal of the strategy is to provide guidance on understanding and reducing the risk of vessel collisions and the impacts they may have on marine megafauna. **Application to activity**: Applying the recommendations within this document and implementing effective controls can reduce the risk of the vessel collisions with megafauna. Section 7.11 details the requirements applicable to vessel activities.	-	DCCEEW
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 21: Safety and emergency arrangements. MO 30: Prevention of collisions. MO 31: SOLAS and non-SOLAS certification.	Certain sections of MARPOL International Convention for the Safety of Life at Sea 1974 COLREG 1972	AMSA

Legislation	Scope	Related International Conventions	Administering Authority
	Application to activity: The relevant vessels (according to class) will adhere to the relevant MO with regard to navigation and preventing collisions in Commonwealth waters. Section 7 details the requirements applicable to vessel activities.		
Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act) OPGGS(E)R	The Act addresses all licensing, health, safety, environmental and royalty issues for offshore petroleum exploration and development operations extending beyond the three-nautical mile limit. Part 2 of the OPGGS(E)R specifies that an EP must be prepared for any petroleum activity and that activities are undertaken in an ecologically sustainable manner and in accordance with an accepted EP. **Application to activity**: The OPGGS Act provides the regulatory framework for all offshore petroleum exploration and production activities in Commonwealth waters, to ensure that these activities are carried out: consistent with the principles of ecologically sustainable development as set out in section 3A of the EPBC Act. so that environmental impacts and risks of the activity are reduced to ALARP. so that environmental impacts and risks of the activity are of an acceptable level. Demonstration that the activity will be undertaken in line with the principles of ecologically sustainable development, and that impacts and risks resulting from these activities are ALARP and acceptable is provided in Section 7.	-	NOPSEMA
Protection of the Sea (Prevention of Pollution from Ships) Act 1983	This Act regulates 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. **Application to activity**: All ships involved in petroleum activities in Australian waters are required to abide to the requirements under this Act. Several MOs are enacted under this Act relating to offshore petroleum activities, including: MO 91: Marine Pollution Prevention – Oil.	Various parts of MARPOL	AMSA

Legislation	Scope	Related International Conventions	Administering Authority
	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. Section 7 details the requirements applicable to vessel activities.		
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. **Application to activity**: All ships involved in offshore petroleum activities in Australian waters are required to abide to the requirements under this Act. The MO 98: Marine Pollution Prevention – Anti-fouling Systems is enacted under this Act. Section 7 details the requirements applicable to vessel activities.	International Convention on the Control of Harmful Anti-fouling Systems on Ships 2001	AMSA
Underwater Cultural Heritage Act 2018	Protects the heritage values of shipwrecks, sunken aircraft and relics (older than 75 years) 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. **Application to activity**: 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 5.8.1 identifies no known shipwrecks or sunken aircraft in the EMBA.	Agreement between the Netherlands and Australia concerning old Dutch Shipwrecks 1972	DCCEEW

Table 3-3: Victorian environment legislation relevant to potential impacts and risks to State waters and lands

Legislation	Scope	Application to Activity	Administering Authority
Climate Change Act 2017	This Act provides Victoria with the legislative foundation to manage climate change risks, maximise the opportunities that arise from decisive action, and drive transition to a climate-resilient community and economy with net-zero emissions by 2050. The Act also requires 5-yearly interim emissions reduction targets to be set to keep Victoria on track to meet the state's long-term target of net-zero. Victoria's interim target for the period 2021–2025 is for emissions to reduce 28–33% below 2005 levels by the end of 2025. The interim target for the period 2026–2030 is for emissions to reduce 45–50% below 2005 levels by the end of 2030.	Management of GHG emissions from activities within Victorian waters and land. Section 7.3 Atmospheric Emissions and Table 7 29: Environmental Performance Outcomes, Standards and Measurement Criteria - Operations detail how Beach Energy will manage Scope 1, 2 and 3 GHG emissions to meet Victoria's GHG targets.	Environment Protection Authority (EPA)
Environment Protection Act 1970 (& various regulations)	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 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.	Otway Gas Plant activities, including management of emissions to air and discharges are subject to an operating licence issued by the EPA. Emissions to air subject to an EPA operating licence are reported annually to the EPA.	EPA

Legislation	Scope	Application to Activity	Administering Authority
	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 1970* 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.	Oil pollution management in Victorian State waters. Discharge of domestic ballast water from emergency response vessels into Victorian State waters must comply with these requirements.	
Emergency Management Act 2013 (& Regulations 2003)	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. 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.	Emergency response structure for managing emergency incidents within Victorian State waters. Emergency management structure will be triggered in the event of a spill impacting or potentially impacting State waters. See OPEP.	Department of Justice and Regulation (Inspector General for Emergency Management)

Legislation	Scope	Application to Activity	Administering Authority
Flora and Fauna Guarantee Act 1988 (& Regulations 2011)	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 (Environment that May Be Affected (EMBA)) as adopted (as relevant) within this EP. Triggered if an incident results in the injury or death of a FFG Act listed species (e.g. collision with a whale).	Department of Environment, Land, Water and Planning (DELWP)
Heritage Act 1995	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 5 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 (DELWP)
Marine Safety Act 2010 (& Regulations 2012)	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

Legislation	Scope	Application to Activity	Administering Authority
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.	DELWP
OPGGS Act 2010 and OPGGS Regulations 2011	The Act and Regulations apply to petroleum operations within three nautical miles of the Victorian coast and address licensing, health, safety, environmental and royalty issues for offshore petroleum exploration and development operations. Waters greater than 3 nautical miles offshore from the coast are Commonwealth waters and are covered by Commonwealth legislation (OPGGS Act 2006). The Commonwealth and Victorian legislation are, by agreement, very similar with regard to petroleum.	Applies where there are activities within Victorian State waters.	DJPR
Pollution of Waters by Oil and Noxious Substances Act 1986 (POWBONS) (& Regulations 2002)	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 DJPR and EPA

Legislation	Scope	Application to Activity	Administering Authority
Wildlife Act 1975 (& Regulations 2013)	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 2009* 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 (150 m), whales (300 m) and seals (50 m).	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.	DELWP

Table 3-4: Tasmanian Environment Legislation Relevant to potential impacts to State waters and lands

Legislation	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 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. See OPEP	Department of Primary Industries, Parks, Water and Environment (DPIPWE)

Legislation	Scope	Application to Activity	Administering Authority
Pollution of Waters by Oil and Noxious Substances Act 1987	Pollution of the sea in Tasmanian State waters may be regulated by general pollution laws such as the EMPCA (see above), but the Pollution of Waters by Oil and Noxious Substance Act 1987 deals specifically with discharges of oil and other pollutants from ships. In accordance with current national arrangements, the Pollution of Waters by Oil and Noxious Substance Act 1987 gives effect in Tasmania to the MARPOL international convention on marine pollution.	Gives effect to MARPOL in Tasmanian waters.	DPIPWE

Table 3-5: Recovery plans, threat abatement plans and species conservation advice relevant to the Otway Offshore Operations

Relevant Plan/Advice	Description	Applicable Threats or Management Advice
The Threat Abatement Plan for the impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Ocean (Commonwealth of Australia, 2018)	The plans focus on strategic approaches to reduce 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.
Wildlife Conservation Plan for Migratory Shorebirds – 2015 (DoE, 2015b)	The long-term recovery plan objective for migratory shorebirds is to minimise anthropogenic threats to allow for the conservation status of these bird species.	Habitat degradation/ modification (oil pollution)
Draft Wildlife Conservation Plan for Seabirds (Commonwealth of Australia, 2019c)	The Plan aims to provide a strategic national framework for the research and management of listed marine and migratory seabirds and to outline national activities to support the conservation of listed seabirds in Australia and beyond.	*Habitat modification* Evaluate the risk of oil spill impacts on the ability of a seabird to use an area for breeding, roosting or foraging.
National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011–2016 (DSEWPaC, 2011a)	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*

Relevant Plan/Advice	Description	Applicable Threats or Management Advice
		Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Pterodroma mollis* (soft-plumaged petrel) (TSSC, 2015c)	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) (DSEWPC, 2011c)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the fairy tern.	*Marine pollution* Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.
Draft National Recovery Plan for the Australian Fairy Tern (*Sternula nereis nereis*) (Commonwealth of Australia, 2019b)	Draft 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
Conservation Advice for *Numenius madagascariensis* (eastern curlew) (DoE, 2015e)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the eastern curlew.	Habitat degradation/ loss (oil pollution)
Conservation Advice *Limosa lapponica baueri* (bar-tailed godwit (western Alaskan)) (TSSC, 2016a)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the bar-tailed godwit (western Alaskan).	Habitat degradation/ loss
Approved Conservation Advice for *Pachyptila subantarctica* (fairy prion (southern)) (TSSC, 2015d)	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, 2013c)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Australian painted snipe.	None identified.

Relevant Plan/Advice	Description	Applicable Threats or Management Advice
Draft National Recovery Plan for the Australian Painted Snipe (Commonwealth of Australia, 2019e)	The plan considers the conservation requirements of the species across its range and identifies the actions to be taken to ensure the species' long-term viability in the wild, and the parties that will undertake those actions.	Deterioration of water quality, human disturbance.
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)
Conservation Advice *Calidris ferruginea* (curlew sandpiper) (DoE, 2015f)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the curlew sandpiper.	Habitat degradation/ loss (oil pollution)
Approved Conservation Advice for *Calidris canutus* (red knot) (TSSC, 2016d)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the red knot.	*Marine pollution* Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.
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.	None identified.
National Recovery Plan for *Pterodroma leucoptera leucoptera* (Gould's petrel) (DEC NSW, 2006)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Gould's petrel.	None identified.
National Recovery Plan for the *Neophema chrysogaster* (orange-bellied parrot) (DELWP, 2016)	The recovery plan is a co-ordinated conservation strategy for the orange-bellied parrot.	Illuminated boats and structures: evaluate risk of lighting on vessels and offshore structures.
National Recovery Plan for the *Lathamus discolour* (swift parrot) (Saunders and Tzaros, 2011)	The recovery plan is a co-ordinated conservation strategy for the swift parrot.	None identified.

Relevant Plan/Advice	Description	Applicable Threats or Management Advice
Draft National Recovery Plan for the Swift Parrot (*Lathamus discolor*) (CoA, 2019d)		
Approved Conservation Advice for the *Halobaena caerulea* (blue petrel) (TSSC, 2015e)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the blue petrel	None identified.
National Recovery Plan for the *Prototroctes maraena* (Australian grayling) (Backhouse et al., 2008)	The recovery plan is a co-ordinated conservation strategy for the Australian grayling.	Poor water quality and siltation: Typically, from onshore sources. Impact of introduced fish: Typically, from onshore sources.
Recovery Plan for the *Carcharodon carcharias* (white shark) (DSEWPaC, 2013a)	The recovery plan is a co-ordinated conservation strategy for the white shark.	None identified.
Approved Conservation Advice for the *Rhicodon typus* (whale shark) (TSSC, 2015b)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the whale shark	Vessel strike.
Recovery Plan for Marine Turtles in Australia, 2017-2027 (Commonwealth of Australia, 2017b)	The long-term recovery plan objective for marine turtles is to minimise anthropogenic threats to allow for the conservation status of marine turtles	• chemical and terrestrial discharge. • marine debris. • light pollution. • habitat modification. • vessel strike. • noise interference. • vessel disturbance.
Approved Conservation Advice for *Dermochelys coriacea* (leatherback turtle) (DEWHA, 2008)	See above for the recovery plan for marine turtles in Australia, 2017-2027.	

Relevant Plan/Advice	Description	Applicable Threats or Management Advice
Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015b)	The long-term recovery plan objective for blue whales is to minimise anthropogenic threats to allow for their conservation status to improve	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.
Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015g)	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 Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
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.	Marine debri Noise interference Pollution Vessel disturbance and strike No explicit relevant management actions.
Conservation Management Plan for the Southern Right Whale 2011-2021 (DSEWPaC, 2012a)	Conservation management plan provides threat abatement activities that can be undertaken to ensure the conservation of the southern right whale.	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.
Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015f)	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

Relevant Plan/Advice	Description	Applicable Threats or Management Advice
		Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Conservation Listing Advice for the *Neophoca cinerea* (Australian sea lion) (TSSC, 2010)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the Australian sea lion.	Known threats to this species include habitat and prey availability, competition with other seals, fisheries bycatch (bottom-set gillnet, rock lobster), entanglement in marine debris, disturbance, harassment and displacement, predation and direct killing. Potential threats to this species include habitat degradation, oil spills, pollution, toxins and climate change
Recovery Plan for the *Neophoca cinerea* (Australian sea lion) (DSEWPaC, 2013b).	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

4 Description of the Activity

4.1 General Description and Location

The Otway Gas Development operations consist of producing natural gas including condensate from the Geographe and Thylacine fields which is processed onshore at the Otway Gas Plant located approximately 7 km northeast of Port Campbell. The Thylacine field is approximately 70 km offshore from Port Campbell, Victoria in approximately 100 m of water and the Geographe reservoir is approximately 55 km offshore in 85 m of water.

This revised EP includes the new Geographe-4 (G-4) and Geographe-5 (G-5) productions wells. Separate EP's cover the drilling and completion, and infrastructure and commissioning of these wells. The G-4 and G-5 productions wells form part of this EP from when the field isolations have been removed and hydrocarbons are introduced into the existing infrastructure.

The current variation to the field development plan has an end of field life of 2035. Over this period the fields are expected to supply approximately:

- 432 billion cubic feet of gas, equivalent to 394 petajoules of sales gas.
- 5 million barrels of condensate.
- 0.7 million tonnes of LPG.

End of field life and recovery of resources are dependent on several factors including operational performance and possible future field developments which may lead to the end of field life extending beyond 2035. Section 4.7 provides further information the triggers and processes for decommissioning. Note that decommissioning of facilities is not included within the scope of this EP.

4.2 Operational Area

The operational area is defined as the area where activities managed under this EP will occur. For this petroleum activity, the operational area is a 500 m buffer around all subsea infrastructure and wells, including the Otway Pipeline System (Figure 4-1).

The indicative coordinates, petroleum titles, approximate water depth and distance from Port Campbell are presented in Table 4-1 for the main infrastructure components of the Otway Gas Development. Section 4.4.5 details the status of the main components of infrastructure associated with the Otway offshore operations.

Table 4-1: Otway Gas Development main infrastructure locations

Infrastructure	Title	Location		Water depth (m)	Distance from Port Campbell (km)
		Latitude	Longitude		
Artisan-1 (A-1)	Vic/P43	38° 53.490′ S	142° 52.948′ E	~71 m	~32 km
Geographe-1 (G-1)	Vic/L23	39° 06.696′ S	142° 55.731′ E	~85 m	~55 km
Geographe-2 (G-2)	Vic/L23	39° 06.4945′ S	142° 57.1033′ E	~84 m	~54 km
Geographe-3 (G-3)	Vic/L23	39° 06.487′ S	142° 57.097′ E	~83.4m	~54 km
Geographe-4 (G-4)	Vic/L23	39° 06.494' S	142° 57.068' E	~84 m	~54 km
Geographe-5 (G-5)	Vic/L23	39° 06.480' S	142° 57.086' E	~84 m	~54 km
Thylacine-1 (T-1)	T/L2	39° 14.370′ S	142° 54.819′ E	~101 m	~69.5 km
Thylacine-A Wellhead Platform	T/L2	39° 14.402′S	142° 54.601′ E	~101 m	~69.1 km
Geographe tee	Vic/PL36	39° 06.547′S	142° 55.719′ E	~85 m	~55.4 km
Otway Gas Pipeline Hot tap tee X	Vic/PL36	38° 56.637′S	142° 57.627′ E	~72 m	~35.3 km
Otway Gas Pipeline Hot tap tee Y	Vic/PL36	38° 51.909′S	142° 57.550′ E	~66 m	~27 km
HDD offshore entry point	Vic/PL36(V)	38° 37.153′S	142° 58.454′ E	~6 m	~2.2 km

Coordinates are provided as GDA94

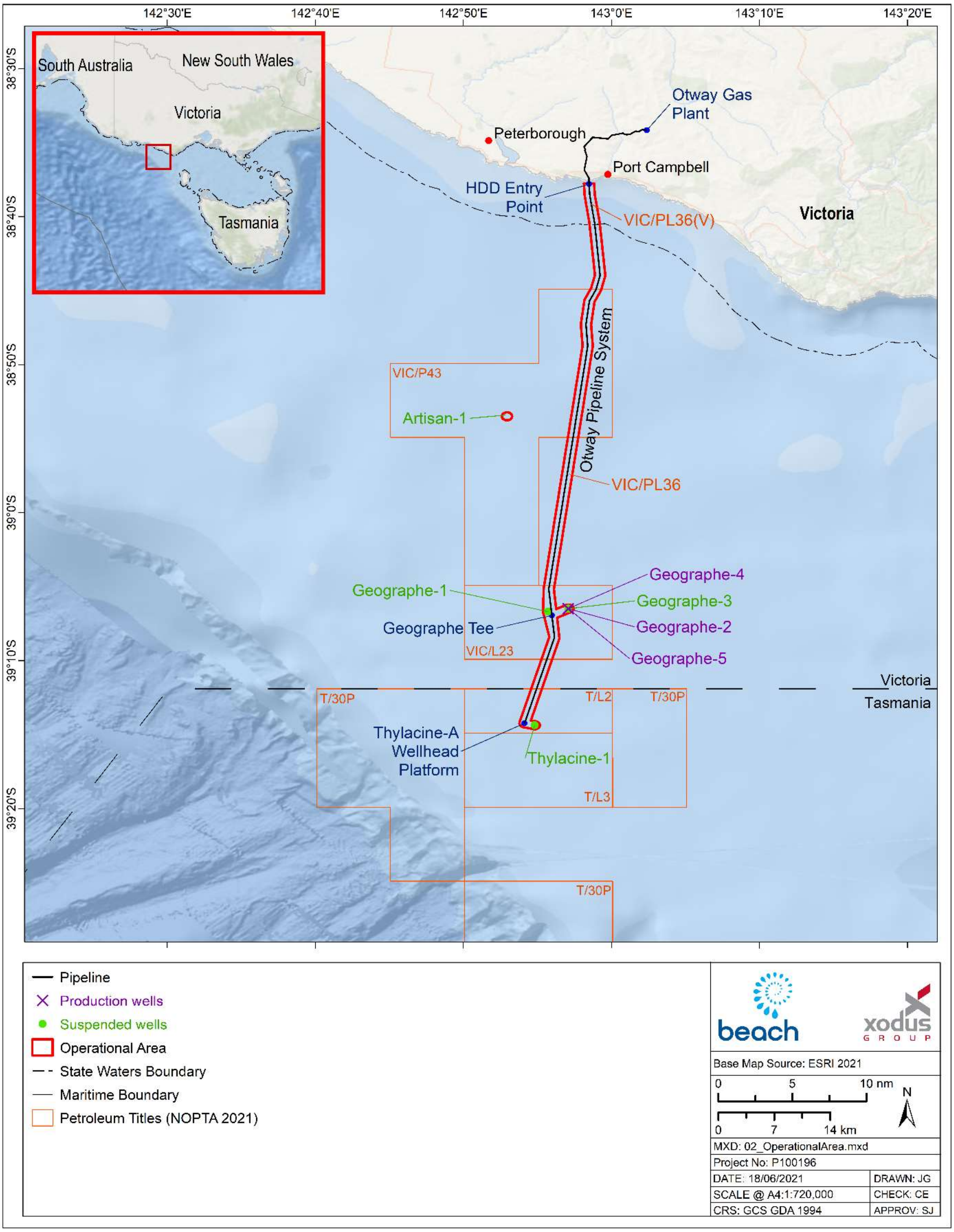


Figure 4-1: Otway Offshore Development Location and Operational Area

4.3 Field Characteristics

The Thylacine and Geographe field fluids are a mixture of reservoir gas, associated liquids, condensed water and formation water. The Thylacine and Geographe fields consist of natural gas reservoirs with associated condensate. No heavy oil is present. Condensate is a light hydrocarbon liquid comprised of C5 to C12 hydrocarbon compounds.

The condensate from the Geographe field is a light condensate with density of 0.751 g/cm^3 and viscosity of approximately 0.5cP at 25°C. The condensate at Thylacine is again a light condensate with a slightly higher density of 0.805g/cm^3 and a viscosity of approximately 0.88cP at 20°C. The reservoir properties for Thylacine and Geographe are provided in Table 4-2 and condensate boiling point ranges are provided in Table 4-3.

The composition of well fluids from the Thylacine and Geographe production wells are shown in Table 4-4. Composition data for the G-4 and G-5 wells will not be available until they commence production.

The condensate ratio ranges from 10 to 20 barrels per 1MMSCF of gas, dependent on the field, well and retrograde effects. Hydrogen sulphide (H_2S) exists in small quantities (2 ppm) in the Thylacine well fluids and the production system is designed for a concentration of 20 ppm as a contingency in the event of an increase in H_2S levels). H_2S levels were monitored during the G-2 well clean up and no significant levels were detected.

Other well fluid constituents (e.g. BTEX, mercury, organic acid salts, radon, naturally occurring radioactive materials (NORMs)) may be present in the well fluids. The design allowance for mercury is 25 µg/m^3 in the gas and 40 ppb in the condensate. Traces of mercury have been detected in the condensate stream from the Thylacine and Geographe fields. A sample taken in December 2015 had a mercury concentration of 12 ppb. BTEX is defined as the light aromatic content of the reservoir fluid and largely comprises benzene, toluene, ethyl-benzene and xylenes. The design allowance for BTEX is 0.25 mol% in each well stream. There has been no confirmed NORM/Radon to date from the producing wells.

Table 4-2: Reservoir physical characteristics

Parameter	Thylacine Condensate	Geographe Condensate
Density (kg/m^3)	805 at 15°C	751 at 15°C
API	44.3	56.9
Dynamic viscosity (cP)	0.875 at 20°C	0.500 at 25°C
Pour point (°C)	-50	-50
Oil category	Group I	Group I
Oil persistence classification	Non-persistent oil	Non-persistent oil

Table 4-3: Condensate boiling point ranges

Parameter	Volatiles (%)	Semi-volatiles (%)	Low-volatiles (%)	Residual (%)
Boiling point (ºC)	<180	180-265	265-380	>380
Thylacine Condensate	64.0	19.0	16.0	1
Geographe Condensate	78.4	13.4	7.2	1
	⇦	Non-Persistent	⇨	⇦ Persistent ⇨

Table 4-4: Typical Well Fluid Composition

	Thylacine Field				Geographe Field
Component	**TA-1**	**TA-2**	**TA-3**	**TA-4**	**G-2**
Carbon dioxide, CO2	10.04	9.49	9.69	9.55	4.309
Nitrogen, N2	1.42	1.46	1.45	1.31	1.700
Methane, C1	80.08	79.95	80.08	80.92	80.908
Ethane, C2	5.06	5.01	5.25	4.87	7.129
Propane, C3	1.82	1.71	1.89	1.64	2.950
iso-Butane, iC4	0.31	0.28	0.33	0.27	0.500
n-Butane, nC4	0.43	0.35	0.44	0.38	0.730
iso-Pentane, iC5	0.18	0.13	0.19	0.16	0.260
n-Pentane, nC5	0.11	0.09	0.13	0.11	0.210
C6	0.27	0.48	0.28	0.28	0.250
C7	0.16	0.69	0.16	0.21	0.410
C8	0.047	0.181	0.047	0.126	0.310
C9	0.025	0.057	0.034	0.053	0.110
C10	0.014	0.026	0.024	0.034	0.060
C11	0.0095	0.0112	0.0031	0.0179	0.040
C12A	0.0069	0.0146	0.0045	0.0134	0.039
C12B	0.0114	0.0296	0.0044	0.0252	0.027
C12C	0.0085	0.0303	0.0041	0.0241	0.038
C12D	0.0055	0.0036	0.0022	0.0125	0.020
C12E	0.0013	0.0001	0.0005	0.0029	0.002

Note: C7 and upwards indicates heavier hydrocarbons than hexane, C6. The C6 to C12E are pseudo components based on the Fluid and Reservoir Properties Basis of Design Data Sheet.

4.4 Facilities and Infrastructure Description

Facilities and infrastructure associated with the recovery of natural gas from the Thylacine and Geographe fields are detailed in this section. Figure 4-2 provides an overview of the Thylacine and Geographe operations infrastructure described in this section. The infrastructure in blue has been included as part of this revised EP.

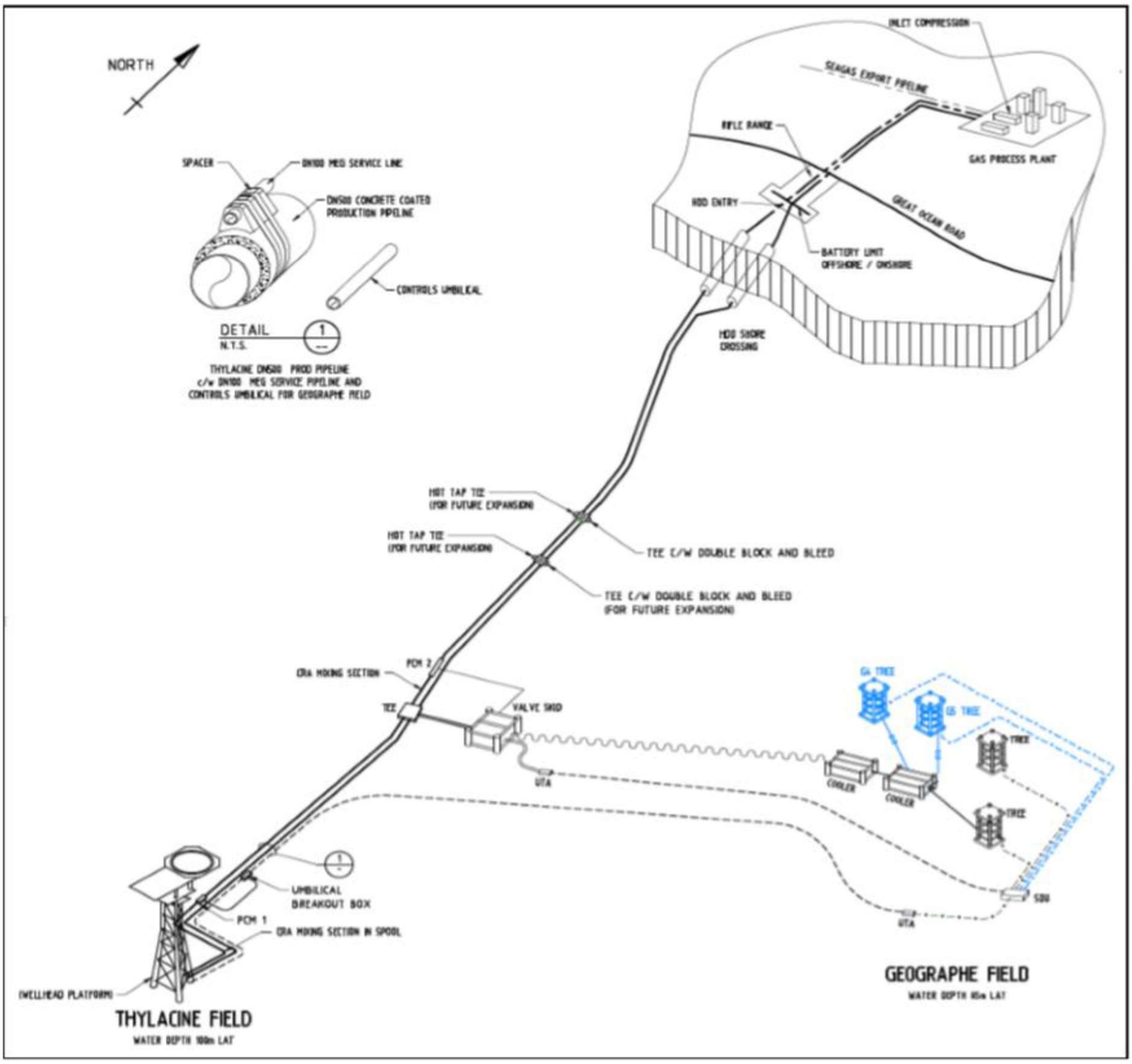


Figure 4-2: Simplified schematic of the Thylacine and Geographe operations infrastructure

4.4.1 Thylacine-A Wellhead Platform

The Thylacine-A Wellhead Platform is a steel jacket structure with topsides consisting of an integrated deck on four levels. The platform is designed to be operated as a normally unmanned installation. It is remotely operated from the Otway Gas Plant Central Control Room via duplicated communication links giving a high availability for the control and shutdown systems. All offshore equipment is capable of being started, stopped, controlled and monitored (including all process variables) from the Otway Gas Plant and where necessary this control is automated. All processes associated with normal operation are controlled from the Otway Gas Plant, including well valves and chokes, MEG supply, methanol and chemical injection and depressurisation.

The Integrated Control System on the platform (comprising the process control system, Emergency Shutdown and fire and gas systems) is designed for autonomous operations and shuts the platform down after a time delay or loss of communication with the Otway Gas Plant.

The Otway Gas Pipeline and MEG Pipeline risers are located inside the jacket structure and connect to a subsea umbilical.

Utilities required to support platform operations are described in Table 4-5. Sand removal facilities were initially installed but have been isolated (by physical barriers) as there is no evidence of sand production from the wells. Produced formation water is transported with the gas and other reservoir liquids to the Otway Gas Plant.

The Thylacine-A Wellhead Platform has aviation risks associated with the presence of migratory birds roosting on the platform. Several improvements have been made to the platform to deter birds from roosting including non-injuring bird spikes, anti-perching wires, sea water pump and spray system and primary and secondary horns sounded on helicopter arrival. The bird deterrent sea water pump and spray system is defined as a safety critical element within the platform's register of Safety Critical Equipment for the prevention of a bird strike and a consequential helicopter related Major Accident Event.

Further information regarding the design and operating philosophy and the management of hazards and risks associated with the Thylacine-A Wellhead Platform is provided in the Thylacine-A Platform Safety Case (CDN/ID 5214694).

Table 4-5 Thylacine-A well head platform utilities

Utility	Description
Power Generation	Platform power is generated from two gas engines; one normally operating and one standby. A diesel generator (and associated diesel storage) can be installed on the platform to provide emergency power in the event the gas engines are not operational or to provide additional power in the event of a major campaigns (e.g. shutdown or well intervention).
Drains and Vents	All hydrocarbon depressurising, venting and relief devices are connected to the collection system and routed to the Drain Vessel for liquid removal prior to atmospheric discharge through the vent tip. Closed drain piping from the Pig Launcher and Fuel Gas Knockout Drum are also routed to the vent system for liquid removal in the drain vessel. The Drain Vessel not only accumulates liquid from equipment/piping maintenance drainage but also acts as a vent knockout drum separating liquid from gas released during blowdown. Liquid collected in the drain vessel is pumped to the Otway Gas Pipeline by the two drain pumps operating in lead/lag mode. The gas disposal system is required to safely collect and dispose of fluids released during continuous operation, pressure relief (including a fire event), maintenance depressurisation activities and Emergency Shutdown initiated blowdown. Atmospheric venting was selected over flaring because of its inherent simplicity and reliability. The platform has no interconnected open drains system. A collection pan with local isolation valve has been provided should a liquid release during maintenance or operational activities occur. These local isolation valves are normally closed during operation and maintenance.

Utility	Description
Chemical injection	MEG distribution system: The MEG Pipeline provides MEG and corrosion inhibitor to protect the Otway Gas Pipeline. A MEG injection system controls and monitors the supply of hydrate and corrosion inhibitor delivered to the process. Methanol: Methanol is used for the initial start-up of the Geographe wells and is injected at the subsea wellheads via the main umbilical. The methanol injection system on the wellhead platform consists of a methanol storage/transfer tank, a single pump, and injection piping. This injection system feeds into the umbilical via the Topside Umbilical Termination unit. Other chemicals: Chemical injection may be required for the following: • Scale inhibitor injection. • Batch dosing of corrosion inhibitor into the Otway Gas Pipeline during V-jet pigging If required, temporary tanks would be connected to the MEG injection system via drain points.
Service water	The service water system receives and stores fresh water for process wash-down, personnel washing purposes and safety shower.
Heating, ventilation and air conditioning systems	Temperature in the equipment control room is controlled using Heating, Ventilation and Air Conditioning systems. In the event that the ventilation system shuts down whilst the Platform is unattended the ventilation system and the SPCU are equipped with a remote reset facility which enables remote re-start from the Otway Gas Plant.
Stored Chemicals and Other Hazardous Substances	Table 4-6 details the main hazardous substances and typically inventories stored on platform.

Table 4-6: Hazardous substances and typical inventories stored on Thylacine-A Wellhead Platform

Substance	Typical Inventory	Comments
Methanol	3,000 L	Stored in a dedicated double-skinned methanol tank. Tank capacity is 4,600L.
Diesel	2000 L	Crane fuel tank. Additional diesel may be required for a diesel driven temporary power generator during a shutdown campaign.
LPG	8 x 45 kg cylinders	LPG bottles may be required as back-up fuel supply to gas engines.
Carbon Dioxide	6 x G cylinders	CO2 used for snuffing the vent system.
Nitrogen Gas	45 x G cylinders	Nitrogen bottles may be required for purging.
Hydraulic Fluid	1000 L	Hydraulic Fluid for Hydraulic Power Unit (HPU) is Oceanic HW-443 control fluid.
	Over 5,000 L	Contained within HPU supply and return tanks and within umbilicals to Thylacine and Geographe wells.
Miscellaneous	Up to 20 L containers	Cleaning/maintenance chemicals, paint/thinners, grit, lubricant/gear oils.

4.4.1.1 Emergency Shutdown and Isolation Systems

Instrumentation on subsea infrastructure provides a range of continuous monitoring data, such as pressure, temperature and flowrate. Where any of the monitored parameters fall outside of the pre-defined set points the emergency shutdown system is activated.

The shutdown system comprises of four levels:

- Unit Shutdown causes an individual piece of equipment to close in without affecting the rest of the facilities.
- Process Shutdown shuts in the wellheads and leaves the platform pressurised for a fast re-start, gas engine generators continue to run for AC power supply.
- Emergency Shutdown (ESD) shuts in the platform (wellheads and Otway Gas Pipeline) and the gas engine generators are tripped so that AC power supply is unavailable.
- Total Platform Shutdown shuts in the wells at the Surface Controlled Subsurface Safety Valves and ensures Pipeline Riser Emergency Shutdown Valves are shut to activate blowdown and de-pressurise the Topsides. This decreases the potential for piping or equipment rupture and limits consequences of fire by safely removing both the fuel source and equipment inventory.

Safety critical subsea shutdowns will be achieved by using the Safety Instrumented System to vent the hydraulic supplies on the Thylacine Hydraulic Power Unit using fail safe (normally-energised) solenoid-controlled dump valves. The dump valves will fail open in the event of failure/fault or loss of function in the Safety Instrumented System. Loss of hydraulic supply pressure at the Subsea Control Modules at the subsea trees will result in fail- safe closure of all hydraulic functions, causing the subsea valves to fail closed (with the exception of the choke and MEG injection valves on the Xmas trees).

4.4.1.2 Platform Wells

There are four production wells on the Thylacine-A Wellhead Platform producing gas from the Thylacine field (TA-1, TA-2, TA-3, TA-4). Well stream production from the Thylacine wells is received on the Thylacine-A Wellhead Platform and transferred to the Otway Gas Plant via the Otway Gas Pipeline (refer to Section 4.4.2).

All four wells are platform wells with surface wellheads. The wells have surface trees with a Surface Controlled Subsurface Safety Valve (SCSSV), with the exception of TA-3 that has a Wireline Retrievable Subsurface Safety Valve (WRSSV) due to failure of the SCSSV during testing in 2012, and a platform wellhead with a Production Master Valve and Production Wing Valve to provide triple isolation from the reservoir. These valves are designed to fail closed. The valves are hydraulically operated from the Thylacine platform but can also be operated remotely from the Otway Gas Plant.

Each well has been fitted with a choke valve to allow flow control. The choke operations are by remote manual setting. Choke position feedback is provided to confirm the setting, and an alarm is initiated if the position registered is different to that set. These valves are controlled via the communications link with the Otway Gas Plant.

Further details on the wells are provided in the Thylacine Platform Well Operations Management Plan (WOMP) (CDN/ID 4411890).

4.4.2 Otway Pipeline System

The Otway Pipeline System consists of two subsea pipelines – the Otway Offshore Gas Pipeline (Otway Gas Pipeline) and the MEG piggyback service pipeline (MEG pipeline). Figure 4-1 shows the path of the

Otway Pipeline System. Stabilisation of the Otway Pipeline System is currently achieved using mattress (typically 5 m x 3 m) and rock bolts.

The Otway Gas and MEG Pipelines are equipped with Emergency Shutdown and isolation valves at the risers at the Thylacine-A Wellhead Platform and at the Otway Gas Plant.

The Otway Pipeline System is described in detail in the Otway Pipeline System Safety Case (CDN/ID 5214701), which also provided information regarding the design and operating philosophy.

4.4.2.1 Otway Gas Pipeline

The 500 mm (20") Otway Gas Pipeline transports produced gas and well fluids from the Thylacine-A Wellhead Platform and Geographe wells to the Otway Gas Plant.

The Otway Gas Pipeline connects to the foot of the Production Riser at the Thylacine-A Wellhead Platform and runs approximately 14 km along the sea floor in a direct route to the Geographe tee for the Geographe subsea production manifold and then runs approximately 55 km in a direct route to the Horizontal Directional Drilled shore crossing at the Port Campbell Rifle Range. The physical boundaries of the Otway Gas Pipeline are from the riser Emergency Shutdown Valve at the platform to the isolation valve at the Otway Gas Pipeline inlet.

There are two hot tap tees located on the Otway Offshore Gas pipeline – Hot Tap Tee X and Hot Tap Tee Y – which allow for connection to be made to a live ("hot") pipeline without shutting down production. The hot tap tees are covered by protection frames.

The risers, submerged pipelines, shore crossings and onshore buried pipelines have protective coatings to prevent external corrosion. The Otway Gas Pipeline is stabilised by a concrete weight coat along its length and in some sections mattress and rock bolts are used. The risers are located inside the Thylacine-A Wellhead Platform jacket structure for protection from impacts. Sacrificial anodes are installed along the full length of the Pipeline System to provide protection in case of coating damage. No internal pipe coating is provided, and internal corrosion is controlled by material selection and by the continuous injection of corrosion inhibitor with MEG into the Otway Gas Pipeline at the Thylacine-A Wellhead Platform.

Carbon dioxide levels in the production fluids are generally high (Table 4-4), which when combined with saturated water, makes the service conditions corrosive when untreated. Internal corrosion is primarily controlled by suitable material selection (Corrosion Resistant Alloy (CRA)/ duplex stainless steel at critical locations), continuous injection of corrosion inhibitor and pH stabiliser and taking appropriate action when on-line corrosion rate measurements become excessive. The addition of pH stabiliser is to neutralise organic acids accumulating in the MEG stream and address Top of Line corrosion.

4.4.2.2 MEG Pipeline

The 100 mm (4") MEG Pipeline transports MEG and other chemicals (e.g. corrosion inhibitor) from the Otway Gas Plant to the Thylacine-A Wellhead Platform and Geographe subsea infrastructure for continuous injection into the Otway Gas Pipeline.

MEG is injected into the well stream at Thylacine to prevent hydrates forming in the Otway Gas Pipeline, and at the Geographe wellheads to prevent hydrates forming in the flowline to the Otway Gas

Pipeline. A MEG injection system is provided to control and monitor the supply of hydrate suppression and corrosion inhibitor delivered to the process. The Thylacine-A Wellhead Platform topsides process piping is entirely duplex stainless steel, which is a corrosion resistant alloy and as such should not suffer from dead leg corrosion. Likewise, partial filming is not an issue with the piping as it does not suffer from corrosion by the production fluids.

The MEG Pipeline follows the Otway Gas Pipeline along its entire route in the reverse direction; from the Otway Gas Plant to the Thylacine-A Wellhead Platform. It is laid in the same buried trench as the Otway Gas Pipeline onshore and piggybacks the Otway Gas Pipeline for the subsea sections. The MEG Pipeline has a separate Horizontal Directional Drilled hole for the shore crossing.

The MEG delivery operates entirely within a closed system. MEG is supplied by positive displacement type pumps, located at the Otway Gas Plant. The MEG Pipeline has tie-ins and spare capacity for supplying both the Thylacine and Geographe wells, and future wells. Pipeline overpressure protection from the MEG injection pumps is provided onshore.

MEG flow is controlled offshore at Thylacine-A Wellhead Platform. The system is designed so that the MEG flow (controller set point) is calculated to achieve 30 to 40 wt% MEG in the aqueous phase onshore. The calculation considers gas flow and temperature to determine additional condensed water to the multiphase flow meter reading. The multiphase flow meter reading also directs MEG flow into the system.

The MEG in the MEG Pipeline is a typically 80-90 wt% MEG: 10-20 wt% water mixture plus a corrosion inhibitor and alkyl hydroxide. Some other chemicals may also be present, and these could include some residual hydrocarbons, anti-scale, biocide, demulsifier and anti-foam.

4.4.3 Geographe Field Subsea Facilities

The Geographe subsea infrastructure consists of the following major components:

- Four subsea production wellheads (G-2, G-3, G-4 and G-5), located at the Geographe well sites.
- Four subsea Xmas trees (one at each production well) and a Subsea Control Module (SCM). Each Xmas trees has a rigid production spools to connection.
- Three wet gas meters; one downstream from G-2, G-4 and G-5.
- Subsea distribution unit (SDU). Each Xmas tree has electrical and hydraulic control lines (flying leads) to connect to the SDU.
- Umbilical Termination Assembly (UTA) for connecting the main umbilical from Thylacine-A Wellhead Platform to the SDU.
- Two subsea coolers; Subsea Manifold Cooler and Subsea Heat Exchange, arranged in series and connected by a Cooler tie-in spool. Coolers are required to reduce the temperature of the Geographe well fluids before entering the Otway Gas Pipeline to avoid Top of Line corrosion issues.

The Geographe Tee is where the Geographe subsea infrastructure connect to the Otway Pipeline System. At the Geographe Tee, there is a Subsea Valve Skid and an Umbilical Termination Assembly, which connects the in-field umbilical to the Subsea Valve Skid. The hydraulically actuated fail closed isolation valve located at the Subsea Valve Skid can be used to isolate the Geographe subsea fluids from the Otway Gas Pipeline, and to isolate the MEG supply to the Geographe subsea facilities.

Interconnections include:

- 1.8 km flexible flowline (11”) from Subsea Heat Exchange to the Subsea Valve Skid at the Geographe Tee.
- 16 km umbilical from the Thylacine-A Wellhead Platform to the Umbilical Termination Assembly in the Geographe Field.
- 1.9 km in-field umbilical between the Subsea Distribution Unit and the Subsea Valve Skid at the Geographe Tee.
- Electrical and hydraulic flying leads.

The Geographe subsea infrastructure is controlled via two umbilicals which deliver hydraulic and electrical power, communications, and chemicals (MEG, methanol) services. The design also allows for future injection of scale inhibitor from the platform if required.

Stability and protection to interconnections and subsea facilities are provided by concrete mattresses (typically 5 m x 3 m) on the in-field umbilical, spools and main umbilical; sandbags or mats to stabilise the electrical and hydraulic flying leads at approximately 3 m spacing; inflatable grout bags for spool support (1-2 per spool); and protection covers for the Geographe Tee. The Geographe Tee on the Otway Pipeline System and the Subsea Valve Skid have rock bolts, mattresses, sandbags and grout bags. Stabilisation is not required on the flexible flowline and based on the known seabed surveys no spans of any significant length have been identified.

During the Geographe well installation and commissioning campaign there may be a situation where redundant infrastructure cannot be to be recovered to the vessel due to it being under existing infrastructure, for example electrical and hydraulic flying leads. Electrical and hydraulic flying leads left in situ may require stabilisation of the ends on the seabed using grout bags to ensure they do not move around.

4.4.3.1 Geographe Production Wells

The three Geographe production wells (G-2, G-4, G-5) have a SCSSV and a subsea wellhead with a Production Master Valve and Production Wing Valve to provide triple isolation from the reservoir. These valves are designed to fail closed (i.e. they automatically close on loss of hydraulic pressure). The valves are all hydraulically operated, and this hydraulic power is supplied via the main umbilical from the Thylacine-A Wellhead Platform.

Well control and monitoring are achieved through a Subsea Control Module (SCM) on each tree.

Each well has been fitted with a choke valve to allow flow control. The choke operations are by remote manual setting. Choke position feedback is provided to confirm the setting, and an alarm is initiated if the position registered is different to that set. These valves are controlled via the communications link with the Otway Gas Plant.

Well integrity monitoring of the three Geographe production wells is carried out in accordance with the Geographe 2, 3, 4, and 5 Well Operations Management Plan (CDN/ID 18986455); and addressed by the Beach Energy Well Integrity Standard (CDN/ID 7726350).

4.4.3.2 Emergency Shutdown and Isolation Systems

Subsea process shutdown actions for Geographe are implemented by the Geographe Master Control Station in conjunction with the Safety Instrumented System on the Thylacine-A Wellhead Platform, via the Geographe main umbilical. The shutdown actions may be performed manually or autonomously in the event of subsea initiators (such as loss of MEG supply at a producing tree) or in conjunction with the Safety Instrumented System in the event of initiators from Thylacine or the Otway Gas Plant.

In the event of a platform shutdown (Emergency Shutdown or Total Platform Shutdown) a pre-determined well shutdown sequence with operational interlocks is generated for the Geographe wells. Sequenced commands will be transmitted to the Subsea Control Modules and then actioned by the Subsea Control Modules resulting in a controlled well shutdown.

4.4.4 Suspended Wells

The G-1 well was drilled in June 2001 discovering the Geographe field. It was completed with 7” liner across the target reservoir. The well was suspended with two cement plugs (permanent primary and secondary downhole barriers) in 9 5/8” casing for future abandonment. There is no subsea Xmas tree installed on the well or associated subsea infrastructure. The wellhead remains in place with a corrosion cap installed.

The G-3 well was drilled between May and November 2012. The G-3 well is suspended at the surface casing shoe. It has a subsea Xmas tree installed and a ~27 m length of rigid flowline (containing ~1 m^3 dilute MEG / water solution with corrosion inhibitor) connecting the Xmas tree to the production manifold but has no completion installed. The G-3 well and associated infrastructure has never flowed hydrocarbons and G-3 has permanent primary and secondary downhole barriers installed and ~230 bbl (37 m^3) of seawater with corrosion inhibitor (suspension fluid) above the secondary barrier to the Xmas tree.

The T-1 well was drilled in May 2001 discovering the Thylacine field. It was completed with 7” liner across the target reservoir. The well was suspended with two cement plugs (permanent primary and secondary downhole barriers) in 9 5/8” casing for future abandonment. There is no subsea Xmas tree installed on the well or associated subsea infrastructure. The wellhead remains in place with a corrosion cap installed.

Beach is currently developing a strategy to permanently plug and abandon and decommission the G-1, G-3 and T-1 wells to international best practice. This work will be performed as part of a detailed engineering review of all the Beach owned suspended subsea exploration wells by the end of 2022.

As per the Geographe 1 and Thylacine 1 Well Operations Management Plan (CDN/ID 14235732) and the Geographe 2, 3, 4, and 5 Well Operations Management Plan (CDN/ID 18986455) a General Visual Inspection with ROV will be undertaken on the G-1, G-3 and T-1 wells with a maximum duration of 2 years between inspections until the wells are permanently plug and abandoned.

Beach is planning to commence permanent well plug and abandonment including removal of the wellheads from seabed no later than the end of 2026. It is planned to utilise a drill rig in the area as part of the Trefoil production wells drilling campaign (first gas proposed in 2025), or combined with the plug and abandonment of the BassGas suspended wells if the Trefoil Development does not proceed.

The Artisan-1 well is a vertical exploration well drilled in February 2021. The well was suspended with shoe track cement, including an additional 20bbl of cement above the shoe track in the 7” cemented liner set across the reservoir. The shoe track barrier was inflow tested and verified (primary downhole barrier), and an additional combination barrier cement plug (permanent secondary downhole barrier) was set in 9 5/8” casing for future re-entry. There is no subsea Xmas tree installed on the well or associated subsea infrastructure. The wellhead remains in place with a corrosion cap installed. The aim is to complete this well in 2024 as a production well. As per the Artisan-1 Well Operations Management Plan (CDN/ID S4810AD718234) a General Visual Inspection with ROV will be undertaken on this well with a maximum duration of 12 months between inspections until the well is producing.

Well integrity monitoring of suspended wells is carried out in accordance with the Geographe 1 and Thylacine 1 Well Operations Management Plan (CDN/ID 14235732), the Geographe 2, 3, 4, and 5 Well Operations Management Plan (CDN/ID 18986455) and the Artisan-1 Well Operations Management Plan (CDN/ID S4810AD718234); and addressed by the Beach Energy Well Integrity Standard (CDN/ID 7726350).

4.4.5 Infrastructure Inventory and Status

Table 4-7 provides an inventory of the main infrastructure components for the Otway offshore operations and their status at December 2021.

Table 4-7: Otway offshore operations infrastructure inventory and status

Infrastructure	Title	Status
Wells		
Artisan-1 (A-1)	Vic/P43	Suspended
Geographe-1 (G-1)	Vic/L23	Suspended
Geographe-2 (G-2)	Vic/L23	Operational
Geographe-3 (G-3)	Vic/L23	Suspended
Geographe-4 (G-4)	Vic/L23	Operational
Geographe-5 (G-5)	Vic/L23	Operational
Thylacine-1 (T-1)	T/L2	Suspended
Infrastructure		
Thylacine-A Wellhead Platform	T/L2	Operational
Geographe Subsea Control Module	Vic/L23	Operational
Geographe Subsea Distribution Unit	Vic/L23	Operational
Geographe Subsea Manifold Cooler	Vic/L23	Operational
Geographe Subsea Heat Exchange	Vic/L23	Operational
Geographe Subsea Valve Skid	Vic/L23	Operational
Geographe Main Umbilical Termination Assembly	Vic/L23	Operational

Infrastructure	Title	Status
Geographe Infield Umbilical Termination Assembly	Vic/L23	Operational
Geographe tee	Vic/PL36	Operational
Otway Gas Pipeline Hot tap tee X	Vic/PL36	Operational
Otway Gas Pipeline Hot tap tee Y	Vic/PL36	Operational
HDD offshore entry point	Vic/PL36(V)	Operational

Infrastructure	Title	From	To	Status
Flowlines				
Geographe flexible flowline	Vic/L23	Geographe Subsea Heat Exchange	Geographe Subsea Valve Skid	Operational
Thylacine Platform Production Spool	T/L2	Thylacine DN500 Production Riser	Otway Gas Export and piggybacked MEG Pipelines	Operational
Thylacine Platform MEG Spool	T/L2	Thylacine DN100 MEG Riser	Otway Gas Export and Piggybacked MEG Pipelines	Operational
Otway Gas Export and piggybacked MEG Pipelines	Vic/L23 Vic/PL36 Vic/PL36(V)	Thylacine Platform Spool	HDD Entry (interface with Onshore Pipelines)	Operational
Cooler tie-in spool	Vic/L23	Geographe Subsea Manifold Cooler	Geographe Subsea Heat Exchange	Operational
Rigid spool including wet gas meter	Vic/L23	G-2 well	Geographe Subsea Manifold Cooler	Operational
Rigid spool including wet gas meter	Vic/L23	G-3 well	Geographe Subsea Manifold Cooler	Recovered
Rigid spool including wet gas meter	Vic/L23	G-4 well	Geographe Subsea Manifold Cooler	Operational
Rigid spool including wet gas meter	Vic/L23	G-5 well	Geographe Subsea Manifold Cooler	Operational
Geographe Production Tee Rigid Spool	Vic/L23	Geographe Tee	Geographe Subsea Valve Skid	Operational
Geographe MEG Tee Rigid Spool	Vic/L23	Subsea Valve Skid	Geographe Tee	Operational
Thylacine DN500 Production Riser	T/L2	Thylacine Platform Production Spool	Topside pipework	Operational
Thylacine DN100 MEG Riser	T/L2	Topside pipework	Thylacine Platform MEG Spool	Operational
Thylacine DN200 Production Riser	T/L2	N/A	Topside pipework	Installed Spare
Umbilicals				
Geographe Infield Umbilical		Geographe Subsea Distribution Unit	Infield Umbilical Termination Assembly	Operational

Infrastructure	Title	From	To	Status
Geographe Main Umbilical		Thylacine Umbilical Termination Assembly (Thylacine-A Platform)	Main Umbilical Termination Assembly	Operational
G-2 Flying leads	Vic/L23	G-2 well	Geographe Subsea Distribution Unit	Operational
G-3 Flying leads	Vic/L23	G-3 well	Geographe Subsea Distribution Unit	Operational
G-4 Flying leads	Vic/L23	G-4 well	Geographe Subsea Distribution Unit	Operational
G-5 Flying leads	Vic/L23	G-5 well	Geographe Subsea Distribution Unit	Operational
Pipeline Corrosion Monitor (PMC) PCM-1 Electrical flying lead	Vic/L23		PCM-1	Not operating
PCM-2 Electrical flying lead	Vic/L23		PCM-2	Not operating
SDU Flying leads	Vic/L23	Main Umbilical Termination Assembly	Subsea Distribution Unit	Operational
SVS Electrical flying leads	Vic/L23	Infield Umbilical Termination Assembly	Subsea Valve Skid	Operational

4.5 Activities that have the potential to impact the environment

This section outlines the planned activities covered within the scope of this EP which have the potential to result in environmental aspects, leading to impacts to receptors.

Emissions, discharges and disturbances resulting from planned activities are summarised in Table 4-10.

4.5.1 Thylacine-A Wellhead Platform Operations

The Thylacine-A Wellhead Platform is normally unmanned. The platform is manned for approximately 60 days per year for planned maintenance. Additional days are required for specific maintenance activities and projects. The size of the visiting crew will vary depending on the nature of the visit but can involve up to ten personnel in total.

Operations on-board the platform take place during daylight hours, there are no planned overnight stays permitted under normal operations. However, to accommodate potential unforeseen emergencies, incidents (e.g. helicopter failure or sudden change of weather) or repairs; facilities are provided for emergency overnight stays should it be necessary. Overnights says have occurred twice in the last 10 years.

The freshwater system is recharged from Intermediate Bulk Containers (IBCs) of potable water delivered by the supply vessel. The system provides water for personnel washing purposes, safety showers, and general washing down of the platform e.g. helideck and walkways. The toilet on the platform is a portable chemical toilet with internal storage that is shipped back to shore for emptying and disposal.

There is no open drain system, therefore no liquid discharges occur during routine operations. Produced formation water is transported with the gas and other reservoir liquids to the Otway Gas Plant.

Chemicals including methanol and hydraulic fluid are transported to the platform in sealed containers. There are no bunkering facilities.

Seabirds and/or migrating birds are known to be attracted to, and rest on the platform. This poses significant risk to safe operations (i.e. take-off and landing) of helicopters. In order to mitigate these safety risks, bird deterrent techniques as described in Section 4.4.1 are installed to prevent birds from roosting on the helideck. The bird deterrent sea water pump and spray system results in discharge of washdown water to the marine environment.

4.5.2 Otway Pipeline System Operations

The Otway Pipeline System (Otway Gas Pipeline and MEG Pipeline) operate within a closed system, with no planned discharges.

4.5.3 Geographe Field Subsea Facilities Operations

Geographe field subsea facilities are operated within a closed system, though actuation of valves will result in small releases of control fluid.

4.5.4 Inspection, Maintenance and Repair

Inspection, maintenance and repair (IMR) programs are undertaken on infrastructure and the Thylacine-A Wellhead Platform to confirm and maintain their integrity and to ensure property can be removed unless there is agreement at that time from NOPSEMA to do otherwise through an accepted EP.

IMR programs are detailed in the following:

- Otway Offshore Pipeline Safety Case
- Thylacine-A Platform Safety Case
- Thylacine Platform Well Operation Management Plan
- Geographe 1 and Thylacine 1 Well Operation Management Plan
- Geographe 2, 3, 4, and 5 Well Operation Management Plan
- Artisan-1 Well Operations Management Plan

The Integrity Management System for the Otway Gas Development is described in the Beach's Operations Excellence Management System (OEMS) Element 6 – Asset Management. The Computerised Maintenance Management System (CMMS) is used to manage maintenance IMR programs to:

- Ensure a consistent, cost effective and efficient system of maintenance management.
- Provide optimum levels of inspection and maintenance to ensure that equipment and the facilities remain fit for purpose over the life of the operation.

Inspection and testing intervals (including any minimum requirements), survey frequencies, condition monitoring and surveillance, and reporting/record keeping are described in the respective asset integrity management plans (IMPs).

4.5.4.1 Inspection

Inspection programs are undertaken of the Thylacine-A Wellhead Platform, production and suspended wells, Geographe subsea infrastructure and Otway Pipeline System to detect external features, damage or signs of damage, and deterioration that could present a risk. They are typically undertaken from a vessel using an ROV.

The following are typically inspections undertaken:

- General Visual Inspection /Close Visual Inspection – undertaken by ROV in close proximity (within 1 m) of wells, along the pipeline, pipeline spools, risers and associated clamps, and platform jacket members.
- Visual inspection and non-destructive testing of welds and areas of interest for selected high fatigue nodes.
- Cathodic Protection Survey.
- Wall thickness measurements.

Inspection program and frequency are described in detail in the applicable Safety Cases and Well Operation Management Plans.

4.5.4.2 Maintenance and Repair

Maintenance and repair activities may occur to:

- Prevent deterioration and/or failure of infrastructure; and
- Maintain reliability and performance of infrastructure.

Maintenance and repair activities are typically conducted in response to inspection findings, engineering analyses, and/or external events. The activities are typically performed by ROV from a vessel or by divers from a dive support vessel. Table 4-8 summarises the maintenance and repair activities that may be undertaken but this list is not exhaustive. The table also includes details of the initiation triggers for the various maintenance programs.

Where an activity is necessary that is not adequately described in this EP, Beach will undertake a review of the EP and risk register in accordance with Section 8.12.5 and if necessary, revise the EP. Revisions will be reviewed as per Section 8.12.6 to determine if the revised EP is required to be submitted to NOPSEMA and/or DJPR (as appropriate) for assessment.

Major maintenance and shutdown of the Thylacine-A Wellhead Platform for inspection is based on statutory or risk based inspection which sets the shutdown frequency in conjunction with activity requirements. Shutdown may result in purging of nitrogen to the vent.

Table 4-8: Summary of Typical Maintenance and Repair Activities

Maintenance and Repair activity	Description	Initiation Triggers
Pipeline integrity / Leak testing	Pipeline integrity / leak testing is undertaken as required to verify the pressure integrity of components. Leak testing involves filling the component with water dosed with inhibitor, biocide and dye (normally fluorescent) and pressurising the pipeline to an appropriate test pressure.	Where the integrity of the pipeline system must be re-confirmed following a significant wall thickness defect.
V-jet pigging	Routine maintenance (V-jet) pigging is conducted on the platform to transmit liquid held-up in the Otway Gas Pipeline to the Otway Gas Plant. Pigging is undertaken in a closed system with no discharges to the marine environment.	Routine
Pipeline Top of Line Corrosion remediation	The first 2 km of the Otway Gas Pipeline (starting immediately downstream of the corrosion resistant alloy spool) has been found to be subject to Top of Line Corrosion which may require intervention in the future. This may be in the form of the installation of a single or multiple repair clamps at specific locations on the carbon steel section, or the isolation and installation of approximately 2 km of carbon steel line pipe with corrosion resistant alloy. The latter option is outside the scope of this EP.	Inspection identifies remediation is required
Well intervention, wireline, slickline campaigns	The Thylacine-A Wellhead Platform has been designed to facilitate access to the wells for both slick line and electric line well intervention. A well intervention may be needed to repair a faulty Surface Controlled Subsurface Safety Valve, install a storm choke, remediate well integrity failures, fish lost tools, perforate new production intervals, operate sliding sleeves, install tubing plugs to isolate production intervals or perform well surveillance (pressure or production logs). Wireline or well intervention campaigns are undertaken as required and in accordance with the Well Operations Management Plan. Well intervention**,** wireline or slickline campaigns for subsea wells are not covered by this EP.	Inspection or event results in repair valve required
Cathodic protection system maintenance	Replacement of anodes and continuity straps. Installation of cathodic skids.	Anodes are retrofitted when the existing anodes have depleted, or are about to deplete, beyond 90% of their original volume.
Excavation for intervention	To undertake subsea IMR, localised excavation may be required directly adjacent to the subsea system, allowing access to buried infrastructure. Typically, this	Access required to buried subsea infrastructure for

Maintenance and Repair activity	Description	Initiation Triggers
	is conducted by jetting, mechanical and/or digging equipment from an ROV, vessel, or by using divers, depending on the location, depth, and seabed characteristics.	inspection, maintenance or repair.
Marine growth and hard deposit removal	Marine growth and deposits may be removed by water jetting or manual cleaning from an ROV or by divers to access equipment. Water jetting may use potable or sea water. Chemicals, typically Sulfamic Acid (or equivalent such as Citric Acid), may be used to assist clean-up for removing limescale.	Access required to subsea infrastructure for inspection, maintenance or repair.
Removal of debris or fishing net	Removal of debris such as ropes and fishing nets that may become entangled on infrastructure.	Inspection identifies hazardous debris on infrastructure.
Rectification of electrical or hydraulic fault	Rectification of an electrical or hydraulic fault associated with an umbilical and associated connected equipment. Replacement of electrical/hydraulic/chemical umbilical or jumper, cleaning of connectors, testing of connectors.	Electrical or hydraulic fault.
Pipeline repair	Pipeline repair which may, depending upon the damage the pipeline has sustained, include composite wrap application, mechanical clamp installation and anode retrofit.	Inspection identifies significant corrosion or damage to pipeline or a loss of containment from the pipeline.
Flowline jumper replacement	Replacement of flowline jumper with either rigid or flexible flowline between existing flange connections.	Flowline jumper significantly damaged or not functioning.
Service line/hydraulic capping plate removal and reinstallation	Replacement or institute servicing of hydraulic multi quick connect plate including cleaning of interface (ROV and hydraulic) and testing of connections.	Testing / inspection indicates an issue, or local control / intervention required.
Subsea control unit change out	Replacement or institute servicing of Subsea Control Module including cleaning of interface (ROV, hydraulic and electrical) and testing of connections.	Subsea Control Module significantly damaged or not functioning:
Replacement of equipment on the seafloor	Where subsea equipment cannot be repaired it may be replaced. This would typically occur in the same location or near to the previous location.	Subsea equipment significantly damaged or not functioning:
Subsea tree choke replacement	Choke replacement is undertaken from a vessel by ROV and/or divers. The first choke replacement requires top plate trimming. Trimming is performed using a disk cutting tool installed onto the subsea tree to enable access the choke. Cut material is captured and retained on the tool in a magnetic tray beneath the cutting disk. The choke is located on the subsea tree between two valves. Prior to removal, MEG is injected upstream of the choke to flush the line. Fluid is displaced into the Otway Gas Pipeline for processing at the Otway Gas Plant.	Failed, faulty or damaged choke.

Maintenance and Repair activity	Description	Initiation Triggers
	During change-out of the choke, the volume of MEG between the two valves is approximately 75 L, with a small amount lost to the environment.	
Stabilisation and protection	Existing stabilisation / protection may need to be replaced, or visual inspections may identify that additional stabilisation / protection may be required. This may include using rock bolts, mattresses, sandbags or grout bags. Stabilisation mattresses and gravity weights are lowered over the infrastructure (pipeline, flowlines, leads) from a vessel and depending on the infrastructure may cover an area of 18 m2 (6 m x 3 m x 0.5 m). Rock bolt structures are installed by divers using a small installation frame/structure covering 1 m^2.	Inspection identifies stabilisation is required
Subsea trees, flowlines, well bore penetrations, flanges and mechanical connections servicing	Tensioning, blanking or polymer sealant intervention to restore or preserve integrity to subsea conduits.	Subsea equipment significantly damaged or not functioning.
Fabric maintenance	Consists of surface preparation and painting across the entire wellhead platform, over selected areas of structural and process equipment. This involves sand/grit/wet blasting for paint and corrosion product removal followed by painting. Where practicable these activities will be contained with bottom lined humpies (enclosures) to contain as much removed paint and blasting debris as practical.	Inspection identified fabric maintenance required

4.5.5 Geophysical Surveys

Geophysical surveys maybe undertaken to identify the location of buried infrastructure such as pipelines. The frequency and duration of surveys is estimated to be a maximum of 10 days once a year though more likely to be between two and five years.

Geophysical surveys may use the following equipment:

- Single-beam or Multi-beam echo sounder to measure bathymetry.
- Side scan sonar to detect location of buried infrastructure.
- Sub-bottom profile to detect location of buried infrastructure.

4.5.6 Support Operations

4.5.6.1 Vessels

Vessel will be used to support offshore operations and inspection, maintenance, and repair campaigns. Table 4-9 details the main types of vessel activities, type of vessel and frequency.

Due to the distance to shore no fuel bunkering is required. Vessels typically operate out of Victorian ports.

Table 4-9: Vessel Activity, Type and Frequency

Activity	**Example Vessel type**	**Extent of time on site**
Platform resupply Vessel resupply in daylight hours only from ~9.00 to 1500. Daily vessel resupply commences after crew arrives by helicopter and finishes prior to helicopter arriving to take crew to shore.	Siem Offshore VS491	2 days every 3 months ~6 hrs per day
Standby vessel at platform when working over water. Activity typically aligns with supply run. Vessel on standby within 500 m of platform for ~ 6 hrs per day while work being undertaken on the platform.		Twice per year ~ 6 hrs per day
Planned suspended and operational wells ROV inspection	Siem Topaz Tekocean Spirit Bhagwan Dryden	Up to 1 day once per year and up to 5 days every two years
Planned platform subsea (jacket) ROV inspection Planned pipeline, umbilical & subsea equipment ROV inspection		Up to 30 days every 5 years
Planned platform subsea (jacket) inspection – potential for divers	DOF Singapore Sapura Constructor	Up to 15 days every 10 years
Unplanned inspection, maintenance, and repair campaigns – ROV and/or divers		Up to 30 days every 2 years
Oil spill response, including operational and scientific monitoring	Siem Topaz Tekocean Spirit Bhagwan Dryden	In event of a spill

4.5.6.2 Diving activities

Diving may be carried out as part of inspection and maintenance activities and will require the use of a diving support vessel.

4.5.6.3 ROV operations

Underwater ROVs are deployed and controlled from a vessel to undertake IMR activities.

ROVs are generally equipped with a video camera, lighting and have the ability to monitor the subsea infrastructure and the surrounding environment. ROVs are also used to deploy specialist tooling and equipment. Tooling and equipment may be operated with the use of electrics or hydraulics. Hydraulics on ROVs are closed system, where hydraulic fluid is circulated to move components and is designed not to release hydraulic fluid.

ROVs are generally moored on the deck of the vessel and are occasionally temporarily parked on the seabed during IMR activities.

4.5.6.4 Helicopters

Helicopters are the primary form of transport for personnel to and from the Thylacine-A Wellhead Platform and the preferred means of evacuating the platform. However, depending on the accident event and scenario, evacuation by helicopter may not be safe or practicable and alternative means of evacuating the platform are provided. Helicopters may also be used in responding to a hydrocarbon spill, including operational and scientific monitoring.

There are no helicopter refuelling facilities on the Thylacine-A Wellhead Platform, helicopters carry enough fuel to travel to the platform and return. Approximate flight time (one way) between the primary helicopter base at Warrnambool (Victoria) and the Thylacine-A Wellhead Platform is 25 minutes.

4.6 Summary of Planned Emissions, Discharges and Disturbance

A summary of planned emissions, discharges and disturbance from activities covered by this EP is provided in Table 4-10.

Table 4-10 Planned Emissions, Discharges and Disturbances

Activity	**Description**	**Planned Emission, Discharge or Disturbance**
Thylacine-A Wellhead Platform operations		
Power generation	Gas (and possibly diesel) combustion products discharged to atmosphere	Atmospheric emissions
Drains and vents	Continuous gas purge and venting for maintenance activities Closed drain system so no liquid discharges during routine operations.	Atmospheric emissions
Chemical injection	Closed system	None
Service water	Closed system	None

Activity	Description	Planned Emission, Discharge or Disturbance
Heating, ventilation and air conditioning systems	Closed system	None
Stored hazardous substances	Hazardous substances are stored in accordance with the relevant Safety Data Sheet.	None
Emergency Shutdown	Venting via dump valves	Atmospheric emissions
Personnel onboard	All wastes and discharges are contained, with no offshore disposal.	None
Routine platform operations	Navigational lighting	Light emissions
	Petroleum Safety Zone	Physical presence
	Water overboard from seabird deterrent system Deck drainage from rainwater areas	None
Thylacine platform wells	Closed system	None
Otway Pipeline System Operations		
Otway Pipeline System	Closed system	None
Geographe Field Subsea Facilities Operations		
Geographe subsea infrastructure and wells	Valve actuation – subsea wells and subsea valve skid	Planned marine discharges – operations and IMR
	Choke valve operation	Underwater sound emissions
IMR		
Inspection	Undertaken using vessel and ROV (refer below). No discharges, emissions or disturbance from inspection activities.	None
Maintenance and Repair	Pipeline integrity / Leak testing	Planned marine discharge – operations and IMR
	V-jet pigging - closed system	None
	Pipeline Top of Line Corrosion remediation – installation of repair clamps	Benthic disturbance
	Thylacine-A Platform well intervention, wireline or slickline campaigns - closed system	None
	Cathodic protection system maintenance – installation of cathodic skids	Benthic disturbance
	Excavation for intervention - jetting, mechanical and/or digging equipment (ROV) or divers	Benthic disturbance
	Marine growth and hard deposit removal	Benthic disturbance Planned marine discharge – operations and IMR

Activity	Description	Planned Emission, Discharge or Disturbance
	Removal of debris or fishing net	None
	Rectification of electrical or hydraulic fault	None
	Pipeline repair – includes mechanical clamp installation	Benthic disturbance
	Flowline jumper replacement	Benthic disturbance
	Service line/hydraulic capping plate removal and reinstallation	Benthic disturbance
	Subsea control unit change out	Benthic disturbance
	Subsea tree choke replacement	Underwater sound emissions Planned marine discharge – operations and IMR
	Replacement of equipment on the seafloor	Benthic disturbance
	Stabilisation and protection	Benthic disturbance
	Subsea trees, flowlines, well bore penetrations, flanges and mechanical connections servicing	None
	Fabric maintenance	Planned marine discharge – operations and IMR
Support Operations		
Vessels	Food scraps, sewage and grey water Discharge of bilge water treated to contain <15ppm oil in water Uncontaminated engine cooling water Water and approved cleaning chemical	Planned marine discharge – vessel
	Fuel combustion products discharged to atmosphere	Atmospheric emissions
	Navigational lighting	Light emissions
	Resupply and standoff at the platform	Underwater sound emissions
	IMR campaigns	Underwater sound emissions
Diving activities	Vessel-based activity (refer above). No additional impacts.	None
ROV operations	Hydraulic control fluid - closed system	None
Helicopters	Landing and take-off	Underwater sound emissions

4.7 Decommissioning

Decommissioning of the Otway Gas Development will be undertaken in accordance with the relevant Commonwealth and Victorian State regulatory requirements in force at the time of decommissioning or as described in an approved decommissioning EP. In accordance with EPBC referral 2002/621 (Condition 5) a decommissioning plan will be submitted for approval prior to decommissioning of any components associated with the development (i.e. the platform, wells, flowlines or any associated infrastructure). Section 572(3) of the OPGGS Act imposes an obligation on the duty holder to remove all structures, equipment and property within the title area that will not be used for the purposes of petroleum production, and there may be requirements under the Environmental Protection (Sea Dumping) Act 1981 (Cth) that apply to some decommissioning activities.

Beach fully acknowledges that the default position through Section 572 of the OPGGS Act and NOPSEMA Policy Section 572 Maintenance and Removal of Property (N-00500-PL1903, A720369, November 2020) is for removal of all property when it is no longer in use and that any deviations from this position will need to be evaluated and approved by NOPSEMA. Beach will incorporate the requirements of this policy into the Otway Offshore decommissioning concept study.

The decision to commence decommissioning activities will be based on whether Beach can continue to economically commercialise the extracted reservoir fluids from the gas fields in a responsible manner that protects people, communities and environmental values. The current variation to the field development plan has an end of field life of 2035.

All structures, equipment and property associated within the Beach title areas in Table 2-2 will be maintained in good condition and repair to ensure it can be removed, unless there is agreement at that time from NOPSEMA to do otherwise through an accepted EP.

4.7.1.1 Decommissioning Planning Process

Decommissioning is covered by Beach's OEMS Element 6. The suspension of assets is divided into:

1. Temporary suspension
2. Mothballing
3. Preliminary abandonment
4. Final abandonment and removal

The requirement to initiate preliminary or final abandonment for assets of the scale of the Otway Gas Development is managed through a dedicated capital project and the decommissioning process requires a multi-disciplinary team. Final approval to undertake the work must be granted by the regional General Manager Operations and General Manager Development. Consideration for the environmental approvals process is part of the decommissioning standard.

4.7.1.2 Decommissioning Environmental Approvals

Decommissioning guidelines will be considered during the decommissioning planning process, including the former Commonwealth Department of Industry, Innovation and Science (DIIS) (now the Department of Industry, Science, Energy and Resources, DISER) released an Offshore Petroleum Decommissioning Guideline (January 2018); and the NOPSEMA Decommissioning Compliance Strategy (April 2021).

Issues likely to be explored in the decommissioning EP (and addressed through the stakeholder consultation process) include:

- Decommissioning options (leave platform and pipeline in situ vs complete removal vs partial removal).
- If equipment is left in situ:

    - Ongoing monitoring requirements.
    - Impacts to commercial fisheries of remaining infrastructure.
    - Clearance below sea level for commercial fishers (current regulatory requirements in Commonwealth waters for decommissioned platforms are to provide a 30 m clearance from the sea surface in the water column).
- Re-purposing of decommissioned infrastructure to create marine habitat for recreational fishers and divers, either in situ or moved to more accessible location/s.

The timeframe allocated to planning for decommissioning allows for the preparation of a Cessation of Production (CoP) EP and/or decommissioning EP and to have each assessed by NOPSEMA sufficiently in advance of activities commencing to ensure each EP is accepted prior to activities commencing.

Beach has undertaken some initial decommissioning planning and developed a preliminary decommissioning methodology and cost estimate for the development in line with current decommissioning practices in Australia (Worley Parsons 2015).

Aspects of the preliminary plan considers:

- Platform decommissioning: all or partial removal of equipment above the seabed, transportation to shore for dismantling and recycling or reuse as scrap.
- Well decommissioning: removal of wellheads and tubing where feasible. Where feasible, the well will be sealed, and the conductor and casing strings cut off below the seabed. All conductor and casing strings above that point will be removed.
- Subsea equipment decommissioning: removal of equipment such as the manifold with transportation to shore for recycling. Pipeline decommissioning - thorough cleaning and disconnection. The offshore pipeline is likely to be flooded and left open ended on the seabed.

4.7.1.3 Maintaining Inventory

All property owned by Beach, including its condition, is listed in an asset register that is retained within the CMMS and maintained by the Technical Services Team. If any equipment is retained in the title areas after the decommissioning process is complete, the assets register will be updated to reflect this.

All equipment associated with the Otway Gas Development is being inspected, monitored and maintained in accordance with the CMMS to ensure that it is in good condition and can be safely decommissioned when required.

5 Description of the Environment

The physical, biological and socio-economic environment that may be affected (EMBA) is described in this section, together with the values and sensitivities.

5.1 Environment that may be affected

The EMBA by the activity has been defined as an 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 a subsequent impact to occur.

Table 5-1 and Figure 5-1 detail the EMBA zones associated with the Activity that are used to describe the environmental context relevant to the Activity and to support the impact and risk assessments.

Table 5-1: Description of EMBA Zones

EMBA Zones	Description
Operational area	For the activity, the Operational Area is a 500 m radius around the Thylacine-A Wellhead Platform, subsea wells and infrastructure and suspended wells (as described in Section 4.2). Planned operational discharges, physical presence and seabed disturbance that occur during the activity will be within the operational area. Two EPBC Protected Matters Reports for the operational area have been generated; one for the 500 m operational area around the Artisan-1 suspended well, and another for the 500 m operational area around the Thylacine-A wellhead platform and platform wells, Geographe subsea facilities and subsea wells and the Otway Pipeline System to the HDD entry point. The EPBC Protected Matters Reports are provided in Appendix A.2.
Spill EMBA	The spill EMBA extends between approximately Marlo (VIC) in the east, Beachport (SA) in the west and south of King Island (Figure 5-1). Section 7.14 details how the condensate and diesel spill EMBAs were developed. As the condensate EMBA is the largest this is used as the spill EMBA to describe the existing environment in this section. The EPBC Protected Matters Report for the spill EMBA is in Appendix A.1.

5.2 Regulatory context

The OPGGS(E)R define 'environment' as the ecosystems and their constituent parts, natural and physical resources, qualities and characteristics of areas, the heritage value of places and includes the social, economic and cultural features of those matters. In accordance with the Regulations, this document describes the physical, ecological, and social components of the environment.

Under the OPGGS(E)R, the EP must describe the EMBA (Regulation 13(2a)), including details of the particular values and sensitivities (if any) within that environment (Regulation 13(2b)), Identified values and sensitivities must include, but are not necessarily limited to, the matters protected under Part 3 of the EPBC Act.

A greater level of detail is provided for those particular values and sensitivities as defined by the Regulations 13(3) of the OPGGS(E)R which states that particular relevant values and sensitivities may include any of the following:

a. the world heritage values of a declared World Heritage property within the meaning of the EPBC Act;

b. the national heritage values of a National Heritage place within the meaning of that Act;

c. the ecological character of a declared Ramsar wetland within the meaning of that Act;

d. the presence of a listed Threatened species or listed Threatened Ecological Community within the meaning of that Act;

e. the presence of a listed Migratory species within the meaning of that Act;

f. any values and sensitivities that exist in, or in relation to, part or all of:

   i) Commonwealth marine area within the meaning of that Act; or

   ii) Commonwealth land within the meaning of that Act.

With regards to 13(3)(d) and (e) more detail has been provided where listed Threatened or Migratory species have a spatially defined biologically important area (BIA), habitat critical to survival or identified biologically important behaviour such as breeding, foraging, resting or migration.

With regards to 13(3)(f) more detail has been provided in Section 5.4.13 for Key Ecological Features (KEFs) as they are considered as conservation values of the Commonwealth marine area; and in Section 5.4.2 for Australian Marine Parks (AMPs) as they are enacted under the EPBC Act.

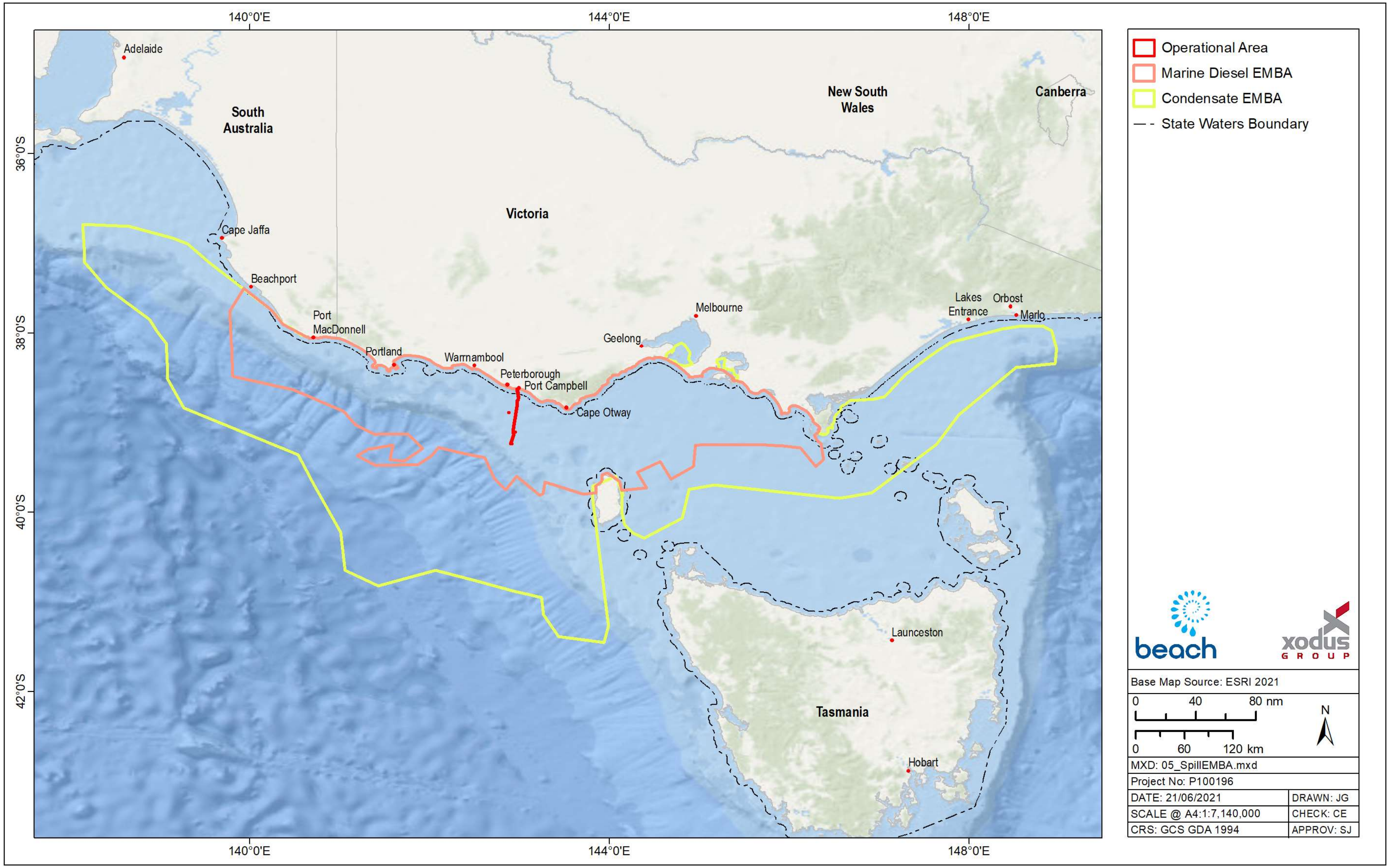


Figure 5-1: Environment that may be affected (EMBA) for the Otway Offshore Operations

5.3 Regional environmental setting

The Operational Area and spill EMBA are located within the South-East Commonwealth Marine Region (SEMR), which extends from the south coast of New South Wales to Kangaroo Island in South Australia and around Tasmania (DNP, 2013).

There are significant variations in seafloor features throughout the SEMR including seamounts, canyons, escarpments, soft sediments and rocky reefs, which support high levels of biodiversity and species endemism (DoE 2015a). Compared to other marine areas, the SEMR is relatively low in nutrients and primary production; however localised areas of high productivity are known to occur. There are areas of continental shelf, which includes Bass Strait and Otway Shelf, which have rocky reefs and soft sediments that support a wide range of species. The shelf break increases currents, eddies and upwelling, and the area is especially biodiverse, including species that are fished recreationally and commercially. There are seafloor canyons along the continental shelf which provide habitat for sessile invertebrates such as temperate corals. The Bonney Coast Upwelling KEF is an area of seasonally higher primary productivity which attracts baleen whales and other species (including EPBC-listed species) which feed on the plankton swarms (krill).

The SEMR has a high diversity of species and also a large number of endemic species. The fish fauna in the region includes around 600 species, of which 85% are thought to be endemic. Additionally, approximately 95% of molluscs, 90% of echinoderms, and 62% of macroalgae (seaweed) species are endemic to these waters (DNP, 2013).

5.4 Conservation values and sensitivities

The following section details the conservation values and sensitivities identified within the spill EMBA.

No conservation values or sensitivities were identified in the operational area.

5.4.1 World Heritage Properties

The PMST Reports (Appendix A) did not identify any World Heritage Areas in the operational area or spill EMBA.

5.4.2 Australian Marine Parks

The South-east Commonwealth Marine Reserves Network was designed to include examples of each of the provincial bioregions and the different seafloor features in the region (DNP, 2013). Provincial bioregions are large areas of the ocean where the fish species and ocean conditions are broadly similar. Ten provincial bioregions in the SEMR are represented in the network. As there is a lack of detailed information on the biodiversity of the deep ocean environment, seafloor features were used as surrogates for biodiversity to design the Marine Reserves Network. The SEMR network contains representative examples of the 17 seafloor features found in the Commonwealth waters of the region.

No Australian Marine Parks (AMPs) were identified within the operational area (Appendix A). Five AMPs were identified within the spill EMBA PMST report and are shown in Figure 5-2, the AMPs are:

- Apollo
- Beagle

- Murray
- Nelson
- Zeehan

All the AMPs, (excluding Nelson Marine Park and a Section of Zeehan Marine Park) in whole or part, are classified as International Union for Conservation of Nature (IUCN) VI – Multiple Use Zones, 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.

The Nelson Marine Park and Zeehan Commonwealth Marine Reserve also has an 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.

The South-east Marine Reserves are managed under the South-east Marine Reserves Management Plan (DNP, 2013).

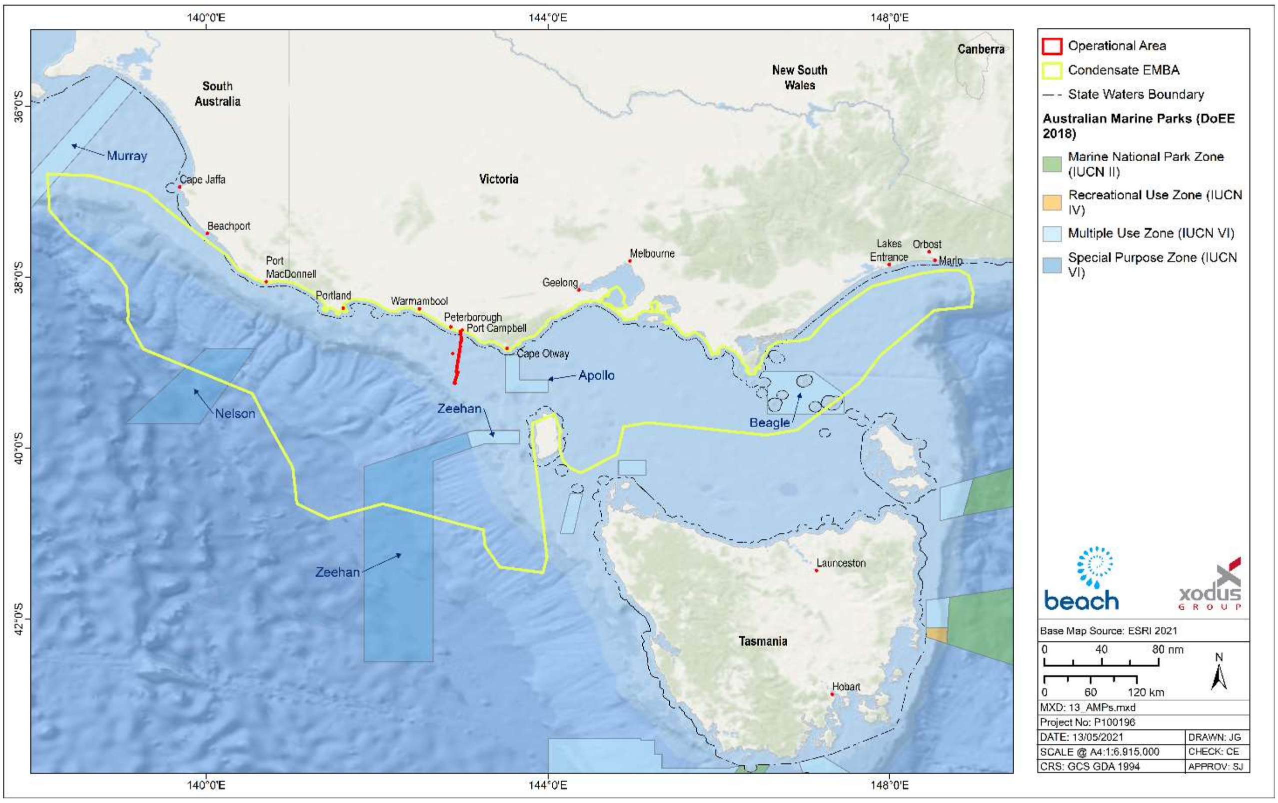


Figure 5-2: Australian Marine Parks within the spill EMBA

5.4.2.1 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 reserve 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 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 (DNP, 2013).

5.4.2.2 Beagle AMP

The Beagle AMP is an area in shallow continental shelf depths of about 50 m to 70 m, which extends around south-eastern Australia to Tasmania covering an area of 2,928 km^2 (DNP, 2013). The reserve includes the fauna of central Bass Strait; an area known for its high biodiversity. The deeper water habitats are likely to include rocky reefs supporting beds of encrusting, erect and branching sponges, and sediment composed of shell grit with patches of large sponges and sparse sponge habitats.

The reserve includes islands that are important breeding colonies for seabirds and the Australian fur seal, and waters that are important foraging areas for these species. The species-rich waters also attract top predators such as killer whales and great white sharks.

The major conservation values of the Beagle AMP are:

- ecosystems, habitats and communities associated with the Southeast Shelf Transition and associated with the seafloor features: basin, plateau, shelf and sill.
- important migration and resting areas for southern right whales.
- it provides important foraging habitat for the Australian fur-seal, killer whale, great white shark, shy albatross, Australasian gannet, short-tailed shearwater, Pacific and silver gulls, crested tern, common diving petrel, fairy prion, black-faced cormorant and little penguin.
- cultural and heritage sites including the wreck of the steamship SS Cambridge and the wreck of the ketch Eliza Davies (DNP, 2013).

5.4.2.3 Murray AMP

The Murray AMP lies south of the mouth of the Murray River, off the South Australian coast and stretches out to Australia’s exclusive economic zone limit, more than 400 km out to sea, covering an area of 25,803 km^2 (DNP, 2013). It spans an extensive area across the Lacepede Shelf, continental slope and deeper water ecosystems that extend from South Australia to Tasmania. The reserve contains the Murray Canyon, which is considered one of the most spectacular geological formations on the Australian continent margin. The reserve is important for many marine species, including those migrating through its inshore waters. The southern right whale uses the inshore area of the reserve to nurse its young. Offshore, many seabird species can be seen foraging.

The major conservation values of the Murray AMP are:

- examples of ecosystems, habitats and communities associated with the Spencer Gulf Shelf Province, the Southern Province, the West Tasmanian Transition and associated with seafloor features: abyssal plain/deep ocean floor, canyon, escarpment, knoll/abyssal hill, shelf, slope, terrace.
- features with high biodiversity and productivity: Bonney coast upwelling, shelf rocky reefs and hard substrate.
- important foraging areas for: blue, sei and fin whales, Australian sea lion, wandering, black-browed, yellow-nosed and shy albatrosses, great-winged petrels, flesh-footed and short-tailed shearwaters, and white-faced storm petrel.
- important breeding area for the southern right whale and important migration area for the humpback whale (DNP, 2013).

5.4.2.4 Nelson AMP

The Nelson AMP spans the deepwater ecosystems (greater than 3,000 m depth) extending from South Australia to the west of Tasmania (DNP, 2013). The reserve spans a range of geological features including plateaus, knolls, canyons and the abyssal plain (a large area of extremely flat or gently sloping ocean floor just offshore from the continent). The knoll features provide a rocky substrate above the abyssal plain. Little is known about the benthic biodiversity of this reserve; however, marine mammals are known to occur here.

The major conservation values of the Nelson AMP are:

- examples of ecosystems, habitats and communities associated with the West Tasmanian Transition and associated with the seafloor features including the abyssal plain/deep ocean floor, canyon, knoll/abyssal hill, plateau and slope.
- important migration area for humpback, blue, fin and sei whales (DNP, 2013).

5.4.2.5 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 reserve 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 tail shearwater (DNP, 2013).

The major conservation values for the Zeehan AMP 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 (DNP, 2013).

5.4.3 National Heritage Places

The places of National Heritage that were identified in the spill EMBA PMST Report (Appendix A) are located onshore; outside the spill EMBA (Figure 5-3) and do not have marine or coastal components. These are:

- Great Ocean Road and Scenic Environs (historic)
- Point Nepean Defence Sites and Quarantine Station Area (historic)
- Quarantine Station and Surrounds (historic).

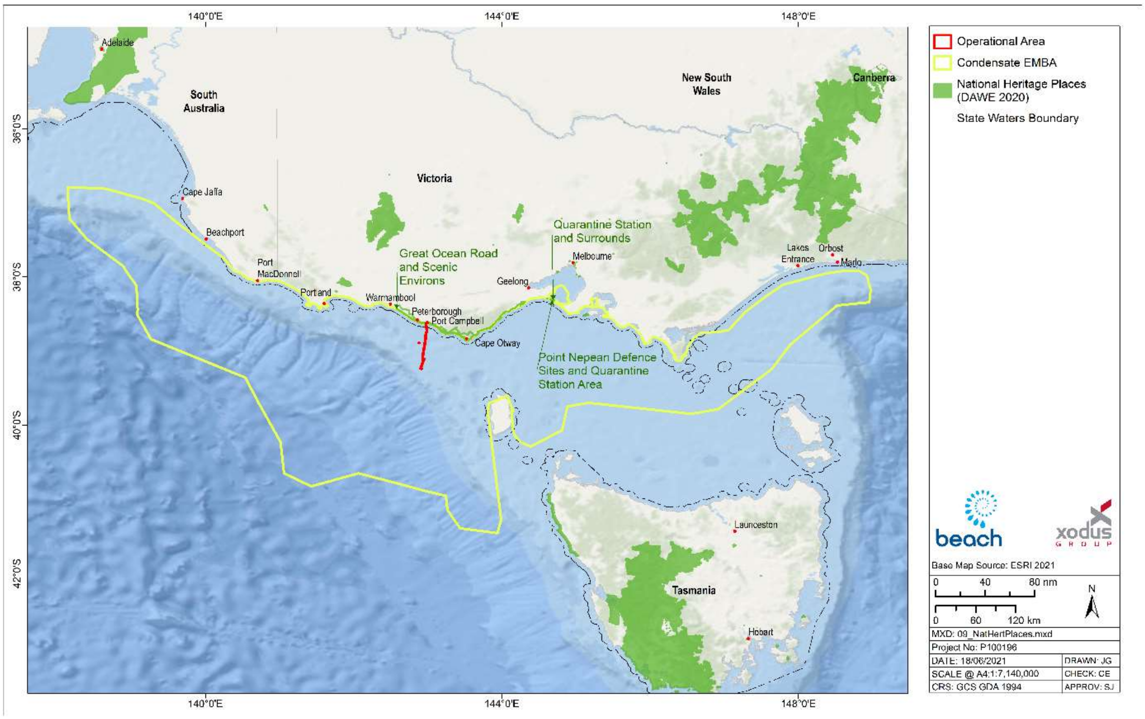


Figure 5-3: National Heritage Places present within the EMBA.

5.4.4 Commonwealth Heritage Places

The spill EMBA PMST Report (Appendix A) identified eight Commonwealth Heritage Places, most of which are historic heritage places located on land and therefore are outside the spill EMBA (Figure 5-4). The eight heritage places are:

- HMAS Cerberus Marine and Coastal Area (Natural, Listed place)
- Swan Island and Naval Waters (Natural, Listed place)
- Cape Northumberland Lighthouse (Historic, Listed place)
- Cape Wickham Lighthouse (Historic, Listed place)
- Fort Queenscliff (Historic, Listed place)
- Sorrento Post Office VIC (Historic, Listed place)
- Swan Island Defence Precinct (Historic, Listed place)
- Wilsons Promontory Lighthouse (Historic, Listed place)

Two of these heritage places include natural coastal areas within the spill EMBA; HMAS Cerberus Marine and Coastal Area and Swan Island and Naval Waters. These are discussed below.

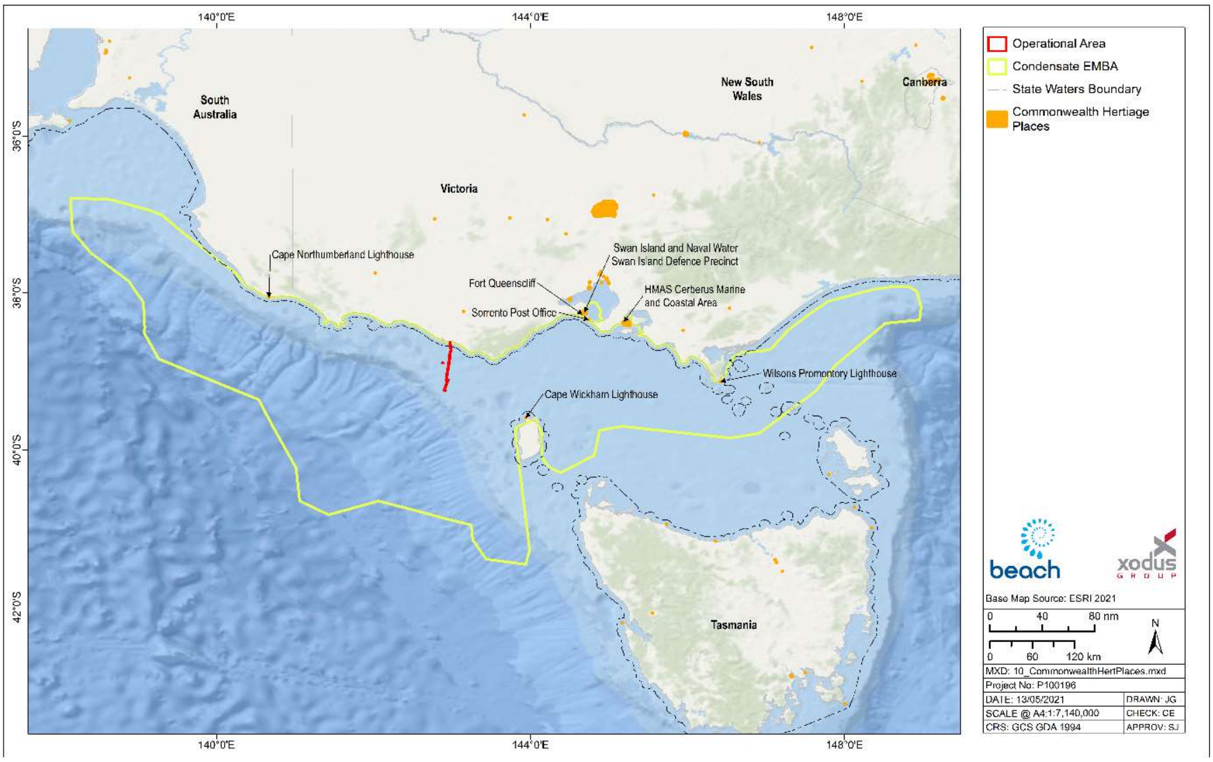


Figure 5-4: Commonwealth Heritage Places present within the spill EMBA

5.4.4.1 HMAS Cerberus Marine and Coastal Area

The Sandy Point/HMAS Cerberus area has high geomorphological, botanical and zoological significance. Sandy Point is one of the largest spit systems on the Victorian coast and one of the State's most dynamic shorelines. Western Port as a whole is a wetland of international significance listed under the Ramsar Convention on Wetlands. It is recognised as the third most important site for migratory and resident waders in Victoria behind Corner Inlet and Swan Bay. The official values of the area include (DotEE, 2004a):

- Relict spits in Hanns Inlet indicate that the sediment regime at the site has changed rapidly, possibly due to the extension of Sandy Point.
- Sandy Point supports some of the best remaining examples of Coastal Banksia Woodland, Coastal Grassy Forest, and Coastal Dune Scrub in the Greater Melbourne region. These communities have been extensively cleared and degraded in the Westernport Catchment and on the Mornington Peninsula.
- Sandy Point is one of the largest spit systems on the Victorian coast and one of the States most dynamic shorelines.
- continuing shoreline progradation at Sandy Point reveals several stages in sand dune succession.

5.4.4.2 Swan Island and Naval Waters

Swan Island is the largest emergent sand accumulation feature in Port Phillip Bay. The island, which has been built principally by wave actions rather than by aeolian forces, has played a major role in determining the pattern of sedimentation in Swan Bay and preserves geomorphological evidence of changing Quaternary sea levels. The eastern and northern shores of the eastern arm of Swan Island are of regional significance as an example of active coastal depositional and erosional processes (DotEE, 2004b).

Sand Island is the most important high tide roosting area in Swan Bay and at high tide regularly supports half of the shorebirds in the Swan Bay - Mud Islands complex. Sand Island maintains a regular breeding population of the fairy tern (*Sterna nereis*) and provides the main roosting habitat in Swan Bay for the nationally endangered little tern (*Sterna albifrons*) (DotEE, 2004b).

5.4.5 Wetlands of International Importance

The spill EMBA PMST Report (Appendix A) identified six marine or coastal Wetlands of International Importance (Ramsar-listed wetlands) (Figure 5-5). The ecological character and values of these Ramsar listed wetlands area described in the following sections.

As defined in Regulations 13(3)(c) of the OPGGS(E)R, particular relevant values and sensitivities include: the ecological character of a declared Ramsar wetland within the meaning of that Act.

Ecological character is the combination of the ecosystem components, processes, benefits and services that characterise the wetland at a given point in time (Ramsar Convention 2005a). Changes to the ecological character of the wetland outside natural variations may signal that uses of the site or externally derived impacts on the site are unsustainable and may lead to the degradation of natural processes, and thus the ultimate breakdown of the ecological, biological and hydrological functioning of the wetland (Ramsar Convention 1996).

The ecological character description of a wetland provides the baseline description of the wetland at a given point in time and can be used to assess changes in the ecological character of these sites. Therefore, the baseline ecological character description of the Ramsar wetlands are described below. The potential to impact the ecological character of the wetlands is evaluated in the impact and risk assessments in Section 7.

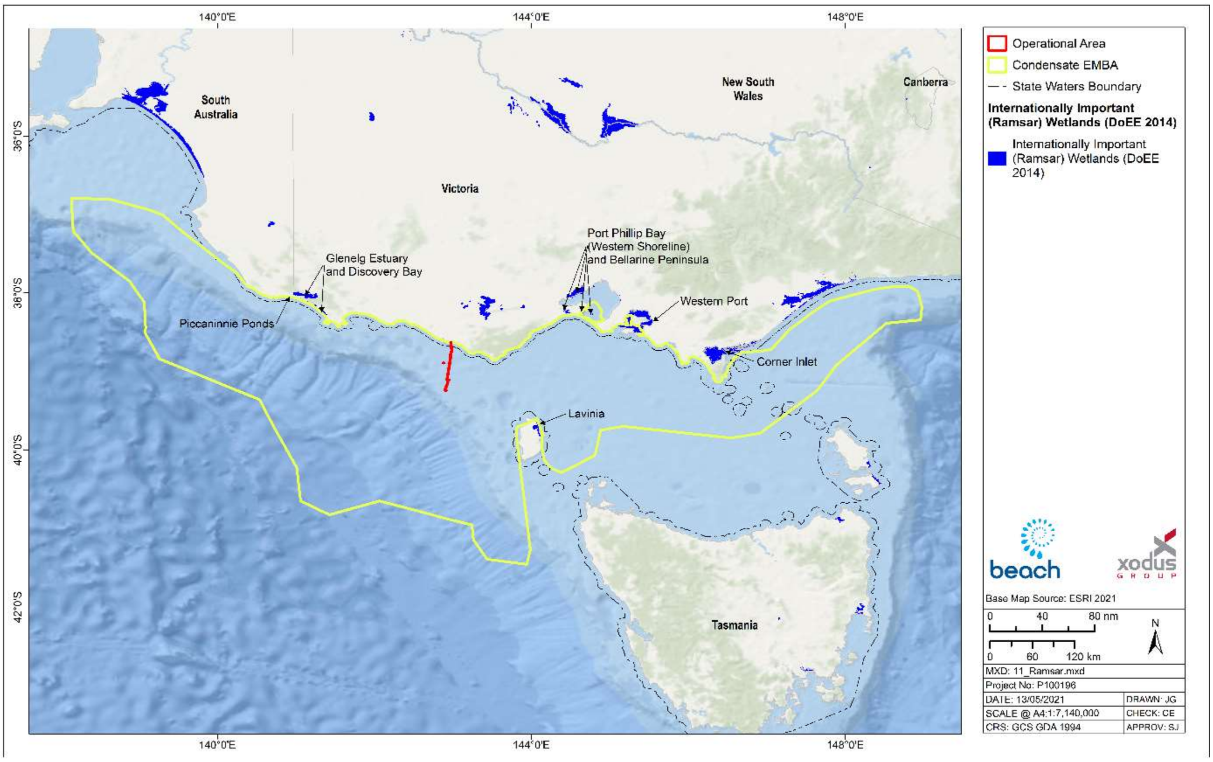


Figure 5-5: Ramsar wetlands within the spill EMBA

5.4.5.1 Corner Inlet

The Corner Inlet Ramsar Site is located approximately 250 km south-east of Melbourne and includes Corner Inlet and Nooramunga Marine and Coastal Parks, and the Corner Inlet Marine National Park. It covers 67,192 ha and represents the most southerly marine embayment and intertidal system of mainland Australia.

The major features of Corner Inlet that form its ecological character are its large geographical area, the wetland types present (particularly the extensive subtidal seagrass beds), diversity of aquatic and semi-aquatic habitats and abundant flora and fauna, including significant proportions of the total global population of a number of waterbird species (BMT WBM, 2011). The description below provides the values and baseline ecological character of the Corner Inlet Ramsar Site.

It is protected by the Corner Inlet Ramsar Site Management Plan (WGCMA, 2014), which identifies the key values as including:

- a substantially unmodified wetland which supports a range of estuarine habitats (seagrass, mud and sand flats, mangroves, saltmarsh and permanent marine shallow water).
- presence of nationally threatened species including orange-bellied parrot, Australian grayling, fairy tern and growling grass frog.
- non-breeding habitats for migratory shorebird species and breeding habitat for variety of waterbirds including several threatened species.
- important habitats, feeding areas, dispersal and migratory pathways and spawning sites for numerous fish species of direct or indirect fisheries significance.

- over 390 species of indigenous flora (15 listed species) and 160 species of indigenous terrestrial fauna (22 threatened species) and over 390 species of marine invertebrates.
- a wide variety of cetaceans and pinnipeds including bottlenose dolphins and Australian fur-seals, as well as occasional records of common dolphins, New Zealand fur-seals, leopard seals and southern right whales.
- significant areas of mangrove and saltmarsh which are listed nationally as vulnerable ecological communities and provide foraging, nesting and nursery habitat for many species.
- sand and mudflats, when exposed at low tide, which provide important feeding grounds for migratory and resident birds and at high tide provide food for aquatic organisms including commercial fish species (CSIRO, 2005).
- ports and harbours – the four main ports (Port Albert, Port Franklin, Port Welshpool and Barry's Beach) service the commercial fishing industry, minor coastal trade, offshore oil and gas production and boating visitors.
- fishing – the area supports the third largest commercial bay and inlet fishery in Victoria, including 18 licensed commercial fishermen, within an economic value of between 5 and 8 million dollars annually (DPI, 2008).
- recreation and tourism – Corner Inlet provides important terrestrial and aquatic environments for tourism and recreational activities such as fishing, boating, sightseeing, horse riding, scuba diving, bird watching and bushwalking. Corner Inlet attracts at least 150,000 visitors each year (DNRE, 2002).
- cultural significance to the Gunaikurnai people, with the Corner Inlet and Nooramunga area located on the traditional lands of the Brataualung people who form part of the Gunaikurnai Nation. The area has a large number of cultural heritage sites that provide significant information for the Gunaikurnai people of today about their history. The Bunurong and the Boon Wurrung peoples also have areas of cultural significance in this region.
- thirty-one shipwrecks are present in the site.
- research and education – the wildlife, marine ecosystems, geomorphological processes and various assemblages of aquatic and terrestrial vegetation within the Corner Inlet Ramsar Site provide a range of opportunities for education and interpretation.

5.4.5.2 Glenelg Estuary and Discovery Bay wetlands

The description below provides the values and baseline ecological character of the Glenelg Estuary and Discovery Bay Ramsar Site.

The Glenelg Estuary is a large estuarine system consisting of the main channel of the Glenelg River and a side lagoon called the Oxbow. The physical features of the area include a geological setting of Quaternary lacustrine, paludal, alluvial and coastal sediments on Quaternary aeolian sediments (DotEE, 2017a).

The Glenelg Estuary is a high value wetland for its ecological features. This wetland is of special geomorphological interest, being the only estuarine lagoon system in Victoria developed within a framework of dune calcarenite ridges. The Glenelg estuary contains the only remaining relatively undisturbed salt marsh community in western Victoria. Spits at river mouths such as those at Glenelg River provide valuable breeding sites for the little tern. This area is one of the few sites where little tern breed in Victoria.

There are ten wetland types within the Ramsar site generated by the interaction between geomorphology, hydrology and vegetation. Hydrology is a key driver in the characteristic of the site. Water sources for the Glenelg Estuary include groundwater, rainfall, river inflows and tidal exchange. Many of the wetlands in the area are groundwater dependent and are seasonally closed off from tidal exchange. During summer low river flow is unable to move displaced sand from low constructive waves creating a sand barrier. When the estuary refills with fresh water the barrier is breached and open to tidal exchange. This process creates a salt wedge comprising of three distinct layers within the estuary. One of the key geomorphic features in the Ramsar site is the dune slack system. Determined by the hydrology of the dune system, vegetation and breeding of aquatic species is influenced by variations in flooding of the dune system. The site also provides a variety of habitat for waterbird feeding, roosting and breeding. Many migratory shorebirds may use the area as 'staging' areas are important for the bird's survival (DELWP, 2017a). The connection between the marine, estuarine and freshwater components is significant for fish migration and reproduction. There are several fish species contributing to the value of the site with different migratory strategies, also supporting fisheries elsewhere in the catchment (DELWP, 2017a). There is one nationally listed ecological community and eight nationally and internationally listed species of conservation significance supported in the Ramsar site.

The western end of Discovery Bay Coastal Park at the Glenelg Estuary is popular for fishing, boating, walking and other activities. The Major Mitchell Trail meets the coast here: the river mouth marks the end of Major Mitchell's expedition of 1836. The Great South West Walk traverses the estuary. Aboriginal culture: several shell middens and surface scatters exist at Glenelg Estuary (DotEE, 2017a).

5.4.5.3 Lavinia

The description below provides the values and baseline ecological character of the Lavinia Ramsar Site.

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.

5.4.5.4 Piccaninnie ponds karst wetlands

The description below provides the values and baseline ecological character of the Piccaninnie ponds karst wetlands Ramsar Site.

The Piccaninnie Ponds Karst Wetlands are an example of karst spring wetlands, with the largest and deepest of the springs reaching a depth of more than 110 m. The majority of the water comes from an unconfined regional aquifer and is consistently 14-15°C. The karst springs support unique macrophyte and algal associations, with macrophyte growth extending to 15 m below the surface as a result of exceptional water clarity. A number of different wetland types exist on the site, including a large area of peat fens.

There are four distinct areas of the Ramsar site. Piccaninnie Ponds (also known as Main Ponds) consists of three interconnected bodies of water - First Pond, The Chasm and Turtle Pond - rounded by an area of shrub dominated swamp. Western Wetland consists of dense closed tea-tree and paperbark shrubland over shallow dark clay on limestone soils. Eastern Wetland includes the spring-fed Hammerhead Pond. Pick Swamp, on the extreme west of the site, includes areas of fen, marshes and sedgelands as well as the spring-fed Crescent Pond on peat soils.

The system is an important remnant of an extensive system of wetlands that once occupied much of the south-east of South Australia. The major groundwater discharge points are Main Ponds, Hammerhead Pond and Crescent Pond. Water principally leaves the site via Outlet Creek and the Pick Swamp drain outlet, which connect the site to the sea. There are a number of fresh groundwater beach springs located on the site.

The geomorphic and hydrological features of the site produce a complex and biologically diverse ecosystem which supports considerable biodiversity, including a significant number of species of national and/or international conservation value. These include the orange-bellied parrot, Australasian bittern and Yarra pygmy perch.

The site attracts 20,000 visitors annually for cave diving, snorkelling, bushwalking, educational activities and birdwatching. The site also has spiritual and cultural value. The Traditional Owners of the land, the Bunganditj (Boandik) and local Indigenous people have a strong connection with the site. Traditionally the site provided a good source of food and fresh water, and evidence of previous occupation still exists (DotEE, 2017b).

The site represents two rare wetland types; karst and fen peatlands. Karst and other subterranean systems are recognised as of global importance and represents one of the few remaining permanent freshwater areas in south east of South Australia. The biota of karst wetlands contributes to the unique element of the regional biodiversity. The site falls within a national biodiversity hotspot and supports nationally and internationally listed species of significance including the critically endangered orange-bellied parrot. The site is also important spawning grounds for species within the freshwater wetlands as well as nearby marine environments. The climate, hydrological and geomorphic components provide a unique habitat. The wetlands are continually fed by groundwater discharge. Water quality in the Main Ponds are characterised by low turbidity and high nitrogen and water clarity. The vegetation is characterised by distinct zones in the karst system while the peatland fens harbour different aquatic species. The site maintains the hydrological regime through constant groundwater discharge. The geomorphology and hydrology of the site support the unique wetlands, provide physical habitat for waterbirds and other species. There are many potential threats to the site including threats to groundwater quality, land clearance, water quality, tourism and introduced species, most of which are controlled under current management (Butcher et al, 2011a).

5.4.5.5 Port Philip Bay (Western shoreline) and Bellarine Peninsula

The Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site is in the western portion of Port Phillip Bay, near the city of Geelong in Victoria. The description below provides the values and baseline ecological character of the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site.

The Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site provides important connective habitat for migratory bird species, habitat for fauna staging and foraging, is home to indigenous cultural sites, provides use of resources, and a site for commercial and recreational activities and education initiatives. The ecological character of the Ramsar site is reliant on the management of human activities and health of environment and water ways. In Victoria, the Victorian Waterway Management Strategy (VWMS) guides the management of rivers, estuaries and wetlands. The Ramsar site Management Plan (DELWP, 2018) aligns with Actions in Water for Victoria by improving waterway health and knowledge of waterways and catchments. Since the requirement for a reduction in nitrogen to ensure the health of the Bay, Melbourne water has undertaken extensive management and monitoring which aimed to maintain the ecological character of the Ramsar Site, specifically targeting six populations: growling grass frog, migratory shorebirds, waterfowl, pied cormorant, straw-necked ibis, whiskered tern (DELWP, 2018).

The Port Phillip Bay Ramsar site consists of a number of component areas that include: parts of the shoreline, intertidal zone and adjacent wetlands of western Port Phillip Bay, extending from Altona south to Limeburners Bay; and parts of the shoreline, intertidal zone and adjacent wetlands of the Bellarine Peninsula, extending from Edwards Point to Barwon Heads and including the lower Barwon River. It is protected under the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar Site Management Plan (DELWP, 2018), which defines the key values as;

- representativeness – it includes all eight wetlands types.
- natural function – the interactions of physical, biological and chemical components of wetlands that enable them to perform certain natural functions and making them a vital element of the landscape.
- flora and fauna – contains the genetic and ecological diversity of the flora and fauna of the region, with at least 332 floral species (22 state threatened species) and 304 species of fauna (29 threatened species).
- waterbirds – provides habitat for migratory shorebirds, including some of international and national importance.
- cultural heritage – many aboriginal sites, particularly shell middens and artefact scatters have been found at the site.
- scenic – provide vistas of open water and marshland in a comparatively pristine condition.
- economic – use of natural resources in agriculture, fisheries, recreation and tourism.
- education and interpretation – offers a wide range of opportunities for education and interpretation of wildlife, marine ecosystems, geomorphological processes and various assemblages of aquatic and terrestrial vegetation.
- recreation and tourism – provides activities such as recreational fishing, birdwatching, hunting, boating, swimming, sea kayaking and camping and activities by commercial operators.

- scientific – site for long-term monitoring of waterbirds and waders.

5.4.5.6 Western Port

The description below provides the values and baseline ecological character of the Western Port Ramsar Site.

Western Port is approximately 60 km south-east of Melbourne, Victoria and in 1982 a large portion was specified of international importance especially as a Waterfowl Habitat (Rasmar Convention). The area consists of large shallow intertidal areas divided by deeper channels with an adjacent narrow strip of coastal land.

Western port Bay is valued for its terrestrial and marine flora and fauna, cultural heritage, recreational opportunities and science value. The area has substantial intertidal areas supported by mangroves, saltmarsh, seagrass communities and unvegetated mudflats, which are significant for its shorebird habitat. Additionally, the saltmarsh and mangroves filter pollutants, trap and process nutrients, stabilise sediments and protect the shoreline from erosion (DSE, 2003). The intertidal mudflats provide significant food source for migratory waders, making it one for the most significant areas in south-east Australia for these birds. The interaction between critical processes and components provide habitat for many waterbirds. The mangrove and saltmarsh vegetation are reported to be of regional, national and international significance because of the role in stabilising the coastal system, nutrient cycling in the bay and providing wildlife habitat. (Ross, 2000). There are three marine parks within the Ramsar sight (Yaringa, French Island and Churchill Island Marine Nation Parks). The Ramsar site is managed by DSE, Parks Victoria, the Victorian Channels Authority, Phillip Island Nature Park, Department of Defence and committees of Management under Crown Lands. There are numerous community and government projects that help monitor, protect, raise awareness and educate the community about the Rasmar site wetland (Brown and Root, 2010).

Western Port is protected under the Western Port Ramsar Site Management Plan (DELWP, 2017d), which describes the values as:

- supports a diversity and abundance of fish and recreational fishing.
- the soft sediment and reef habitats support a diversity and abundance of marine invertebrates.
- supports bird species, including 115 waterbird species, of which 12 are migratory waders of international significance.
- provides important breeding habitat for waterbirds, including listed threatened species.
- provides habitat to six species of bird and one fish species that are listed as threatened under the EPBC Act.
- rocky reefs comprise a small area within the Ramsar site, but includes the intertidal and subtidal reefs at San Remo, which support a high diversity, threatened community and Crawfish Rock, which supports 600 species (Shapiro, 1975).
- the Western Port Ramsar Site has three Marine National Parks, one National Park and has been designated as a Biosphere Reserve under the UNESCO's Man and the Biosphere program.

- the Ramsar site is within the traditional lands of the Boonwurrung, who maintain strong connections to the land and waters.
- the site contains the commercial Port of Hastings that services around 75 ships per year and contributes around $67 million annually to the region's economy.

5.4.6 Nationally Important Wetlands

The spill EMBA PMST Report (Appendix A) identified 10 marine or coastal and one inland Nationally Important Wetlands (Figure 5-6).

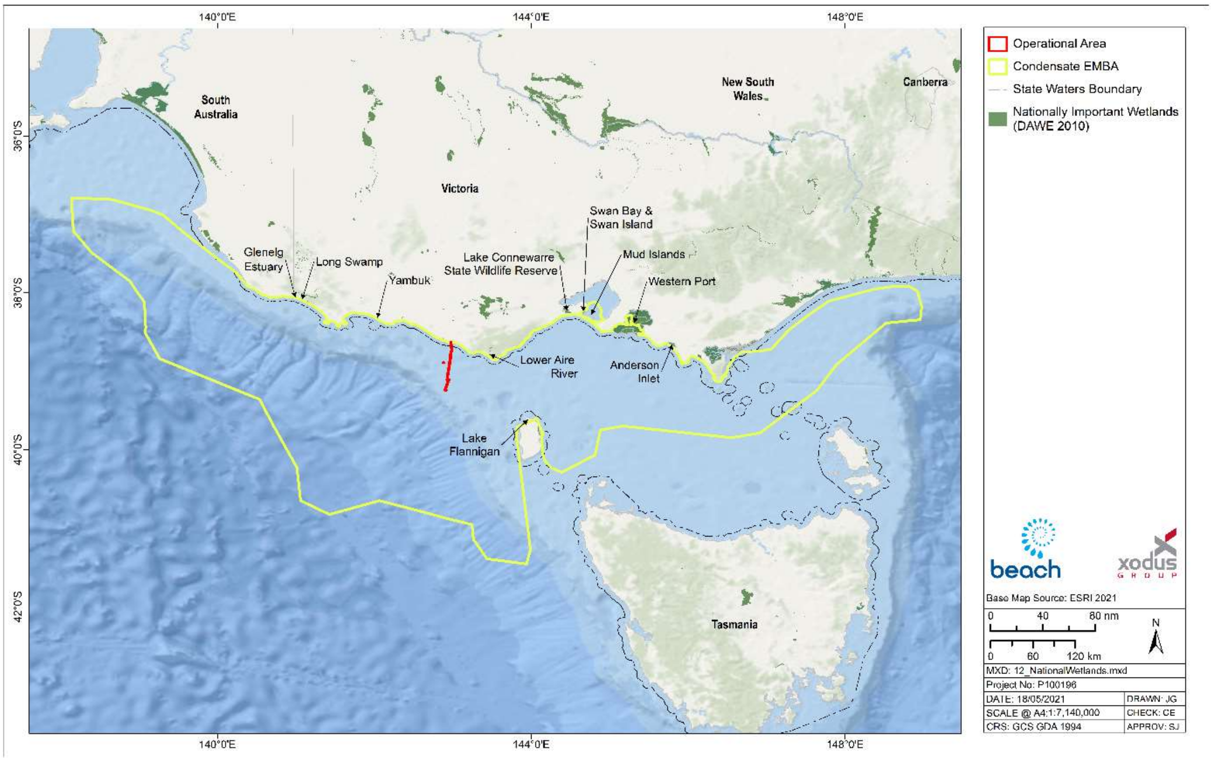


Figure 5-6: Nationally Important Wetlands within the spill EMBA

5.4.6.1 Anderson Inlet

Anderson Inlet is one of the largest estuaries on the Victorian coast. The inlet mouth is permanently open to the sea so that flushing of the estuary constantly occurs. The inlet is of high value for its fauna, including 23 waterbird species. It is popular for recreational fishing, camping, sailing, power-boating and water-skiing.

5.4.6.2 Glenelg Estuary

The Glenelg Estuary is a large estuarine system consisting of the main channel of the Glenelg River and a side lagoon called the Oxbow. The estuary is fed by the Glenelg River which originates in the Grampians Range. Its major tributaries are the Wannon, Stokes and Crawford Rivers. Water drained from wetlands in the Lindsay-Werrikoo Wetlands and Mundi-Selkirk enters the Glenelg River.

5.4.6.3 Lake Connewarre State Wildlife Reserve

The Lake Connewarre State Wildlife Reserve consists of an extensive estuarine and saltmarsh system drained by the Barwon River. It includes a large permanent freshwater lake, a deep freshwater marsh, several semi-permanent saline wetlands and an estuary.

Lake Connewarre State Game Reserve is the largest area of native vegetation remaining on the Bellarine Peninsula. The Lake Connewarre State Game Reserve consists of a wide variety of wetland habitats which support a large and diverse waterbird population and contain a significant area of natural vegetation in this part of the South East Coastal Plain.

5.4.6.4 Lake Flannigan

Lake Flannigan is an inland wetland on King Island, Tasmania and hence would not be impacted by a spill or any other aspects associated with the activity.

5.4.6.5 Long Swamp

Long Swamp is a freshwater wetland in the coastal zone Discovery Bay barrier system. It is separated from the sea by an extensive dunefield. The swamp consists of two major wetlands connected at a natural overflow by a deepened channel. There are three outlets, at Nobles Rocks, White Sands and Oxbow Lake VIC028. The wetlands are mainly fed by groundwater.

5.4.6.6 Lower Aire River Wetlands

These Victorian wetlands consist of three shallow freshwater lakes, brackish to saline marshes and an estuary on the Aire River floodplain. This floodplain occurs at the confluence of the Ford and Calder Rivers with the Aire River. It is surrounded by the Otway Ranges and dune-capped barrier along the ocean shoreline.

The Lower Aire River Wetlands have extensive beds of Common Reed and groves of Woolly Tea-tree which can support large numbers of waterbirds. These wetlands act as a drought refuge for wildlife.

Lake Hordern is considered to be of State significance for its geomorphology.

5.4.6.7 Mud Islands

Mud Islands are a group of low, sandy islands located in the southern part of Port Phillip Bay. The islands are narrow and arranged in a roughly circular configuration around a central tidal lagoon. On the southern, western and northern shores, extensive intertidal mudflats and sea-grass meadows are present.

The islands have very high value for fauna since they support large numbers of migratory wading birds and breeding seabirds.

Mud Islands has a high value for its ecological, recreational, scientific, educational and aesthetic features. It has a very high diversity of birds, 114 species, and is an important feeding and roosting site for many migratory birds. The wetland is an unusual offshore saltmarsh island complex providing breeding habitat for many birds. Mud Islands provides a wilderness experience for visitors.

5.4.6.8 Swan Bay and Swan Island

Swan Bay is a shallow marine embayment partly enclosed by spits and barrier islands such as Swan Island. It is generally <2 m in depth, with 700-1,000 ha of mudflats exposed at low tide, and has extensive seagrass beds. The bay is fringed with saltmarsh including some extensive flats and there are some stands of remnant woodland.

The bay is of high value for its avifauna and flora. It is very productive for birds, molluscs and fish. The saltmarsh and intertidal seagrass meadows are regionally significant. The avifauna is particularly diverse, with 190 bird species recorded.

Swan Bay is a high value wetland for its ecological, recreational and educational features. Swan Bay is an unusual shallow embayment with a mixture of seagrass species which is relatively undisturbed and in good ecological condition.

5.4.6.9 Western Port

Western Port is a large bay with extensive intertidal flats, mangroves, saltmarsh, seagrass beds, several small islands and two large islands. Refer to description in Section 5.4.5.6.

5.4.6.10 Yambuk Wetlands

The Yambuk Wetlands are a network of the estuary of the Eumeralla River and Shaw River (Lake Yambuk), associated freshwater meadows and semi-permanent saline wetlands.

The Yambuk Wetlands are high value for their flora and fauna and they act as drought refuges. The vegetation consists of extensive reed beds and narrow bands of saltmarsh. Lake Yambuk is an excellent example of an estuary with extensive overbank swamps.

5.4.7 Victorian Protected Areas – Marine

Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodatasets (DCCEEW), and the Otway Offshore Operations spill EMBA boundary. Both the protected area geodatabases were filtered for those protected areas managed by State authorities (i.e. not Commonwealth reserves) and for protected areas that include land/water below high tide mark (i.e. excludes those whose management areas are only above high water).

Victoria has a representative system of 13 Marine National Parks and 11 Marine Sanctuaries established under the National Parks Act 1975 (Vic). Seven Marine National Parks and seven marine sanctuaries are located within the spill EMBA as shown in Figure 5-7.

Figure 5-7: State Marine Protected Areas within the spill EMBA

5.4.7.1 Bunurong Marine National Park

The Bunurong Marine National Park and Bunurong Marine Park are managed through the Bunurong Marine National Park Management Plan (Parks Victoria, 2006a). 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).
- a 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.
- a 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.
- the Bunurong Marine National Park is classified as IUCN II (National Parks) and the Bunurong Marine Park as IUCN IV (Habitat/species management area).

5.4.7.2 Churchill Island Marine National Park

Churchill Island is located south of Rhyll, on the eastern shore of Phillip Island. The park extends from Long Point to the north point of Churchill Island. Within the park are numerous marine habitats including mangroves, sheltered intertidal mudflats, seagrass beds, subtidal soft sediments and rocky intertidal shores. Churchill Island Marine National Park is part of the Western Port RAMSAR site, along with the following National Parks:

- Yaringa Marine National Park;
- French Island Marine National Park;
- Sandstone Island; and
- Elizabeth Island.

Churchill Island is an important habitat for many bird species. Migratory waders roost and feed within the Marine National Park including the bar-tailed godwit and the red-necked stint. The seagrass beds are major food sources for many commercially viable species such as king George whiting, black bream and yellow-eyed mullet (Visit Victoria, 2019a).

5.4.7.3 Discovery Bay Marine National Park

The Discovery Bay Marine National Park is situated 20 km west of Portland and covering 2,770 ha and covers part of the largest coastal basalt formation in western Victoria. In deep water (30 – 60 m) there are low reefs forms from ancient shorelines or dunes. There is a rich diversity of marine life within this park due to the cold, nutrient rich waters of the area. The deep calcarenite reefs support diverse sponge gardens whilst the shallower reefs support the brown alga Ecklonia radiata. The offshore waters support a diverse array of invertebrates including southern rock lobster, black-lip abalone and gorgonians. The waters also support great white sharks and blue whales during the summer breeding season. The Discovery Bay National Park is protected as part of the Ngootyoong Gunditj Ngootyoong Mara South West Management Plan (Parks Victoria, 2015) which covers over 116,000 ha of public land and freehold Gunditjmaraland in south-western Victoria. The Plan (Parks Victoria, 2015) describes some key values of the Discovery Bay (which includes the National Park and the coastal reserve), namely;

- recognised roosting, feeding and nesting area for birds such as the hooded plover.
- important habitat for the orange-bellied parrot.
- subtidal reefs with giant kelp forest communities (TEC).
- a foredune and dune complex that was formerly recognised on the National Estate.
- surfing, boating and passive recreation.
- tourism such as dune buggy tours.

5.4.7.4 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, 2005a) 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.
- a high diversity of algal, invertebrate and fish species.
- a 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.
- a spectacular seascape complementing well-known visitor experiences on the Great Ocean Road.

5.4.7.5 Port Phillip Heads Marine National Park

Port Phillip Heads Marine National Park is an area of 35.8 km^2 that is located at the southern end of Port Phillip bay. Many areas within the Port Phillip Heads Marine National Park are popular for a range of recreational activities.

The habitats that are found within the park are seagrass beds, sheltered intertidal mudflats, intertidal sandy beaches and rocky shores, subtidal soft substrate and rocky reefs. The bay has a high diversity and abundance of marine flora and fauna that provides a migratory site for wader birds (Visit Victoria, 2019b).

5.4.7.6 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 0.1 m^2. These species were predominantly polychaetes, crustaceans and nematodes with the mean number of individuals decreasing with water depth (Heisler & 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, 2006b) 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.
- a 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.
- the wreck of the Loch Ard (shipwreck).
- underwater limestone formations of arches and canyons.
- a diverse range of encrusting invertebrates.
- a spectacular dive site (Parks Victoria, 2006b).

5.4.7.7 Wilsons Promontory Marine National Park

Wilsons Promontory National Park is in South Gippsland, about 200 km south-east of Melbourne and at 15,550 ha is Victoria’s largest Marine Protected Area. It extends along 17 km of mainland coastline around the southern tip of Wilsons Promontory and is managed through the Wilsons Promontory Marine National Park and Wilsons Promontory Marine Park Management Plan May 2006 (Parks Victoria, 2006a) and is classified as IUCN II (National Parks). The Plan describes the key environmental, cultural and social values as;

- granite habitats, which are unusual in Victorian marine waters, including extensive heavy reefs with smooth surfaces, boulders and rubble and low-profile reefs.
- biological communities with distinct biogeographic patterns, including shallow subtidal reefs, deep subtidal reefs.
- intertidal rocky shores, sandy beaches, seagrass and subtidal soft substrates.
- abundant and diverse marine flora and fauna, including hundreds of fish species and invertebrates such as sponges, ascidians, sea whips and bryozoans.
- 68 species of marine flora and fauna recorded, or presumed to be, at their eastern or western distributional limits.
- important breeding sites for a significant colony of Australian fur seals.
- important habitat for several threatened shorebird species, including species listed under international migratory bird agreements.
- outstanding landscapes, seascapes and spectacular underwater scenery.
- seascape, cultural places and objects of high traditional and cultural significance to Indigenous people.
- Indigenous cultural lore and interest maintained by the Gunai / Kurnai and Boonwurrung people.
- important maritime and other history.
- historic shipwrecks, many of which are listed on the Victorian Heritage Register (Parks Victoria, 2006a).

5.4.7.8 Marengo 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.

5.4.7.9 The Arches Marine Sanctuary

The Arches Marine Sanctuary protects 45 ha of ocean directly south of Port Campbell. 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. The Arches Marine Sanctuary 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.

5.4.7.10 Barwon Bluff Marine Sanctuary

Barwon Bluff Marine Sanctuary (17 ha) is located at Barwon Heads, approximately 100 km south-west of Melbourne. The Barwon Bluff Marine Sanctuary Management Plan (Parks Victoria, 2007b) identifies the environmental, cultural and social values 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 and mobile fish and are also used by migratory marine mammals.
- marine habitats and species that are of scientific interest and valuable for marine education.
- opportunities for underwater recreation, including visits to subtidal communities that are easily accessible from the shore.
- outstanding coastal vistas, seascapes and underwater scenery.
- 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.

5.4.7.11 Eagle Rock Marine Sanctuary

Eagle Rock Marine Sanctuary (17 ha) is about 40 km south-west of Geelong, close to Aireys Inlet. The sanctuary extends from high water mark around Split Point between Castle Rock and Sentinel Rock. It extends offshore for about 300 m and includes Eagle Rock and Table Rock. The main habitats protected by the sanctuary include intertidal and subtidal soft sediment, intertidal and subtidal reefs, and the water column. It is managed in conjunction with Point Addis Marine National Park and Point Danger Marine Sanctuary.

5.4.7.12 Merri Marine Sanctuary

The Merri Marine Sanctuary is on the Victorian south-west coast near Warrnambool, approximately 260 km west of Melbourne. Merri Reefs Marine Sanctuary (25 ha) is located at the mouth of the Merri River, west of Warrnambool Harbour. Merri Marine Sanctuary contains a mixture of habitats, including intertidal reef, sand, shallow reef and rocky overhang. These areas provide a nursery for many fish species and a habitat for many algae species, hardy invertebrates and shorebirds. Bottlenose dolphins and fur seals are regular visitors to the shore (Parks Victoria, 2007c).

The Sanctuary is protected with the Merri Marine Sanctuary Management Plan (Parks Victoria, 2007c) identifies the environmental, cultural and social values as:

- culturally significant to indigenous communities that have a long association with the area.
- Merri River, wetlands and islands and headlands provide a variety of habitats.
- provision of nursery for many fish species and habitat for algal species, hardy invertebrates and shorebirds.

5.4.7.13 Mushroom Reef Marine Sanctuary

The Mushroom Reef Marine Sanctuary is on the Bass Strait coast at Flinders near the western entrance to Western Port, 92 km by road south of Melbourne. The sanctuary (80 ha) abuts the Mornington

Peninsula National Parkland extends from the high-water mark to approximately 1 km offshore. The sanctuary is protected under the Mushroom Reef Marine Sanctuary Management Plan (Parks Victoria, 2005b) which identifies the environmental, cultural and social values as:

- 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 bottoms 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 crabs, seastars and gastropod species.
- intertidal habitats that support resident and migratory shorebird species including threatened species.
- an important landmark and area for gathering fish and shellfish for the Boonwurrung people.
- excellent opportunities for underwater recreation activities such as diving and snorkelling among accessible subtidal reefs.

5.4.7.14 Point Danger Marine Sanctuary

Point Danger Marine Sanctuary (25 ha) is 20 km south-west of Geelong, close to the township of Torquay and nearby Jan Juc. It extends from the high-water mark at Point Danger offshore for approximately 600 m east and 400 m south, encompassing an offshore rock platform. It is managed in conjunction with Point Addis Marine National Park and Eagle Rock Marine Sanctuary.

5.4.8 Victorian Protected Areas – Terrestrial

Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodatasets (DCCEEW) and the Otway Offshore Operations spill EMBA boundary. Both the protected area geodatabases were filtered for those protected areas managed by State authorities (i.e. not Commonwealth reserves) and for protected areas that include land/water below high tide mark (i.e. excludes those whose management areas are only above high water). Figure 5-8 details that there are several Victorian National Parks, Coastal Parks and Wildlife Reserves within the spill EMBA.

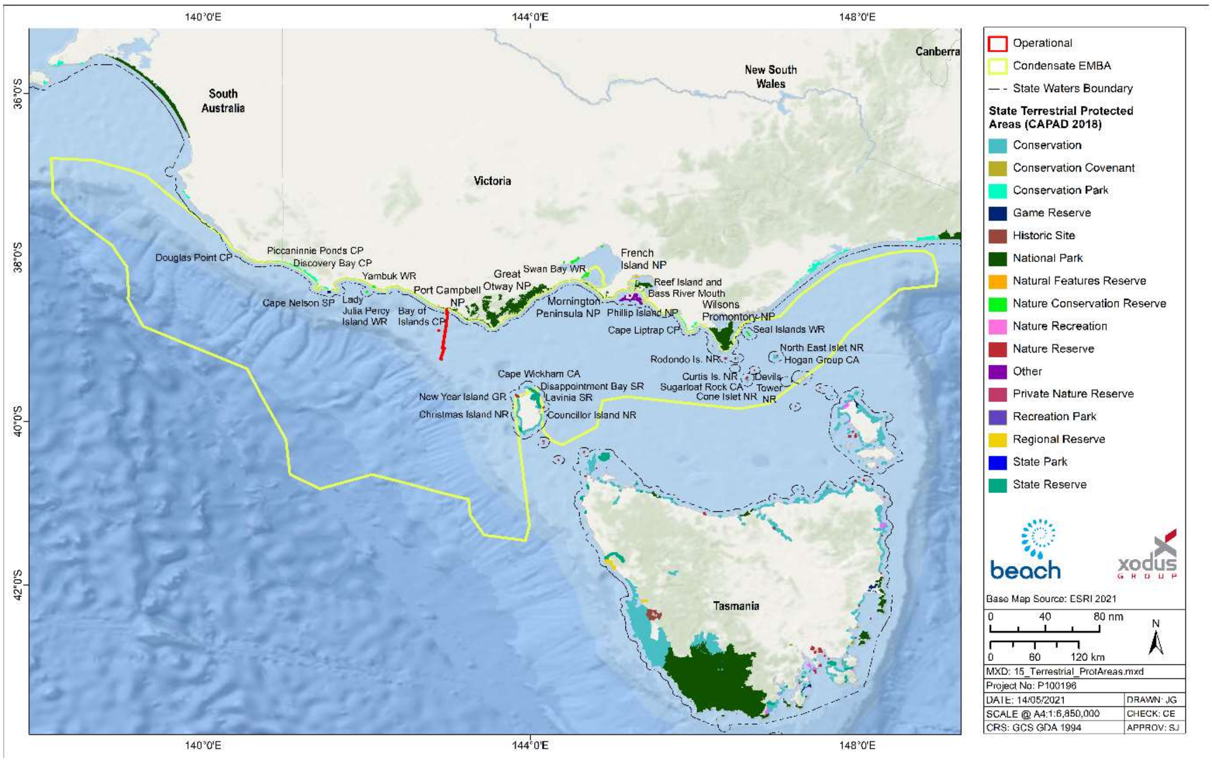


Figure 5-8: State Terrestrial Protected Areas within the spill EMBA

5.4.8.1 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).

5.4.8.2 Cape Liptrap Conservation Park

Cape Liptrap Coastal Park is located in South Gippsland, 180 km south-east of Melbourne. It is protected under the Cape Liptrap Coastal Park Management Plan (Parks Victoria, 2003), which identifies the environmental, cultural and social values as:

- extensive heathland and coastal forest vegetation communities.
- the occurrence of about 270 species of flowering plants, including 27 orchid species.
- thirty threatened fauna species, including ten species listed as threatened under the Flora and Fauna Guarantee Act 1988 (Vic.), 17 migratory bird species and ten threatened flora species.
- one of the most interesting and complex geological sequences in the State, ranging from ancient Cambrian rocks to Recent sands.

- spectacular coastal landforms at Cape Liptrap, Arch Rock and at Walkerville.
- numerous middens and other significant Aboriginal sites.
- relics of the lime-burning industry at Walkerville.
- Cape Liptrap lighthouse.
- spectacular and diverse coastal scenery.
- opportunities for fishing, nature observation, camping, and walking in natural settings.

This park protects the terrestrial environment above the low water mark of this coastline.

5.4.8.3 Cape Nelson State Park

Cape Nelson State Park is near Portland on Victoria’s southwest coast with an area of 243 ha. The park offers an archaeologically, ecologically and geologically rich and diverse attractions.

5.4.8.4 Discovery Bay Coastal Park

The Discovery Bay Coastal Park is a remote coastal park that protects 55 km of ocean beach. Inland, the park encompasses high coastal cliffs, sand dunes, freshwater lakes and swamps, with thriving coastal vegetation and wildlife. The park extends along the coast of Discovery Bay from Cape Nelson north-westwards to the border of South Australia, covering an area of 10,460 ha (Parks Victoria, 2015).

5.4.8.5 Douglas Point Conservation Park

Douglas Point Conservation Park is popular for recreational bush walking, bird watching, fishing, diving and surfing that is located 11 km north-west of Port MacDonnell. The park has natural and cultural values and conserves the coastal health habitat and associated endangered and vulnerable plant and animal species (DEH, 2003).

5.4.8.6 French Island National Park

The French Island National Park is located 10 km south of Tooradin, French Island Marine National Park is adjacent to the northern shoreline of French Island National Park in Western Port. Extending 15 km along the shoreline, the park encompasses approximately 2800 ha. It includes one of Victoria's most extensive areas of saltmarsh and mangrove communities and also includes mudflats of state geomorphological significance (Parks Victoria, 2019a).

5.4.8.7 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.

5.4.8.8 Lady Julia Percy Island Wildlife Reserve

Lady Julia Percy Island is off the coast of Victoria near Port Fairy. It is one of the two largest breeding sites for the Australian fur seal species in Australia (DoE, 2017a) and provides habitat to migratory seabirds. There is no management plan for Lady Julia Percy Island Wildlife Reserve.

5.4.8.9 Mornington Peninsula National Park

Mornington Peninsula National Park is situated about 70 km south of Melbourne. Mornington Peninsula National Park runs along the coast from Point Nepean, at the western tip of the Mornington Peninsula, to Bushrangers Bay, where it turns inland along the Main Creek valley, still as a narrow band, until it joins the more expansive Greens Bush section of the Park. This park protects the terrestrial environment above the low water mark of this coastline. The Park is managed under the Mornington Peninsula National Park and Arthurs Seat State Park Management Plan, which has identified the key environmental, social and cultural values as (Parks Victoria, 2013):

- 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 land systems formed within the Southern Victorian Coastal Plains and the Southern Victorian Uplands.

- many significant native plants and vegetation communities, especially in Greens Bush and former McKellar Flora Reserve, and the most extensive remnant coastal grassy forest habitat on the Mornington Peninsula.
- highly scenic landscape values along the ocean coast and at Port Phillip heads and the prominent landscape 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.
- nationally significant and fascinating historic sites at Point Nepean.
- the historic Seawinds Gardens in Arthurs Seat State Park.
- one of the highest recorded densities of Aboriginal archaeological sites along the Victorian Coast
- South Channel Fort is an important component of the historic fortification defence system of Port Phillip (and an important bird nesting and roosting site).
- spectacular scenery and popular surf beaches associated with a wild and rugged coastline.
- local and regional economic benefits.
- intensively used recreational nodes, e.g. at Portsea, Sorrento, Cape Schanck and Arthurs Seat.

5.4.8.10 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 (DAWE, 2021). There is no management plan for Phillip Island Nature Park.

5.4.8.11 Piccaninnie Ponds Conservation Park

The Piccaninnie Pond covers an area of 8.64 km^2, that has a wide diversity of fauna and flora with 60 bird species and six vegetation communities. Other vegetation found within the park includes reeds, sedge swamp, open heath and tussock grassland.

5.4.8.12 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, 2019b).

5.4.8.13 Reef Island and Bass River Mouth Nature Conservation Reserve

Reef Island and Bass River Mouth Nature Conservation Reserve is situated on the eastern shores of Westernport Bay. Reef Island is accessible at low tide via a narrow spit. The day visitor area on the banks of the Bass River is ideal for fishing and bird watching. There is no management plan for this Conservation Reserve,

5.4.8.14 Seal Island Wildlife Reserve

Seal Islands is east of Wilsons Promontory. Seal Island is one of the two largest breeding sites for the Australian fur seal (DAWE, 2021). There is no management plan for Seal Islands Wildlife Reserve.

5.4.8.15 Swan Bay Wildlife Reserve

Swan Bay Wildlife Reserve is an internationally recognized wetland and marine ecosystem within Port Phillip Bay. Swan Bay supports diverse saltmarsh communities which form part of the habitat critical for survival of the endangered orange bellied parrot and is an important recreational and tourism resource (AANRO, 1991).

5.4.8.16 Wilsons Promontory National Park

The Wilsons Promontory National Park is in South Gippsland, about 200 km southeast of Melbourne and includes the Wilsons Promontory Wilderness Zone, Southern Wilsons Promontory Remote and Natural Area and Wilsons Promontory Islands. It is managed under the Wilsons Promontory National Park Management Plan. The Plan identifies the key environmental, social and cultural values as (Parks Victoria, 2002):

- entire promontory of national, geological and geomorphological significance containing a number of sites of State and regional significance.
- diverse vegetation communities, including warm temperate and cool temperate rainforest, tall open forests, woodlands, heathlands, and swamp and coastal communities.
- unmodified rivers and streams with no introduced fish species.
- half of Victoria's bird species.
- intertidal mudflats, which are an internationally important habitat for migratory wading birds.
- the largest coastal wilderness area in Victoria.
- numerous middens and other significant Aboriginal sites.
- remains of sites of several small European settlements and past uses including timber milling, mining and grazing.
- a number of shipwrecks in the waters around Wilsons Promontory.
- the heritage buildings of Wilsons Promontory Light Station.
- outstanding natural landscapes including spectacular and diverse coastal scenery.

This park protects the terrestrial environment above the low water mark of this coastline.

5.4.8.17 Yambuk Wetlands Natural Conservation Reserve

Yambuk Wetlands Natural Conservation Reserve is located south of Lake Yambuk along the coastline with an area of 0.77 km^2 (Protected Planet, 2019).

5.4.9 Tasmanian Protected Areas - Marine

Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodatasets (DCCEEW), and the Otway Offshore Operations spill EMBA boundary. Both the protected area geodatabases were filtered for those protected areas managed by State authorities (i.e. not Commonwealth reserves) and for protected areas that include land/water below high tide mark (i.e. excludes those whose management areas are only above high water).

As per Figure 5-7 one marine Tasmanian Protected Area is within the spill EMBA.

5.4.9.1 Kent Group National Park

Kent Group National Park is made up of islands and islets, situated halfway between Wilsons Promotory in Victoria and Flinders Island off Tasmania's north-eastern tip. Kent Group National Park is in the middle of Bass Strait where it is subject to a constant barrage of wild seas and currents that with it brings richness in nutrients that supports a unique diversity of marine life. The islands are an important refuge for seabirds along with providing a sanctuary for the Australian fur-seals who make their home on the rocky outcrops (DPIPWE, 2020)

5.4.10 Tasmanian Protected Areas – Terrestrial

Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodatasets (DCCEEW), and the Otway Offshore Operations spill EMBA boundary. Both the protected area geodatabases were filtered for those protected areas managed by State authorities (i.e. not Commonwealth reserves) and for protected areas that include land/water below high tide mark (i.e. excludes those whose management areas are only above high water).

Figure 5-8 details that there are several Tasmanian National Reserves, Conservations Areas and Game Reserves within the spill EMBA.

5.4.10.1 Cape Wickham Conservation Area

The Cape Wickham Conservation Area is 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.

5.4.10.2 Christmas Island Nature Reserve

Christmas Island is located off the west coast of King Island. It is designated IUCN 1a which is a strict nature reserve, which allows minimal human use (DPIPWE, 2015). It is a BIA for both breeding and foraging for the little penguin (DAWE, 2021). There is no management plan for the Christmas Island Nature Reserve.

5.4.10.3 Cone Islet Conservation Area

Cone Islet Conservation Area has an area of about 0.06 km^2 and is part of the Curtis Island group. Cone Islet is lying in the northern Bass Strait between Furneaux Group and Wilsons Promontory in Victoria.

5.4.10.4 Councillor Island Nature Reserve

Councillor Island Nature Reserve is a 10.53 ha granite reserve east of Tasmania approximately 2.5 km off the mainland coastline of Tasmania within the Bass Strait.

5.4.10.5 Curtis Island Nature Reserve

Curtis Island is located in the Bass Strait between Wilsons Promontory and Tasmania. It is designated IUCN 1a which is a strict nature reserve, which allows minimal human use (DPIPWE, 2015). It has a large population of breeding seabirds and waders (Carlyon et al., 2011). It is also a recognised BIA for breeding and feeding for little penguins (DAWE, 2021). There is no management plan for the Curtis Island Nature Reserve.

5.4.10.6 Devils Tower Nature Reserve

Devils Tower are two small granite islands which are part of the Curtis Group and are located in the Bass Strait between Wilsons Promontory and Tasmania. It is designated IUCN 1a which is a strict nature reserve, which allows minimal human use (DPIPWE, 2015) and is noted as being important for breeding seabirds and waders. There is no management plan for the Curtis Island Nature Reserve.

5.4.10.7 Disappointment Bay State Reserve

The Disappointment Bay State Reserve is located on the north coast of King Island. It is designated IUCN II which is a national park (DPIPWE, 2015). There is no management plan for the Disappointment Bay State Reserve.

5.4.10.8 East Moncoeur Island Conservation Area

East Moncoeur Island is part of Tasmania's Rodondo Group. It is designated as IUCN Category V which is a protected landscape/seascape. There is no management plan for the East Moncoeur Island Conservation Area.

5.4.10.9 West Moncoeur Island Nature Reserve

West Moncoeur Island Nature Reserve is an area of 0.14 km^2 that is situated 2.5 km east of East Moncoeur Island. West Moncoeur is part of the Rodondo Group It supports large breeding colonies of Australia fur-seals (Carlyon et al, 2015).

5.4.10.10 Hogan Group Conservation Area

The Hogan Group is in Bass Strait south of Wilsons Promontory. The Hogan archipelago is an important seabird location and supports major breeding colonies of many species (Carlyon et al, 2011). It is designated as IUCN Category IV which is habitat/species management area. There is no management plan for the Hogan Group Conservation Area.

5.4.10.11 Lavinia State Reserve

Lavinia State Reserve is located on the north-east coast of King Island. The reserve contains a number of rare birds, including the endangered orange-bellied parrot (DPIPWE, 2013). It includes the Lavinia Ramsar site and two freshwater lakes. Lavinia Beach is a popular location for surfing and fishing.

5.4.10.12 New Year Island Game Reserve

New Year Island is located on the north-west coast of King Island. It is a game reserve for the muttonbird (short-tailed shearwater), with non-commercial harvesting of the species permitted during the open season.

5.4.10.13 North East Islet Nature Reserve

North East Islet (or Boundary Islet) is part of the Hogan Island Group. It is a haul-out site for the Australia fur-seal (Carlyon et al, 2011).

5.4.10.14 Rodondo Island Nature Reserve

Rodondo Island is located in Bass Strait, approximately 10 km south of Wilsons Promontory. Both Australian and New Zealand fur-seal have haul-out sites on Rodondo Island (Carlyon et al, 2015). It hosts a number of breeding seabirds, with the short-tailed shearwater being the most common (Carlyon et al, 2015).

5.4.10.15 Sugarloaf Rock Conservation Area

Sugarloaf Rock is a small granite island, with an area of 1.07 ha, in south-eastern Australia. It is part of Tasmania's Curtis Group, lying in northern Bass Strait between the Furneaux Group and Wilson's Promontory in Victoria. Known breeding sites for the fairy prion and common diving-petrel along with known haul-out site for the Australian fur-seals.

5.4.11 South Australian Protected Areas - Marine

Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodatasets (DCCEEW), and the Otway Offshore Operations spill EMBA boundary. Both the protected area geodatabases were filtered for those protected areas managed by State authorities (i.e. not Commonwealth reserves) and for protected areas that include land/water below high tide mark (i.e. excludes those whose management areas are only above high water).

One South Australian marine park, the Lower South East Marine Park, was identified in the spill EMBA (Figure 5-7).

The Lower South East Marine Park covers 360 km^2 and is divided into two sections: the area adjacent to Canunda National Park; and the area extending from Port MacDonnell Bay just west of French Point to the South Australian - Victorian border. The marine park borders Canunda National Park and partially overlays Piccaninnie Ponds Conservation Park.

The Lower South East Marine Park Management Plan 2012 (DEWNR, 2012) details the following values:

- high diversity of plants and animals, including blue whales, due to the influence of the Bonney coast upwelling, an ocean current that supplies nutrient-rich water to the area.
- diverse range of habitats ranging from high-energy sandy beaches and freshwater springs, various reef types (shore platforms, fringing and limestone).
- kelp forests and algal communities and is strongly influenced by natural processes such as the Bonney coast upwelling.

- spring lakes such as Ewen Ponds and Piccaninnie Ponds (both Wetlands of National Importance) emerge from the beaches and are unusual in South Australia.
- habitat for several threatened or potentially threatened species that require freshwater and marine environments during their lifecycle, including the pouched lamprey, short-headed lamprey and shortfinned eel.
- feeding and resting grounds for migratory and resident shorebirds.
- recreational activities including fishing, diving and snorkelling.
- commercial fisheries including the Southern Zone Abalone Fishery, the Southern Zone Rock Lobster Fishery, the Marine Scalefish Fishery, the Charter Fishery and the Miscellaneous Giant Crab Fishery.
- the Buandig Aboriginal people have traditional associations with areas of the marine park.

5.4.12 South Australian Protected Areas - Terrestrial

Identification of State Parks and Reserves (marine and terrestrial) was undertaken in GIS, using the CAPAD2018_marine and CAPAD2018_terrestrial geodatasets (DCCEEW), and the Otway Offshore Operations spill EMBA boundary. Both the protected area geodatabases were filtered for those protected areas managed by State authorities (i.e. not Commonwealth reserves) and for protected areas that include land/water below high tide mark (i.e. excludes those whose management areas are only above high water).

As per Figure 5-8 there are no terrestrial South Australian Protected Areas within the spill EMBA.

5.4.13 Key Ecological Features

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

The spill EMBA PMST Report (Appendix A) identified three KEFs:

- Bonney Coast Upwelling
- Upwelling East of Eden
- West Tasmanian Marine Canyons

The following KEF was also identified as potentially occurring within the spill EMBA:

- Shelf Rocky Reefs and Hard Substrates
- Bass Cascade

No KEFs were identified within the operational area (Figure 5-9).

5.4.13.1 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 (DAWE 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 (DAWE 2015). 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).

The Bonney Coast Upwelling KEF lies on the continental shelf situated ~120 northwest of Cape Jaffa, South Australia to Portland, Victoria (Figure 5-9). 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).

The Bonney Coast Upwelling KEF is situated ~83 km to the west of the operational area (Artisan-1 being the closest point).

5.4.13.2 Upwelling East of Eden

The Upwelling east of Eden is valued for having high productivity and aggregations of marine life. In this region, dynamic eddies of the east Australian current cause episodic productivity events when they interact with the continental shelf and headlands. The episodic mixing and nutrient enrichment events drive phytoplankton blooms that are the basis of productive food chains including zooplankton, copepods, krill and small pelagic fish.

The upwelling supports regionally high primary productivity that supports fisheries and biodiversity, including top order predators, marine mammals and seabirds.

This area is one of two feeding areas for blue whales and humpback whales, known to arrive when significant krill aggregations form. The area is also important for seals, other cetaceans, sharks and seabirds.

5.4.13.3 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 & 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 (Adams 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 400 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, 2015a).

The West Tasmania Canyon is situated ~16 km south of the operational area (Thylacine-A Wellhead Platform being the closest point).

5.4.13.4 Shelf Rocky Reefs and Hard Substrates

Rocky reefs and hard grounds are located in all areas of the SEMR continental shelf including Bass Strait, from the sub-tidal zone shore to the continental shelf break. The continental shelf break generally occurs in 50 m to 150– 220 m water depth. The shallowest depth at which the rocky reefs occur in Commonwealth waters is approximately 50 m.

On the continental shelf, rocky reefs and hard grounds provide attachment sites for macroalgae and sessile invertebrates, increasing the structural diversity of shelf ecosystems. The reefs provide habitat and shelter for fish and are important for aggregations of biodiversity and enhanced productivity.

The shelf rocky reefs and hard substrates are defined as a key ecological feature as they are an area of high productivity and aggregations of marine life. This KEF has not yet been spatially defined (DoE, 2015a).

5.4.13.5 Bass Cascade

The Bass Cascade refers to the "underwater waterfall" effect brought about by the northward flow of Bass Strait waters in winter which are more saline and slightly warmer than surrounding Tasman Sea waters. As the water approaches the mainland in the area of the Bass Canyon group it forms an undercurrent that flows down the continental slope. The cascading water has a displacing effect causing nutrient rich waters to rise, which in turn leads to increased primary productivity in those areas. The cascading water also concentrates nutrients, and some fish and whales are known to aggregate along its leading edge.

Bass Cascade is defined as a key ecological feature as it is an area of high productivity. The Bass Cascade occurs during winter months only and has not yet been spatially defined (DoE, 2015a).

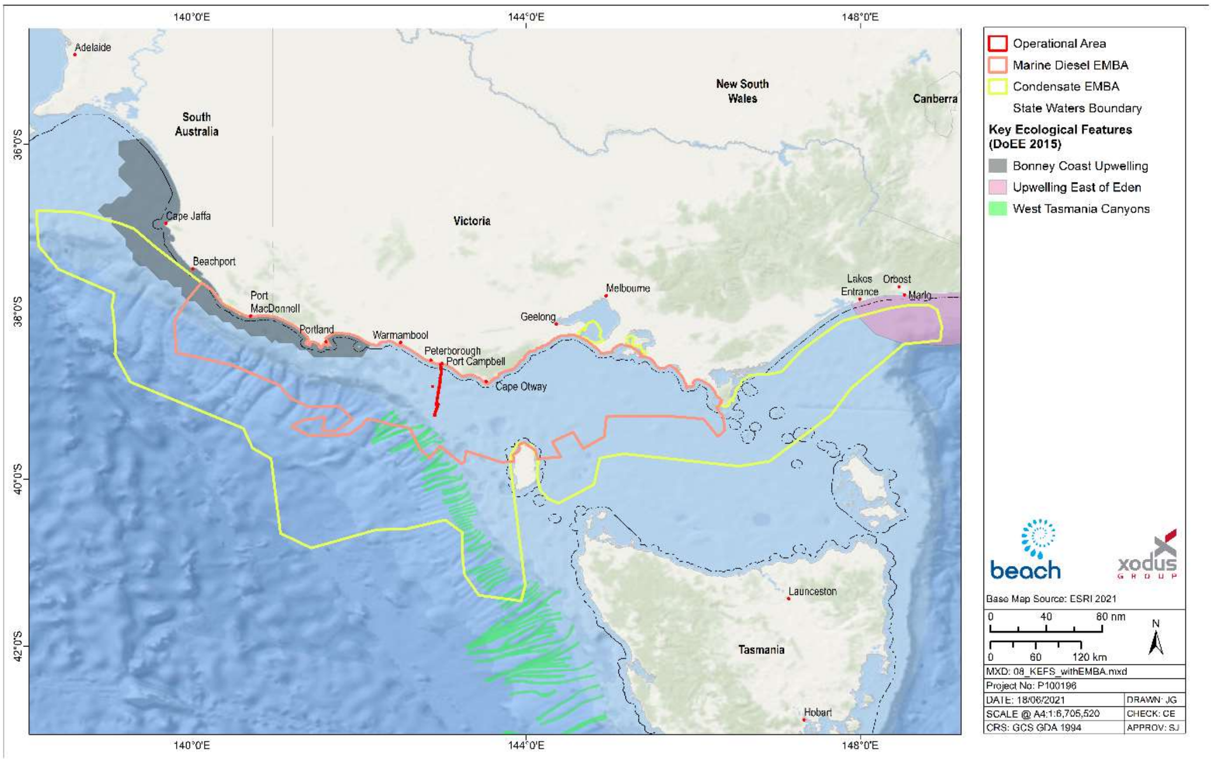


Figure 5-9: Key Ecological Features present within the EMBA

5.5 Physical environment

The physical marine environment of the Otway region is characterised by very steep to moderate offshore gradients, high wave energy and temperate waters subject to upwelling events.

5.5.1 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 of Robe, SA, and eastward to 80 km of 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 5-10).

The spill EMBA is within the five zones while the operational area is within the shallow and middle shelf.

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, bio clastic 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/nanno-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.

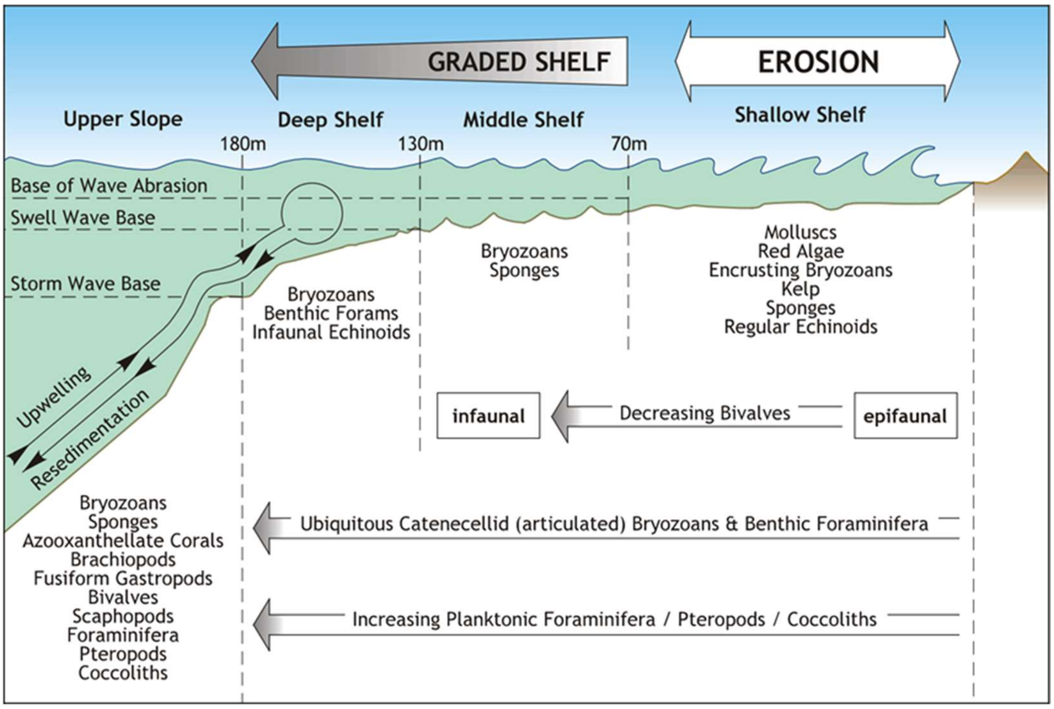


Figure 5-10: Model of the geomorphology of the Otway Shelf

5.5.2 Otway assessments and surveys - EMBA

A comprehensive assessment of the coast to continental shelf margin has been undertaken within approximately 4 km^2 of bathymetric data and video footage collected of the pipeline right-of-way options from the Otway Gas Project EIS (Woodside, 2003). These data have been supplemented by numerous benthic sampling events; however, data for this assessment have been referenced primarily from Boreen et al., (1993), and the Otway Gas Project EIS (Woodside, 2003).

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 Geomatics, 2011). Overall, the seabed in the Otway area surveyed slopes to the south at a gentle average gradient of less than 1. 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 5-2toTable 5-6.

Table 5-2: 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 5-3: 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 5-4: 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 5-5: 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 5-6: 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 sampling survey of the surficial sediments, benthic invertebrates and demersal fishes of Bass Strait was undertaken by the Victorian Museum between 1979 and 1983 (Wilson and Poore, 1987). More than 200 sites were sampled with sites 51 through 61, 118, 119, 120, 121, 183, 186 and 192 representatives of the area (Figure 5-11). Sediments were described in the field from a visual impression or according to the classification of Shepard (Shepard, 1954) (Table 5-7). Carbonate percentage of sediments was also assessed. These samples indicate that surficial sediments throughout the area are dominated by carbonate rich medium to coarse sands. Data on benthic invertebrates and demersal fishers has not been summarised and published.

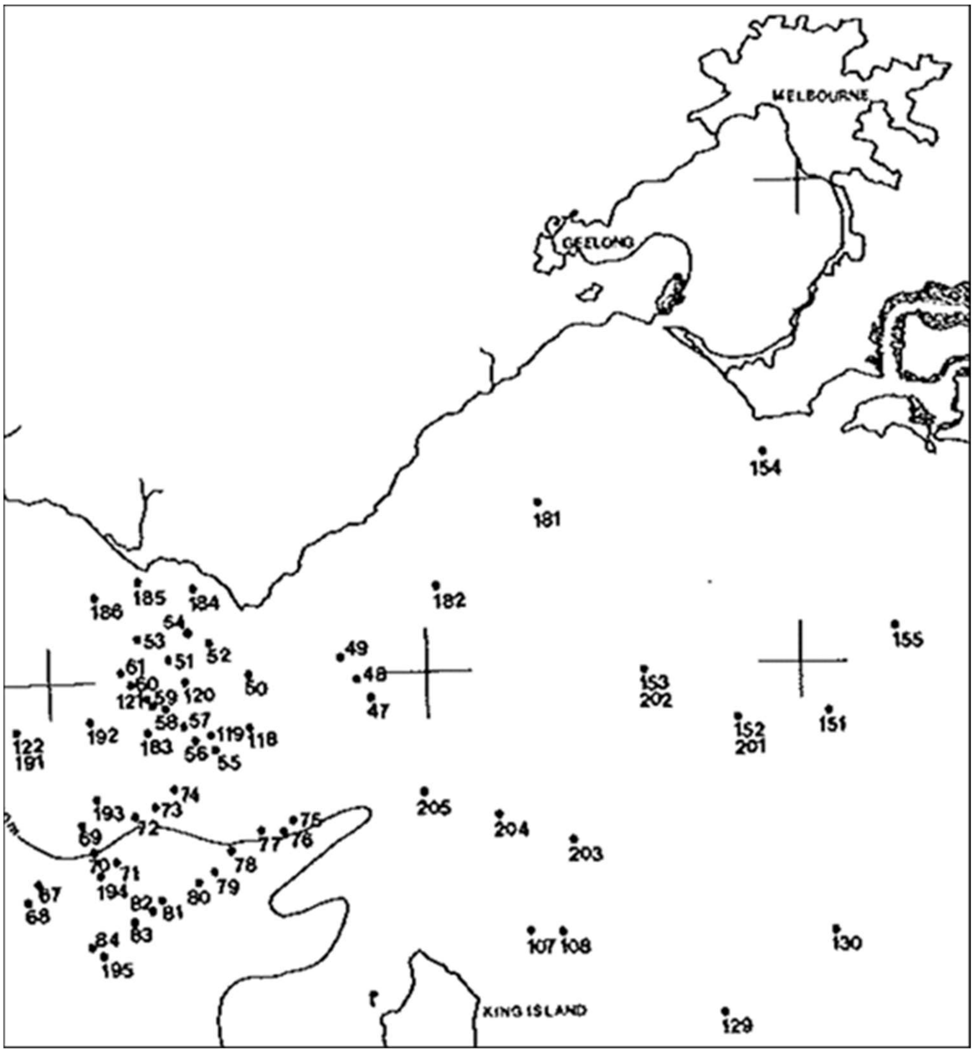


Figure 5-11: Sampling sites for the Bass Straight survey in the region of the spill EMBA (Wilson and Poore, 1987)

Table 5-7: Classification of surficial sediments sampled during the Bass Strait survey in the vicinity of the EMBA (Wilson and Poore, 1987)

Site No.	Depth (m)	Surficial sediments	Carbonate % by weight
51	67	Medium sand	ND
52	49	Coarse sand	72
53	67	Medium sand	45
54	70	Very coarse shelly sand	70
55	85	Coarse carbonate sand	93
56	77	Medium sand	ND
57	59	Coarse sand	97
58	47	Coarse sand	92
59	70	Coarse sand	89
60	79	Medium carbonate sand	100

Site No.	Depth (m)	Surficial sediments	Carbonate % by weight
61	68	Coarse sand	ND
118	95	Fine sand	96
119	92	Fine sand	99
120	84	Medium sand	90
121	84	Medium sand	ND
183	84	Coarse sand	99
186	69	Fine sand	ND
192	81	Medium sand	100

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 5-12). 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 5-8.

Table 5-8: Seabed characteristics and epifaunal assemblage at video survey sites (BBG, 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

Site No.	Depth (m)	Seabed type	Benthic Assemblage
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.
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

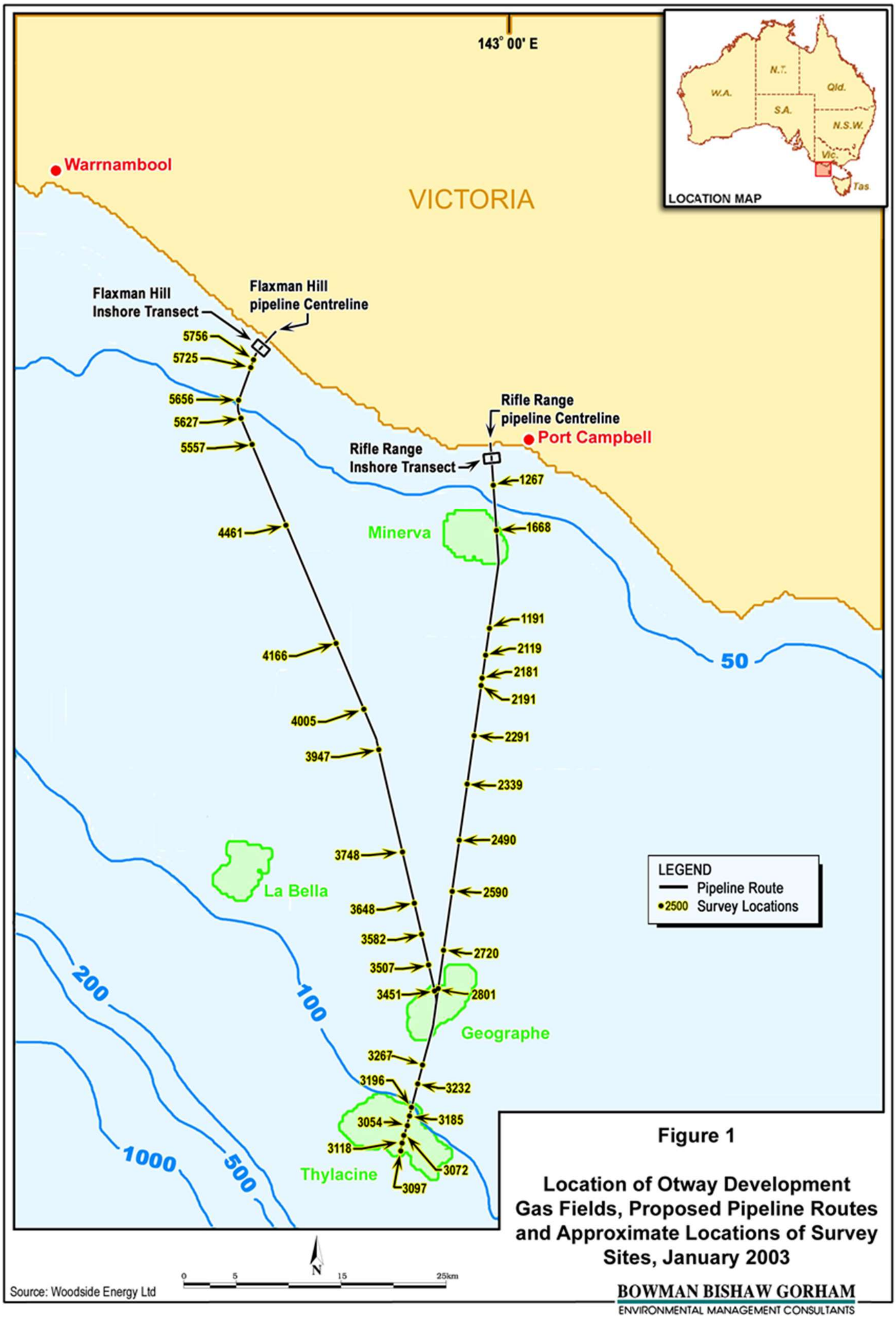


Figure 5-12: Seabed sites assessed by video survey during 2003 (BBG, 2003)

Beach commissioned a seabed site assessment for the Otway Gas Development. The seabed site assessment was undertaken from November 2019 to January 2020 and ranged in water depths from 70 to 104 m. The survey extent including the gas fields and infrastructure routes which are shown in Figure 5-13.

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 platform or pipeline. Several different investigation techniques were used to examine and describe the seabed, as well as identify possible hazards from manmade, natural and geological features.

Sediment samples for infauna were collected at two of the gas fields, Artisan and Thylacine (Ramboll, 2020. Appendix E). Due to poor weather conditions sampling had to be reduced. It was decided 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 (Ramboll, 2020. Appendix E). Photographs were taken at the anchor points for proposed well locations to provide a represented sample of the area where the seabed could potentially be disturbed by the drilling activity.

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 while the lowest coverage of epibiota was recorded along the route between Artisan and Hot Tap Y (Figure 5-13). Of the gas field sites, Artisan and Hercules had a slighted 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 a 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 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.

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 species or ecological communities listed as threatened under the *Environmental Protection and Biodiversity Conservation Act* 1999 (the EPBC Act) were observed.

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 EMBA. In summary the seabed of the EMBA 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. Six basalt rises occur in the eastern and south-eastern section of the EMBA, the largest of which is the ‘Big Reef’.

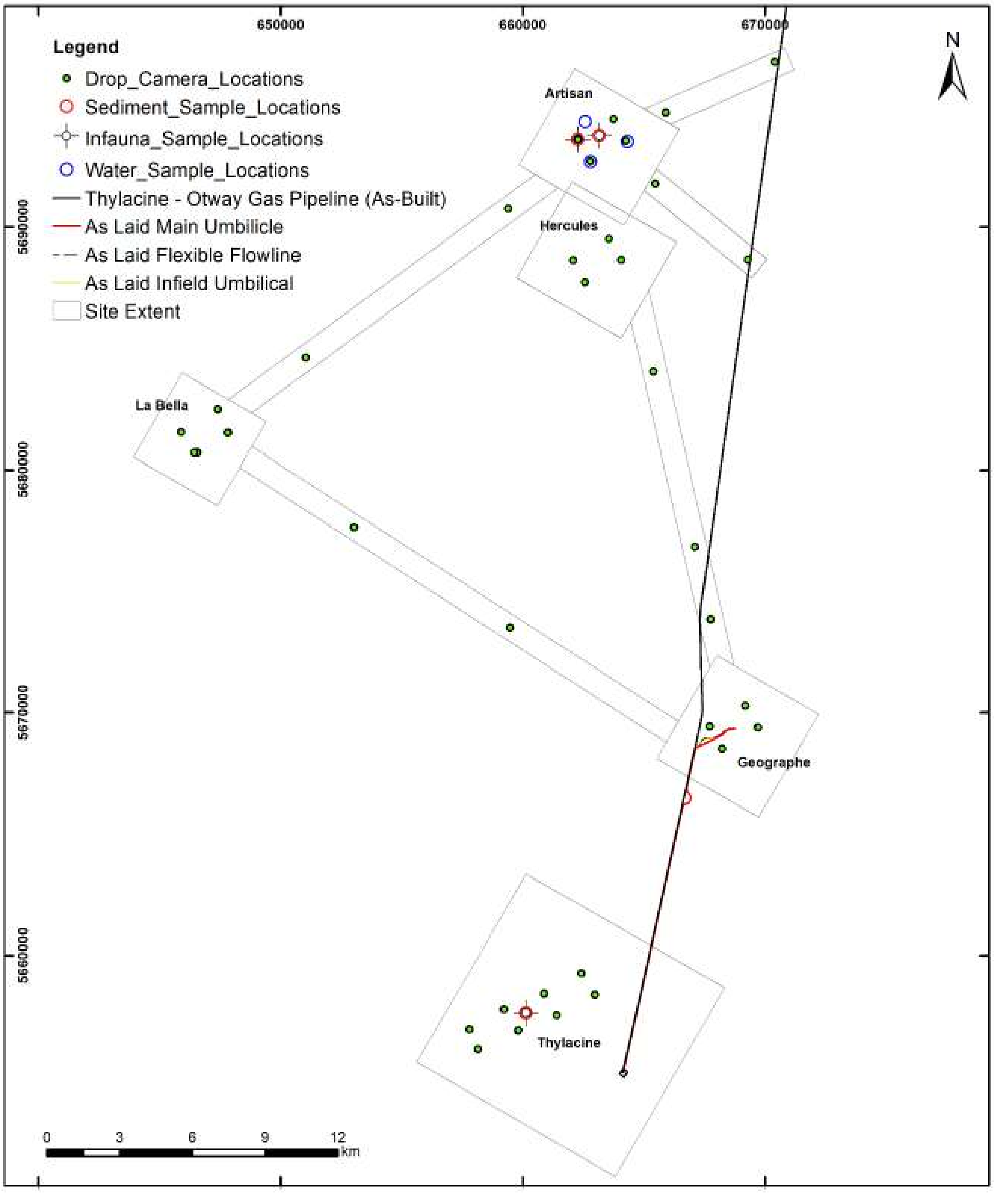


Figure 5-13: Location of the Otway Gas Development seabed site assessment

5.5.3 Otway assessments and surveys - Operational area

As detailed in Section 5.5.2 Beach commissioned a seabed site assessment for the Otway Gas Development. The seabed site assessment was undertaken from November 2019 to January 2020 and ranged in water depths from 70 to 104 m. The survey extent included the gas fields and infrastructure routes are shown in Figure 5-13.

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 platform or pipeline, however the information gathered is relevant to the Otway Offshore Operations due to the locations surveyed. The geophysical survey comprised of multibeam bathymetry, side scan sonar, magnetometer and sub-bottom profiling. The geotechnical investigation comprised of cone penetration tests and seabed samples. In addition, sediment samples for infauna were collected at the Artisan and Thylacine gas fields and the composition and percent coverage of epifauna was assessed from photographs of the seafloor taken with a drop camera at several locations including the Thylacine and Geographe gas fields (Ramboll, 2020. Appendix E). The drop camera locations for the Geographe and Thylacine locations are shown in Figure 5-14. These investigation techniques were used to examine and describe the seabed and benthic biota, as well as identify possible hazards from manmade, natural and geological features.

The seabed site assessment for the Thylacine field (Fugro, 2020a; Ramboll, 2020) identified:

- the seabed depths vary ranging from 92 m to 115 m. LAT, with an overall southwestern slope.
- the 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 3 m is identified on the rocky scarp surfaces, which are separated by shallow depressions often with a transgressive sandy infill.
- the 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).
- the epibiota on the seabed in the vicinity of the Thylacine 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.

The seabed site assessment for the Geographe field (Fugro, 2020b; Ramboll, 2020) identified:

- there is very little bathymetric variation across the survey area with water depths ranging from 80 m to 91 m. the seabed is characterised by rocky outcrop on the seabed
- rocky outcrops of the Port Campbell Limestone show some variable relief up to 2 m.
- sand is clean washed and well sorted and comprising predominantly of angular broken shells and bryozoans.
- the 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).

Based on the information from the seabed site assessment for the Otway Gas Development, Condition 1 (d) of EPBC 2002/621 is met as information from the seabed site assessment was used to determine the final selection of the Thylacine and Geographe well locations. No high relief outcrops, reefs, sponge beds or historic shipwrecks were identified within the well locations.

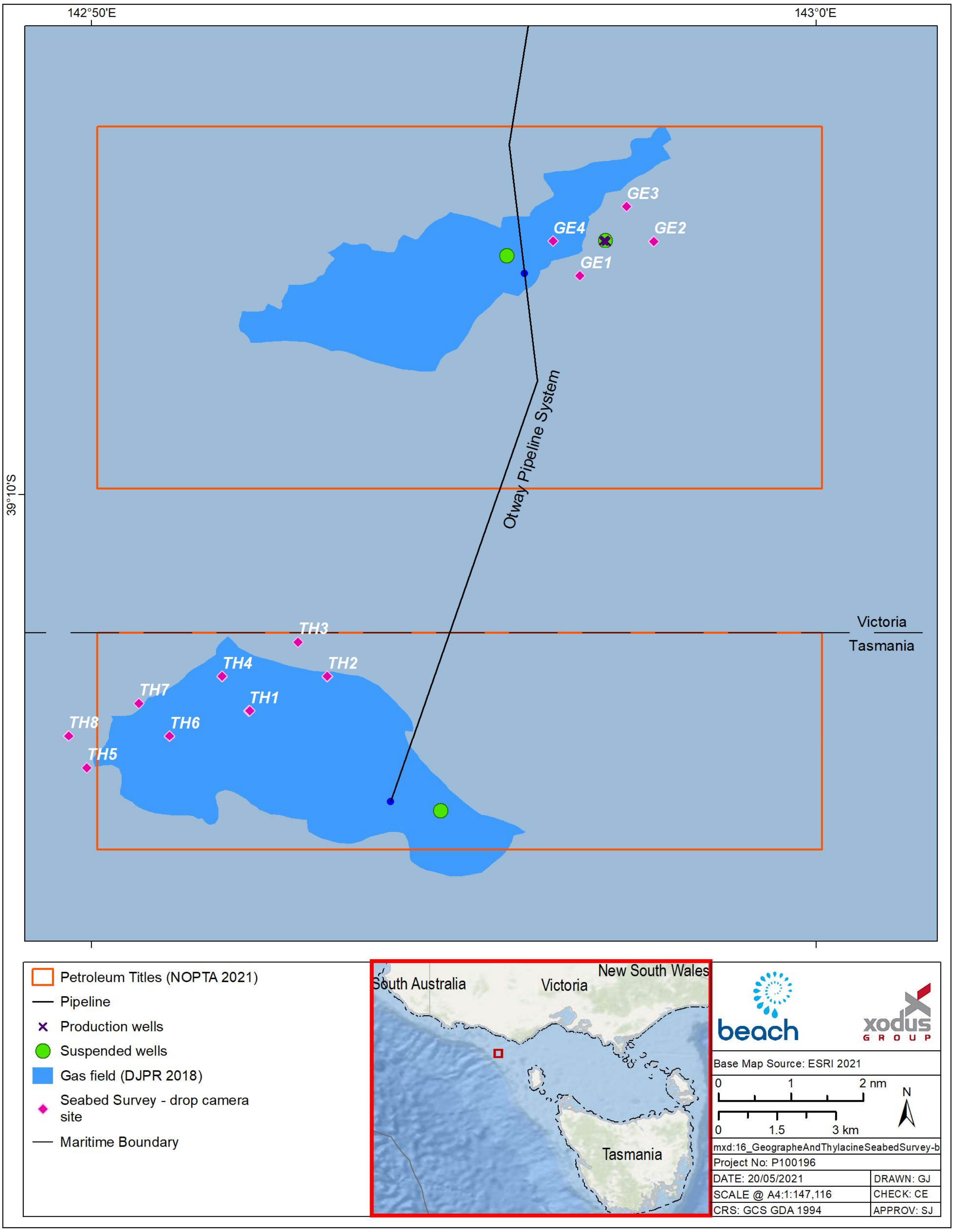


Figure 5-14: Drop camera locations within operational area

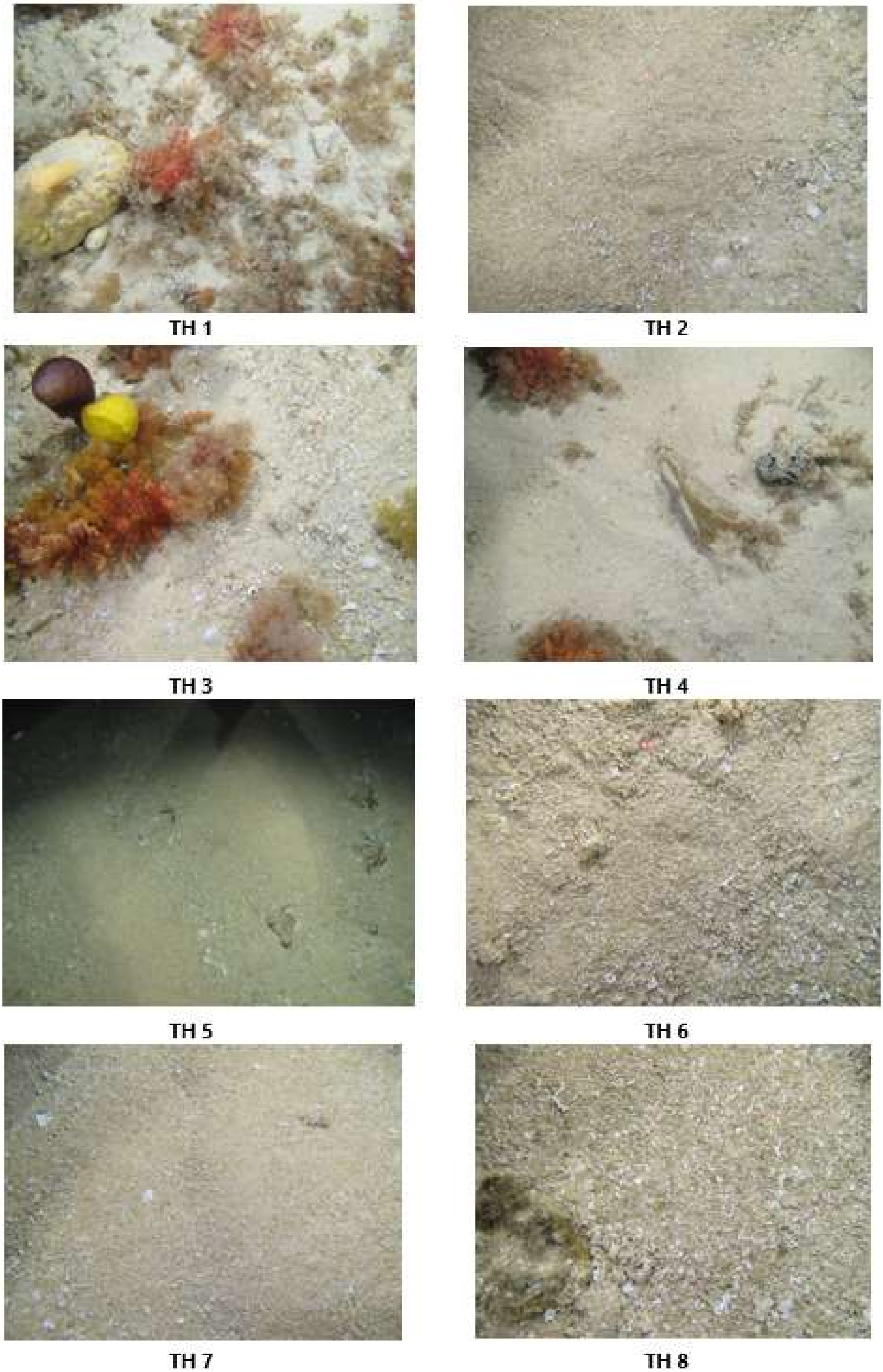


Figure 5-15: Drop camera images TH 1-8

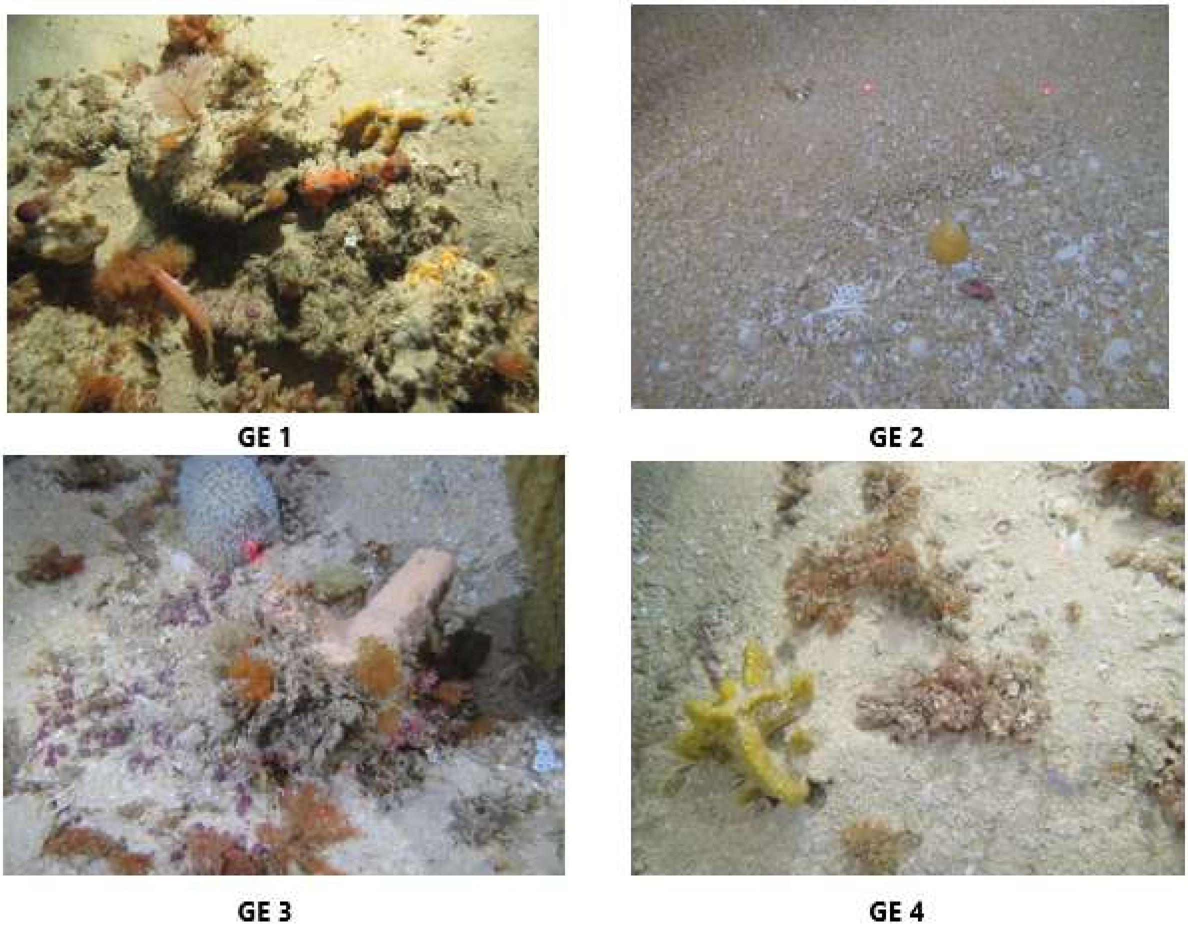


Figure 5-16: Drop camera images GE 1-4

5.5.4 Metocean conditions

5.5.4.1 Climate

The area is typical of a cool temperate region with cold, wet winters and warm dry summers. The regional climate is dominated by sub-tropical high-pressure systems in summer and sub-polar low pressure systems in winter. The conditions are primarily influenced by weather patterns originating in the Southern Ocean. The low-pressure systems are accompanied by strong westerly winds and rain-bearing cold fronts that move from south-west to north-east across the region, producing strong winds from the west, north-west and south-west.

The day-to-day variation in weather conditions is caused by the continual movement of the highs from west to east across the Australian continent roughly once every 10 days.

5.5.4.2 Winds

Bass Strait 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.

Winds in this section of the Otway basin and western Bass Strait generally exceed 13 knots (23.4 km/h) for 50% of the time. Winds contribute to the predominant moderate to high wave-energy environment of area and are predominantly south-westerly cycling to north-westerly. September is the windiest month, with average wind speeds of 29 km/h (Figure 5-17).

5.5.4.3 Tides

Tides are semi-diurnal with some diurnal inequalities (Jones and Padman, 1983), generating tidal currents along a north-east/south-west axis, with speeds generally ranging from 0.1 to 2.5 m/s (Fandry, 1983). The maximum range of spring tides in western Bass Strait is approximately 1.2 m. Sea level variation in the area can arise from storm surges and wave set up (Santos, 2004).

5.5.4.4 Ocean currents

The East Australian Current is one of the four major currents known to heavily influence on the conditions and biodiversity in Australian oceans and coastal environments. There are also a number of smaller and more complex current systems. All these ocean features can change from season to season, and may be more or less extensive and energetic, depending on climate factors.

Ocean currents in Bass Strait are primarily driven by tides, winds and density-driven flows (Figure 5-18). 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.

Furthermore, during winter, the Bass Strait cascade occurs, a wintertime downwelling caused by cooling of the shallow waters of Bass Strait in the Gippsland Basin. Downwelling currents that originate in the shallow eastern waters of Bass Strait flow down the continental slope to depths of several hundred meters or more into the Tasman Sea. Lateral flushing within the strait results from inflows from the South Australian Current, East Australian Current, and sub-Antarctic surface waters. The importance of this phenomenon is recognised through the designation of the seasonal Bass Cascade Key Ecological Feature.

Surface currents within the permit area have been modelled by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2009 – 2013 inclusive to produce monthly surface currents. These show a rotational aspect because of inflow and outflow to Bass Strait. Although unimodal the currents are stronger from the west in all months excepting February when the currents from the east are the strongest. Minimum currents have been derived as 0.2-0.4 m/s and maximum currents as 0.8-2.0 m/s, with the strongest currents during the months July to October.

5.5.4.5 Waves

Bass Strait is a high-energy environment exposed to frequent storms and significant wave heights. The Otway coast has a predominantly south-westerly aspect and is highly exposed to swell from the Southern Ocean.

There are two principal sources of wave energy in the Otway Basin:

1. from the westerly swell from the Great Australian Bight and Southern Ocean.

2. from locally generated winds, generally from the west and east.

The Otway area is fully exposed to long period 13 second average south-westerly swell from the Southern Ocean as well as periodic shorter 8 second average period waves from the east. Wave heights from these winds generally range from 1.5 m to 2 m, although waves heights to 10 m can occur during storm events and a combination of wind forcing against tidal currents can cause greater turbulence. The largest waves are associated with eastward-moving low pressure and frontal systems that cross the site every 4 to 6 days in winter.

5.5.4.6 Sea temperature

The waters have average surface temperatures ranging from 14°C in winter to 21°C in summer. However, subductions of cooler nutrient-rich water (upwellings) occur along the seafloor during mid to late summer, though this is usually masked in satellite images by a warmer surface layer.

The upwelled water 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, 2010).

During winter and spring onshore winds cycling from the southwest to northwest 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.

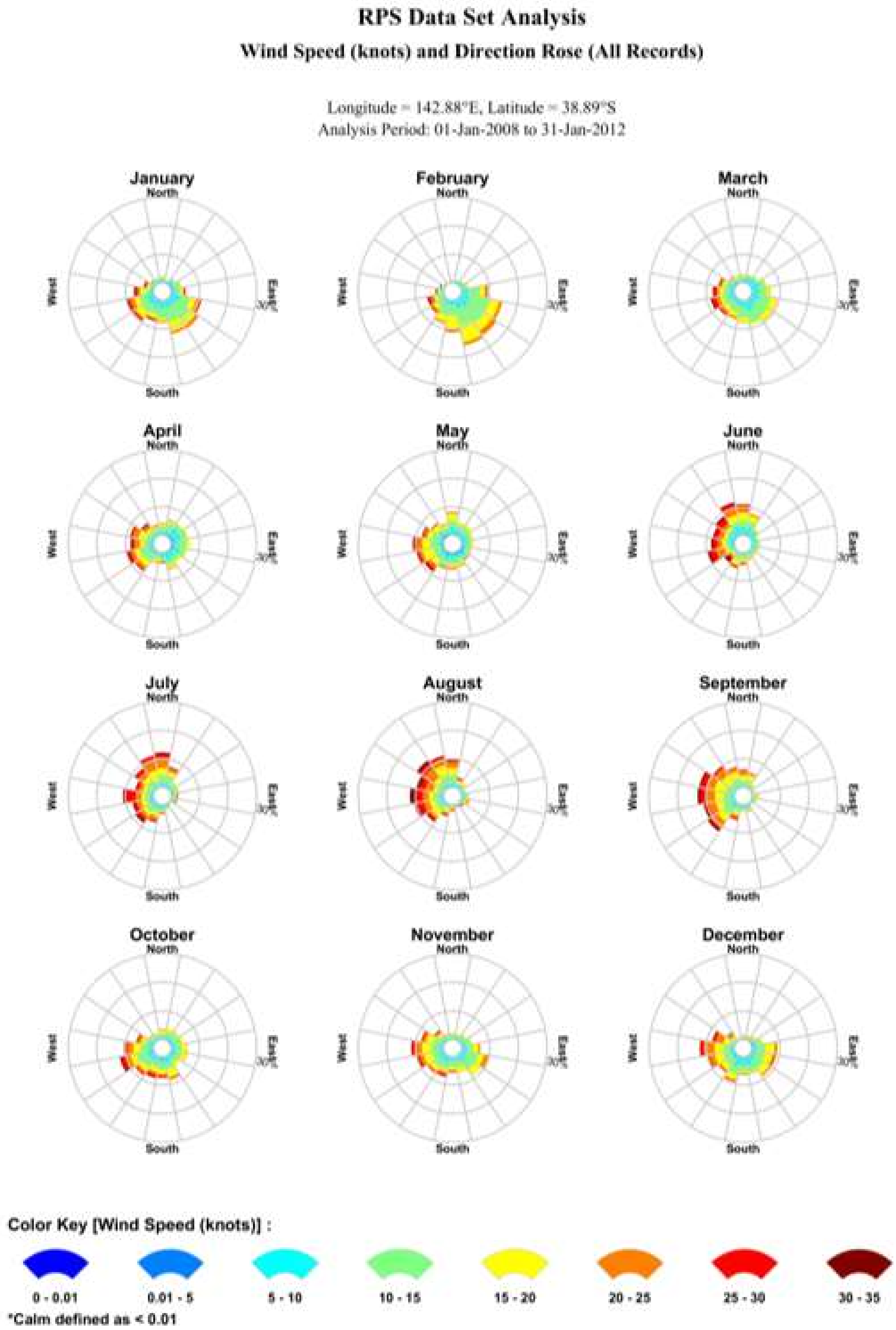


Figure 5-17: Modelled monthly wind rose distributions (RPS, 2019)

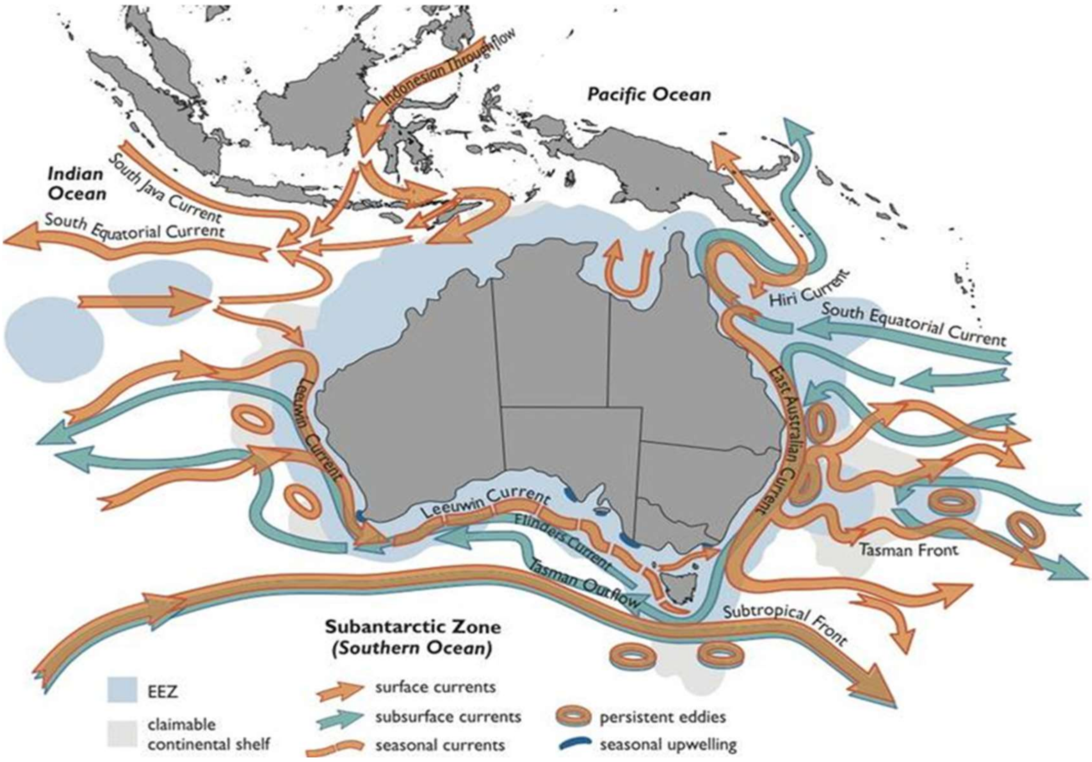


Figure 5-18: Australian ocean currents

5.5.5 Ambient sound levels

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.

In terms of monitoring work with the Otway and Bass Strait regions, 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 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.

The following features were noted with respect to underwater noise environment at the Thylacine location:

- the Thylacine site was 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.

The following features were noted with respect to underwater noise environment at the shipping lane location:

- 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 are 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.

5.5.6 Water quality

Marine water quality considers chemical, physical and biological characteristics with respect to its suitability to support marine life, or for a purpose such as swimming or fishing. Marine water quality can be measured by several factors, such as the concentration of dissolved oxygen (DO), the salinity, the amount of material suspended in the water (turbidity or total suspended solids) as well as the concentration of contaminants such as hydrocarbons and heavy metals.

The Otway Basin is characterised by high wave energy and cold temperature waters subject to upwelling events (Bonney coast upwelling) around the continental shelf margin (Origin, 2015). Significant upwelling of colder, nutrient rich deep water during summer can cause sea surface temperatures to decrease by 3°C compared with offshore waters (Butler et al., 2002).

The Bass Strait and Otway Basin are known for a complex, high energy wave climate and strong ocean currents (Origin, 2015), and therefore water column turbidity on the Victorian coastline is subject to high natural variability. Weather conditions in the coastal environment around Port Campbell and Port Ferry are known to influence offshore hydrodynamic conditions and are a driver of sediment dynamics, impacting benthic and pelagic habitats and changing water column turbidity. Wave-driven sediment resuspension generates high turbidity levels within coastal zones, commonly exceeding 50 mg/L (Larcombe et al. 1995, Whinney 2007, Browne et al., 2013), but coastal communities appear generally well adapted to deal with these extrinsic stresses.

An environmental survey was undertaken from November 2019 to January 2020 for the Otway Gas Development (Ramboll, 2020. Appendix E). Water samples were collected at two of the gas fields, Artisan and Thylacine. Due to poor weather conditions sampling had to be reduced. It was decided that the Artisan field would be representative of the water quality closer to shore and of the LaBella and Hercules fields, while the Thylacine field which is further offshore would represent the Geographe field.

Insitu measurements were taken for DO, pH and oxidation-reduction potential (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 (ANZECC, 2000). 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 compared to the ANZECC (2000) 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 the level of reporting (LOR) for all samples. Only one sample contained a concentration of nitrate-nitrite, NO_{-3}, TKN and TN above the LOR, 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 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 Zn against ANZECC protection level (or trigger values) 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 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 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.

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 operational area and spill EMBA 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.

5.5.7 Sediment quality

An environmental survey was undertaken from November 2019 to January 2020 for the Otway Gas Development (Ramboll, 2020. Appendix E). Sediment samples were collected at two of the gas fields, Artisan and Thylacine using a Double Van Veen grab sampler. Due to poor weather conditions sampling had to be reduced. It was decided that 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 Geographe field. Three replicate sediment samples were to be collected at each of the fields, 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 sediment within all samples and, therefore at both fields, 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 ORP or oxidation reduction potential 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 is 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 Interim Sediment Quality Guidelines 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.

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 operational area and spill EMBA will be typical of the offshore marine environment of the Otway Basin.

5.5.8 Air quality

Historical air quality data for the region is available from the Environment Protection Authority (EPA) Victoria air quality monitoring stations, and Cape Grim Baseline Air Pollution Station on Tasmania's west coast, which is one of the three premier baseline air pollution stations in the World Meteorological Organisation-Global Atmosphere Watch (WMO-GAW) network, measuring greenhouse and ozone depleting gases and aerosols in clean air environments.

The Victorian air quality data is collected at 15 performance monitoring stations representing predominantly urban and industrial environments in the Port Phillip and Latrobe Valley regions of Victoria. Results are assessed against the requirements of the National Environment Protection (Ambient Air Quality) Measure for the pollutants carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), lead (Pb), particles less than 10 micrometres in diameter (PM10) and particles less than 2.5 micrometres in diameter (PM2.5). The most recent annual air monitoring report shows Victoria's air quality in 2015 was generally good with AAQ NEPM (Ambient Air Quality National Environmental Protection Measure) goals and standards being met for carbon monoxide (CO), nitrogen dioxide (NO_2), Ozone (O_3) and sulphur dioxide (SO_2). There were some exceedances for particles.

The Geelong monitoring station is the closest to the operational area; however, it is situated in an urban environment and is not representative of the clean air environment over the majority of the EMBA. The Cape Grim Baseline Air Pollution Station data is likely a more reliable point of reference for air quality in the operational area and spill EMBA as the air sampled arrives at Cape Grim after long trajectories over the Southern Ocean and is representative of a large area unaffected by regional pollution sources (cities or industry) (CSIRO, 2017). The Cape Grim station monitors greenhouse gases (GHGs), including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and synthetic GHGs such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF6).

Historical air quality data from Cape Grim show that most GHGs have shown continuous increases in concentration since the mid-to-late 1970s with carbon dioxide levels increasing by more than 15% since 1976, and concentrations of methane and nitrous oxide increasing by around 20% and 8% respectively since 1978. The increase in methane levels however has slowed recently and CFCs and halons are in decline. Increases have been attributed to anthropogenic causes, for example, fossil fuel consumption and agricultural practices (CSIRO, 2017).

5.5.9 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 Ekman 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, 2002; Roughan et al., 2003; 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).

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.

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.

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 (BOM) 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. Given this, development of management strategies for petroleum activities in the area using prevailing climatic conditions as a predictor of seasonal blue whale abundance is not currently feasible.

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 operational area was unlikely with an upwelling frequency for this area of <10%. The closest areas of increased frequency of upwelling events to the operational area (10-30% occasional/semi-seasonal) were small isolated areas situated in coastal areas (Figure 5-19) >35 km from the Thylacine-A Wellhead Platform. Areas of further increased frequencies of Bonney coast upwellings (30-50% seasonal) were found to the west >235 km of the operational area.

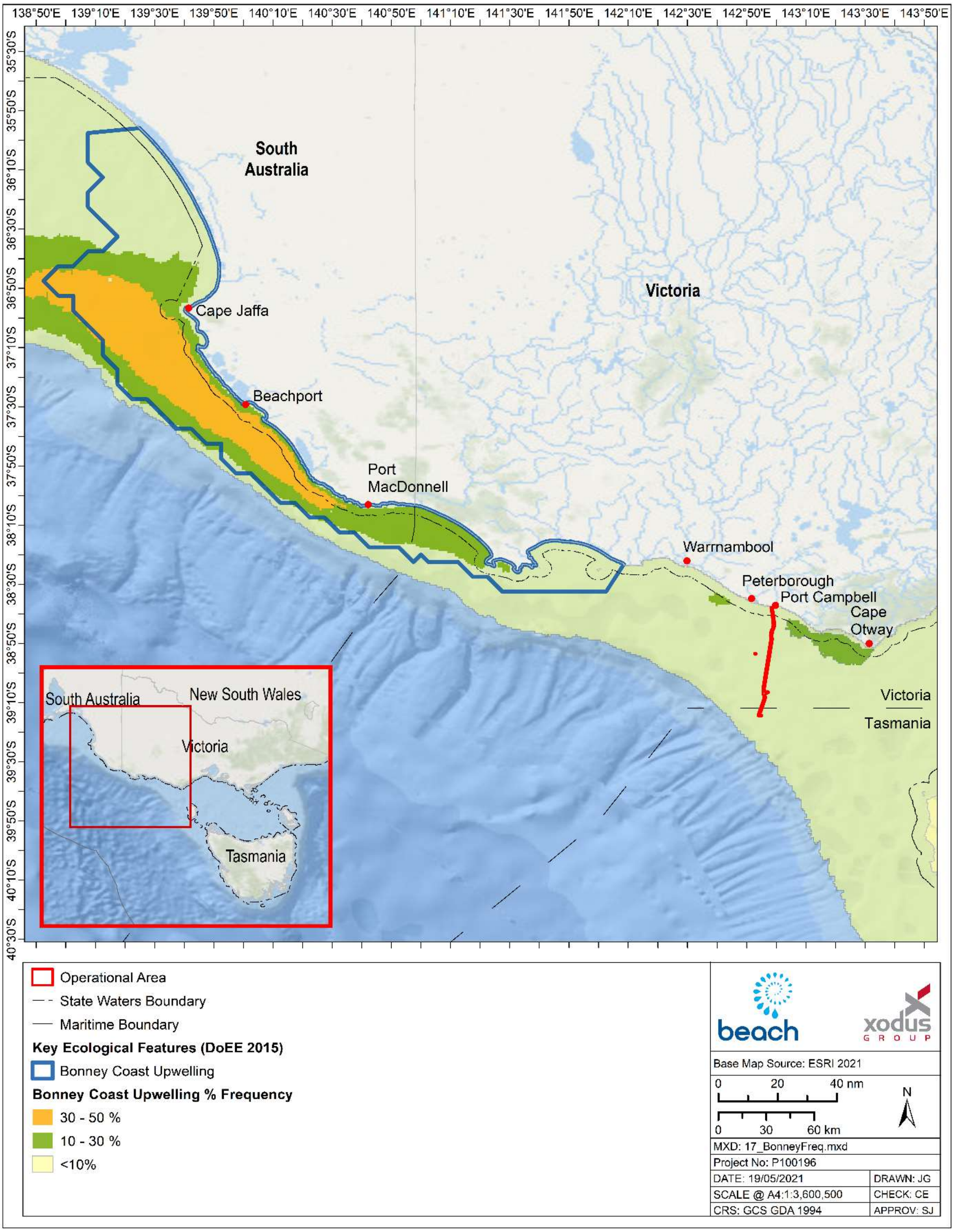


Figure 5-19: Bonney coast upwelling frequency (*Source: Huang and Wang 2019; Geoscience Australia 2020*).

5.6 Ecological environment

To characterise the ecological environment, a literature search and online resources and databases were reviewed to identify and assess flora and fauna species known to be present or potentially present in the operational area and spill EMBA. The following information sources were reviewed to assure consistency with previous assessments and to develop an up-to-date overview of the existing environment.

- online government databases, publications, and interactive mapping tools, such as the SPRAT database.
- the Protected Matters Search Tool (PMST) for Matters of National Environmental Significance (MNES) protected under the EPBC Act.
- 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.
- Woodside's Otway Gas Project Environmental Effects Statement/Environmental Impact Assessment (EES/EIS) (2003) (Woodside, 2003).
- Santos Casino Gas Field Development Environmental Report (2004) (Santos, 2004).
- BHP Billiton's Minerva Environmental Impact Statement and Environmental Effects Statement and Associated Supplemental Environmental Monitoring published research papers (BHP Billiton, 1999).
- Origin Energy's Environment Plans for previous activities in the region.
- the National Conservation Values Atlas.
- relevant listings under the Victorian FFG Act 1988 (DELWP, 2017b)
- relevant listings under the Tasmanian Threatened Species Conservation Act (1995) (TSC Act)
- relevant environmental guidelines and publicly available scientific literature on individual species.

5.6.1 Benthic habitats and species assemblages

Benthic communities are biological communities that live in or on the seabed. These communities typically contain light-dependent taxa such as algae, seagrass and corals, which obtain energy primarily from photosynthesis, and/or animals such as molluscs, sponges and worms. Benthic habitats are the seabed substrates that benthic communities grow on or in; these can range from unconsolidated sand to hard substrates (e.g. limestone) and occur either singly or in combination.

The Otway continental margin is a swell-dominated, open, cool-water carbonate platform which can be divided into depth-related zones (Figure 5-10, Boreen et al., 1993):

1. shallow shelf: consisting of exhumed limestone substrates that host encrusting mollusc, sponge, bryozoan and red algae assemblages.

2. middle shelf: a zone of swell wave shoaling and production of mega-rippled bryozoan sands.
3. deep shelf: accumulations of intensely bioturbated, fine bioclastic sands.
4. shelf edge/top of Slope: nutrient-rich upwelling currents support extensive, aphotic bryozoan/sponge/coral communities.

The dominant benthic habitat throughout the area, as indicated by the seabed and benthic habitat studies detailed in Section 5.5.2 and 5.5.3, is medium to coarse carbonate sands with areas of low relief exposed limestone. A series of basaltic rises occur in the south eastern corner of the spill EMBA. The benthic species assemblages known or likely to be associated with these habitats are described in the following sections.

5.6.1.1 Soft Sediment

Unvegetated soft sediments are a widespread habitat in both intertidal and subtidal areas, particularly in areas beyond the photic zone. Factors such as depth, light, temperature and the type of sediment present can vary the biodiversity and productivity of soft sediment habitat.

The Middle Otway Shelf (70-130 m depth) is a zone of large tracts of open sand with little or no epifauna to characterise the area: infaunal communities and bivalves, polychaetes and crustaceans dominate in the open sand habitat. The Deep Otway Shelf (130 – 180 m) sediments consist of accumulations of intensely bioturbated, fine, bio clastic sands. The Upper Slope of Otway Shelf (>180 m) incorporates the edge/ top of the shelf which displays nutrient-rich upwelling currents support extensive, aphotic bryozoan/sponge/coral communities. The upper slope is dominated by bioturbated mixture of periplatform bioclastic debris and pelleted foraminiferal/nannofossil mud. Turbidites and resedimentation features are common. Bioturbation and shelf-derived skeletal content decrease progressively downslope and pelagic muds dominate below 500 m.

Scientific surveys have shown that some shallow Victorian sandy environments have the highest levels of animal diversity in the sea ever recorded (Parks Victoria, 2016a). Some of the larger animals found in these soft sediment environments in Victoria include smooth stingray (*Dasyatis brevicaudata*), pipi (*Plebidonax deltoids*), dumpling squid (*Euprymna tasmanica*), common stargazer (*Kathetostoma leave*) and heart urchin (*Echinocardium cordatum*) (Parks Victoria, 2016a).

5.6.1.2 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). Known seagrass meadows within the spill EMBA include Corner Inlet, Port Phillip Bay and Western Port Bay. 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).

Within the spill EMBA, seagrass is present along the South Australian (SA) and Victorian coastline (Figure 5-20).

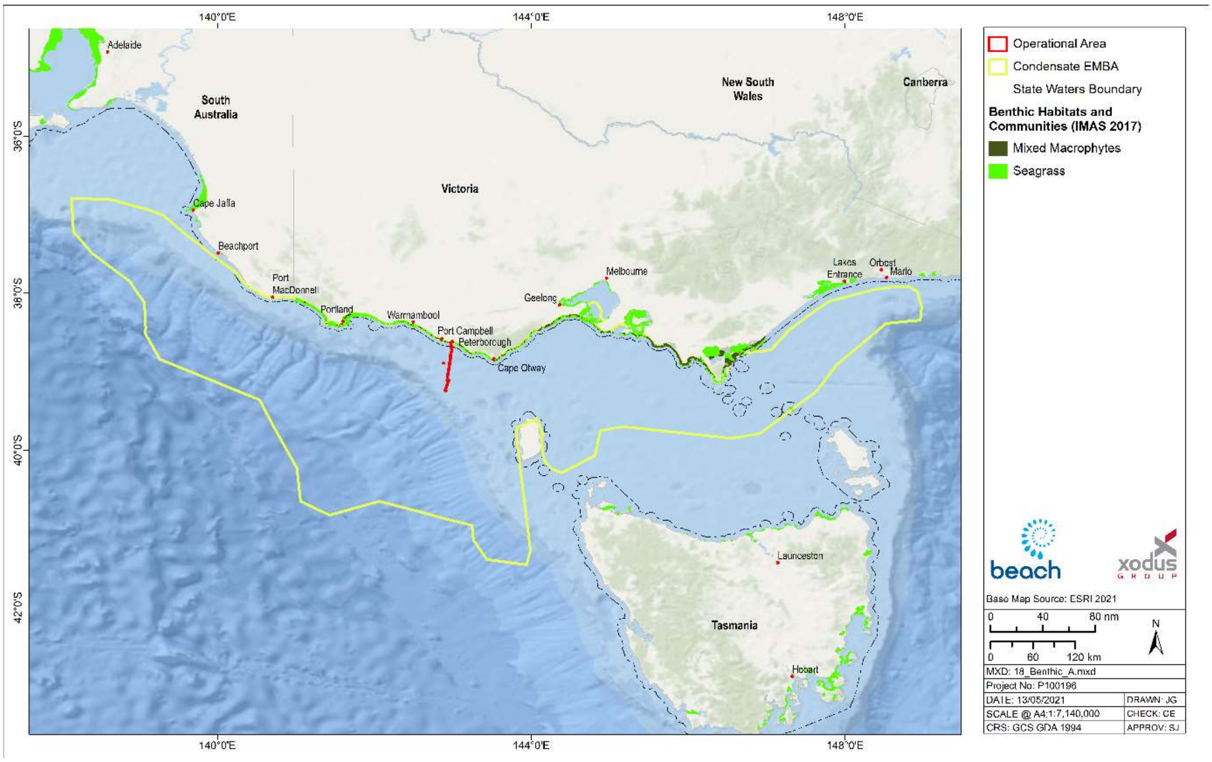


Figure 5-20: Presence of seagrass (and mixed macrophyte) habitat within the spill EMBA

5.6.1.3 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 gastropod 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 spill EMBA macroalgae is present along the South Australian (SA) and Victorian coastline from Beachport in SA to Philip Island (Figure 5-21).

5.6.1.4 Coral

Corals are generally divided into two broad groups: the zooxanthellate ('reef-building', 'hermatypic' or 'hard') corals, which contain symbiotic microalgae (zooxanthellae) that enhance growth and allow the coral to secrete large amounts of calcium carbonate; and the azooxanthellate ('ahermatypic' or 'soft') corals, which are generally smaller and often solitary (Tzioumis and Keable, 2007). Hard corals are generally found in shallower (<50 m) waters while the soft corals are found at most depths, particularly those below 50 m (Tzioumis and Keable, 2007).

Corals do not occur as a dominant habitat type within the operational area and spill EMBA, however, their presence has been recorded around areas such as Wilsons Promontory National Park and Cape Otway. Reef development by hard corals does not occur further south than Queensland (Tzioumis and Keable, 2007). Soft corals are typically present in deeper waters throughout the continental shelf, slope and off-slope regions, to well below the limit of light penetration.

Reproduction methods for cold water corals are not as well understood as warm water corals such as those of the Great Barrier Reef, but it is likely that some are still broadcast spawners (like their tropical counterparts), while others brood and release formed larvae (Roberts et al., 2009).

Figure 5-21: Presence of macroalgae (and mixed macrophyte) habitat within the spill EMBA

5.6.1.5 Carbonate sands and exposed limestone

Boreen et al., (1993) reported that carbonate sands in the Otway middle shelf support a benthic fauna dominated by bryozoans, infaunal echinoids and assemblages of sponges. Other components include bivalves (commonly *Mysella donaciformis* and *Legrandina bernardi*), *Chlamys* sp. scallops and small gastropods. The sand octopus (*Octopus kaurna*) also inhabits sandy sediments. This description is broadly supported by video footage of the Otway pipeline, which also indicates that hard substrates in mid shelf areas in the west of the operational support low to medium density sponge dominated communities.

Within the inner shelf, Boreen et al., (1993) reported that the benthic communities associated with hard limestone substrates were comprised of sponges, encrustlng and branching corailine algae, poysonellid algae, bryozoa, benthic forams, robust sarpullds, brachiopods, bivalves, gastropods, fleshy red algae and kelp.

A benthic survey of inner shelf sediments in the vicinity of the Minerva Gas Field development, found the seafloor was composed of course, well-sorted sand (Currie and Jenkins, 1994). This survey identified 196 species and a total of 5,035 individuals comprised of 63% crustaceans, 15% polychaetes, 8% molluscs and 5% echinoderms. The most abundant species were the bivalve *Katlysia* sp. (12.4 individuals/m^2), the sarconid *Triloculina affinis* (8.9 individuals/m^2), the tanaid isopod *Apsuedes* sp. (8.3 individuals/m^2) and the spionid polychaete *Prionospio coorilla* (4.8 individuals/m^2) (Currie, 1995).

Demersal fishes likely to be associated with carbonate sands on the middle and inner shelf include (LCC, 1993) eastern stargazer (*Kathetostoma laeve*), elephant shark (*Callorhynchus milli*), greenback flounder (*Rhombosolea taoarina*), gummy shark (*Mustelus antarcticus*), long-snouted flounder (*Ammotretis rostraus*), saw shark (*Pristiophorus nudipinnis*), southern sand flathead (*Platycephalus bassensis*) and southern school whiting (*Sillago bassensis*).

5.6.1.6 Basalt rises

There is no published information on the species assemblages of the basalt rises in the south east and east of the spill EMBA, other than general information on their importance as a southern rock lobster fishing area. Following the classification system of Hutchinson et al., (2010) these rises can be classified as deep reefs, defined as rocky habitat at depths greater than 20 m.

In general, deep reef biota is typified by invertebrate animals rather than algae, usually in the form of sessile, filter feeding fauna. Organisms such as sponges, octocorals, bryozoans and ascidians usually dominate rock faces on deep reefs (Hutchison et al., 2010). This is partly due to the ability of species such as sponges to survive in low light conditions that algae are unable to survive in. The most common algae present on deep reefs are encrusting coralline red algae which is able to tolerate low levels of penetrating light (Hutchison et al., 2010).

The distribution of fish fauna is governed by biologically formed habitat structure as well as by food. Fish assemblages typically begin to change at depths greater than 20 m, with the loss of the kelp-associated wrasses and leatherjackets, and the appearance of deeper water fishes such as boarfishes (family Pentacerotidae), splendid perch (*Callanthias australis*) and banded seaperch (*Hypoplectrodes nigroruber*). Schools of barber perch (*Caesioperca razor*) are replaced by the related butterfly perch (*Caesioperca lepidoptera*) (O'Hara et al., 1999). While fish present on shallow subtidal reefs include algavores, omnivores and carnivores, those on deep reefs are typically carnivorous as algae are typically not abundant at depth.

Although common on rocky reefs, sponges, hydrozoans, anthozoans, bryozoans, and ascidians are thought to be largely unpalatable to reef fish. It is therefore likely that fish at these depths are feeding on associated mobile invertebrate fauna. Edmunds et al. (2006) suggests that mobile invertebrate organisms play an ecologically significant role, providing food for carnivorous fishes on deep reefs in Port Phillip Bay, and are likely to include a variety of crustaceans and molluscs.

Information from the few specific studies of specific deep reef habitats in Bass Strait can be assessed to draw broad conclusions about the species assemblages likely to occur on the basalt rises, noting that assemblages of reef species are likely to differ based on geology, habitat structure, exposure to tidal and wave motion and nutrient availability. These studies are generally limited to one off video surveys with little or no temporal replication. More generally little is known about deep reefs in the Bass Strait, or the biology and ecology of organisms that live on them, due in part to difficulties associated with conducting observational work or manipulative experiments in situ.

Beaman et al. (2005) undertook video surveys of the New Zealand Star Bank in the eastern Bass Strait, approximately 600 km east of the operational area. This feature is comprised of granite outcrops between approximately 30 to 40 m water depth, rising from the surrounding relatively flat seabed of mainly unconsolidated quartz sands with variable amounts of shell debris.

Underwater video footage revealed a structurally complex surface of crevices and steep slopes, which is densely covered in erect large and small sponges and encrusting calcareous red algae. Encrusting red algae are usually the greatest occupier of space due to tolerance of low light conditions (< 1% of surface) found at these depths (Andrew, 1999). Mobile benthos observed were crinoids within crevices and the black sea urchin (*Centrostephanus rodgersii*) in low numbers on high slope surfaces and dense encrustations on low relief lower slopes. Underwater video showed a draughtboard shark (*Cephaloscyllium laticeps*) cruising above the crevices of high-relief granite outcrop as well as schools of butterfly perch feeding on plankton in the water column above the bank (Andrew, 1999).

This study demonstrated a significant difference between communities that live on hard-ground granite outcrops of the New Zealand Star Bank and those which exist on soft substrate surrounding the rocky bank. These granite outcrops support a diverse sessile fauna of large and small sponges, bryozoans, hydroids and ascidians which prefer stable attachment surfaces (Underwood et al., 1991; Andrew 1999; Andrew and O'Neill, 2000). It is likely that similar species assemblages occur within the spill EMBA between the flat carbonate sands of the seabed and the basalt rises.

Edmunds et al. (2006) investigated assemblages of benthic fauna at near shore deep reefs within Central Victoria (Point Addis and Wilsons Promontory) and Port Phillip Bay. The Port Phillip Bay deep reef assemblages were dominated by sponges, occupying 70 to 90% of the rocky substratum. The Point Addis assemblage was dominated by upright sponges (arborescent, massive and flabellate growth forms), but cnidarians including hydroids were entirely absent. Wilson’s Promontory had a low coverage of encrusting sponges and hydroids, with high abundances of red and brown algae and the gorgonian fan *Pteronisis* sp. The Port Phillip Heads assemblage was dominated by encrusting sponges, hydroids, ascidians and bryozoans.

In summary, the species assemblages associated with the basalt rises in the south-east and east of the spill EMBA are likely to be significantly different to the species assemblages of the surrounding flat seabed supporting carbonate sands. The depth of the basalt rises is likely to preclude significantly algal growth, with red algae likely to be most abundant. Sponges, hydrozoans, anthozoans, bryozoans, and ascidians are likely to occur though the relative abundances of these groups are not known. Targeting of the rises for rock lobster fishing indicates presence of this species in relatively high densities. The trophic effects of long term targeting of this species at these rises is not known. Site attached fishes are not likely to include kelp-associated wrasses and leatherjackets. Further statements cannot be made with sufficient confidence as site specific data for these rises are not available.

5.6.2 Mangroves

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 within the spill EMBA. (Figure 5-22).

Figure 5-22: Presence of mangrove habitat within the spill EMBA.

5.6.3 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 (Figure 5-23) (Boon et al., 2011).

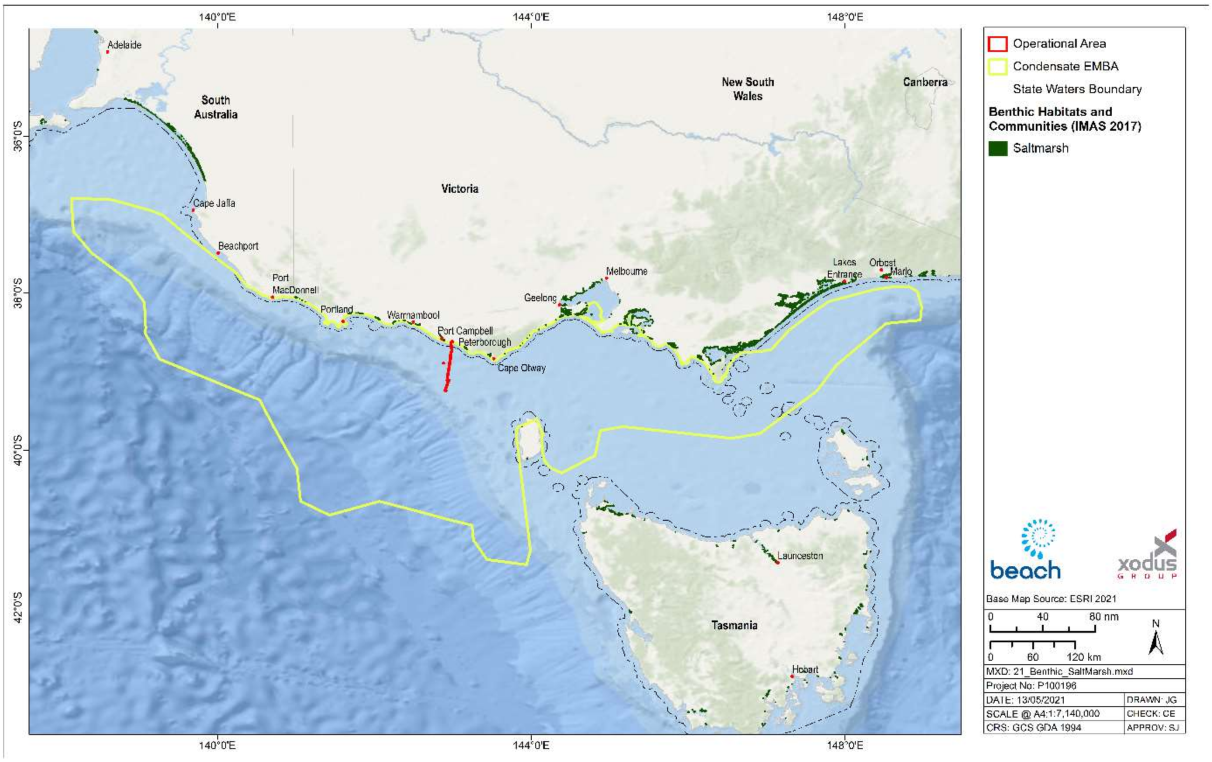


Figure 5-23: Presence of saltmarsh habitat within the spill EMBA

5.6.4 Plankton

Plankton species are the key component of the food web and support nearly all marine life. Copepods are the most common zooplankton and are some of the most abundant animals on earth. Plankton communities are highly diverse, with members from almost all phyla. Phytoplankton are photosynthetic organisms that drift with ocean currents and are mostly microscopic; however, some gelatinous plankton can be up to 2 m in diameter. Phytoplankton is grazed by zooplankton such as small protozoa, copepods, decapods, krill and gelatinous zooplankton.

The carrying capacity of marine ecosystems (the mass of fish resources) and recruitment of individual stocks is strongly related to plankton abundance, timing and composition. In the spill EMBA, the seasonal Bonney coast upwelling is a productivity hotspot, with high densities of zooplankton and are important for fish and whales. Of importance in the region is the coastal krill, *Nyctiphanes australis*, which swarms throughout the water column of continental shelf waters primarily in summer and autumn, feeding on microalgae and providing an important link in the blue whale food chain. The fisheries in this region account for half of Australia's total annual catch and the main fishery in the region is sardine, which feeds on plankton, which illustrates the interdependence of the fishing industry on plankton.

There have been relatively few studies of plankton populations in the Otway and Bass Strait regions, with most concentrating on zooplankton. Watson and Chaloupka (1982) reported a high diversity of zooplankton in eastern Bass Strait, with over 170 species recorded. However, Kimmerer and McKinnon (1984) reported only 80 species in their surveys of western and central Bass Strait.

Plankton distribution is dependent upon prevailing ocean currents including the East Australia Current, flows into and from Bass Strait and Southern Ocean water masses. Plankton distribution in the spill

EMBA 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.

5.6.5 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 habits support a range of animal communities such as sparse sponges to extensive 'thickets" of lace corals and sponges, polychaete worms and filter feeders (Director of National Parks, 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.

5.6.6 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). The spill EMBA PMST Report (Appendix A) identified the following TECs:

- 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.
- grassy eucalypt woodland of the Victorian Volcanic Plain.
- natural damp grassland of the Victorian Coastal Plains.
- natural temperate grassland of the Victorian Volcanic Plain.
- subtropical and temperate coastal saltmarsh.

- Tasmanian forests and woodlands dominated by black gum or Brookers fum (Eucalyptus ovata/ E. brookeriana).
- white box-yellow box-Blakely's red gum grassy woodland and derived native grassland.

Of the TECs listed above, only the assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community, the giant kelp marine forests of South East Australia and the subtropical and temperate coastal saltmarsh are marine/coastal features; the rest are terrestrial listings (Figure 5-24). No Threatened Ecological Communities were identified within the operational area.

5.6.6.1 Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community

This ecological community 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 ecological community 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 ecological community 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 (e.g. reproduction, feeding, refuge, migration) (TSSC, 2018).

5.6.6.2 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, 2012).

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 DoE, 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 5-24 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 (0.2 ha) of rocky reef (Barton et al., 2012).

5.6.6.3 Subtropical and Temperate Coastal Saltmarsh

The Subtropical and Temperate Coastal Saltmarsh 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 (Threatened Species Scientific Committee, 2013). The community is found in coastal areas which have an intermittent or regular tidal influence. Figure 5-24 shows that from Corner Inlet to Marlo there is a substantial amount of subtropical and temperate coastal saltmarsh along the Victorian coastline.

The coastal saltmarsh 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 saltmarsh community 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 coastal saltmarsh community 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, the 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.

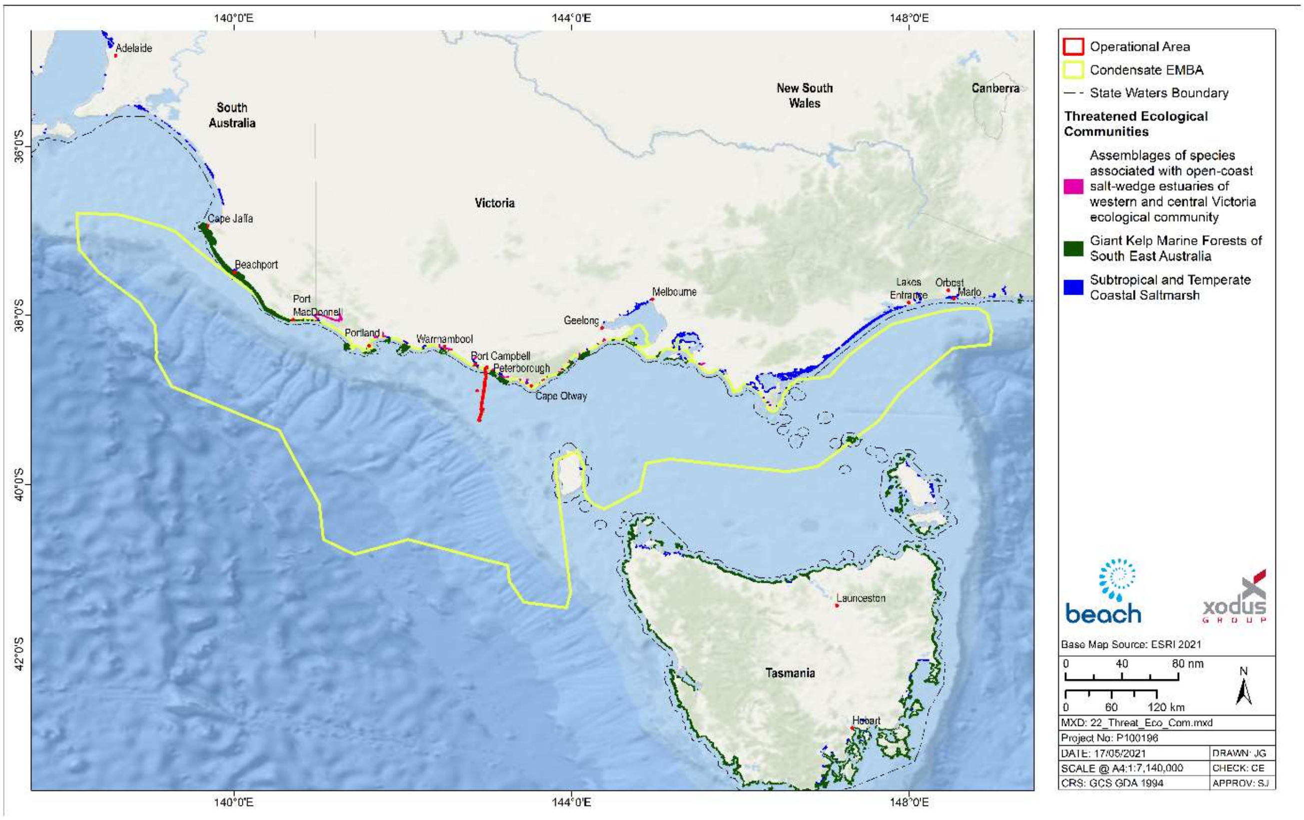


Figure 5-24: Threatened ecological communities within the spill EMBA

5.6.7 Threatened and Migratory species

PMST reports were generated for the operational area and spill EMBA to identify the listed Threatened and Migratory species that may be present (Appendix A). The spill EMBA encompasses the smaller operational area.

A total of 36 Threatened species and 41 Migratory species were identified as potentially occurring within the operational area. There were also 131 marine species and 32 cetaceans identified as potentially occurring within the spill EMBA.

5.6.7.1 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 operational area or spill EMBA are provided in the following sections.

For the purpose of the EP, only species listed as threatened or migratory under the EPBC Act likely to occur in the operational area or spill EMBA are considered to have conservation significance warranting further discussion. Likely occurrence was determined by the PMST report or through designation of important habitat (e.g. BIA).

5.6.7.2 Biologically Important Areas and Critical Habitat to the survival of the species

Biologically Important Areas (BIAs) are areas that are particularly important for the conservation of protected species and where aggregations of individuals 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.

There is no habitat critical to the survival of listed species within the operational area or spill EMBA. BIAs within the operational area and spill EMBA are summarised in Table 5-9 with further details in the relevant species sections.

Table 5-9: BIAs identified within the operational area and spill EMBA

Receptor	Operational area (500 m)	Spill EMBA	Type of BIA
Birds			
Antipodean albatross	Overlap	Overlap	Foraging
Australasian gannet	>80 km	Overlap	Foraging
	>115 km	Overlap	Aggregation
Black-browed albatross	Overlap	Overlap	Foraging
Black-faced Cormorant	>90 km	Overlap	Breeding
	>80 km	Overlap	Foraging
Buller's albatross	Overlap	Overlap	Foraging
Campbell albatross	Overlap	Overlap	Foraging
Common diving-petrel	Overlap	Overlap	Foraging
	>85 km	Overlap	Breeding
Indian yellow-nosed albatross	Overlap	Overlap	Foraging
Little penguin	>80 km	Overlap	Foraging
	>90 km	Overlap	Breeding
Shy albatross	Overlap	Overlap	Foraging
Wandering albatross	Overlap	Overlap	Foraging
Wedge-tailed shearwater	Overlap	Overlap	Foraging
	>7 km	Overlap	Breeding
White-faced storm petrel	>50 km	Overlap	Foraging
	160 km	Overlap	Breeding
Fish			
White shark	Overlap	Overlap	Distribution
	>278 km	Overlap	Breeding
	>55 km	Overlap	Foraging
Pinnipeds			
Australian sea lion	>275 km	Overlap	Foraging
Cetaceans			
Southern right whale	>20 km	Overlap	Aggregation
	Overlap	Overlap	Migration and resting on migration
	Overlap	Overlap	Known core coastal range
	90 km	Overlap	Connecting habitat
Blue and Pygmy blue whale	180 km	Overlap	Possible Foraging Area
	Overlap	Overlap	Foraging (annual high use area)

Receptor	Operational area (500 m)	Spill EMBA	Type of BIA
	>45 km	Overlap	Known Foraging Area
	Overlap	Overlap	Distribution

5.6.7.3 Fish

Fish species present in the operational area or spill EMBA are either pelagic (living in the water column), or demersal (benthic). Fish species inhabiting the region are largely cool temperate species, common within the SEMR. The spill EMBA PMST report (Appendix A.1) identified 39 listed fish species that potentially occur in the spill EMBA. Table 5-10 details the listed fish species identified in the spill EMBA and operational area PMST report (Appendix A.2).

Threatened or migratory species that are likely or known to occur in the area or have an intercepting BIA with the operational area and spill EMBA are discussed in more detail.

Table 5-10: Listed fish species identified in the PMST report

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (500 m)
		Listed Threatened	Listed Migratory	Listed marine		
Fish						
Australian grayling	*Prototroctes maraena*	V	-	-	SHK	SHL
Whale shark	*Rhincodon typus*	V	M	-	SHM	
Sharks and rays						
Porbeagle, mackerel shark	*Lamna nasus*	-	M	-	SHL	SHL
Shortfin mako	*Isurus oxyrinchus*	-	M	-	SHL	SHL
White shark	*Carcharodon carcharias*	V	M	-	BK	SHK
Oceanic whitetip shark	*Carcharhinus longimanus*	-	-	L	SHM	
Pipefish, seahorse, seadragons						
Australian long-snout pipefish	*Vanacampus poecilolaemus*	-	-	L	SHM	SHM
Australian smooth pipefish	*Lissocampus caudalis*	-	-	L	SHM	SHM
Bigbelly seahorse	*Hippocampus abdominalis*	-	-	L	SHM	SHM
Black pipefish	*Stigmatopora nigra*	-	-	L	SHM	SHM
Briggs' crested pipefish	*Histiogamphelus briggsii*	-	-	L	SHM	SHM
Brushtail pipefish	*Leptoichthys fistularius*	-	-	L	SHM	SHM
Bullneck Seahorse	*Hippocampus minotaur*	-	-	L	SHM	
Common seadragon	*Phyllopteryx taeniolatus*	-	-	L	SHM	SHM

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (500 m)
		Listed Threatened	Listed Migratory	Listed marine		
Deep-bodied pipefish	*Kaupus costatus*	-	-	L	SHM	SHM
Double-end pipehorse	*Syngnathoides biaculeatus*	-	-	L	SHM	
Hairy pipefish	*Urocampus carinirostris*	-	-	L	SHM	SHM
Half-banded pipefish	*Mitotichthys semistriatus*	-	-	L	SHM	SHM
Javelin pipefish	*Lissocampus runa*	-	-	L	SHM	SHM
Knife-snouted pipefish	*Hypselognathus rostratus*	-	-	L	SHM	SHM
Leafy seadragon	*Phycodurus eques*	-	-	L	SHM	SHM
Mollison's pipefish	*Mitotichthys mollisoni*	-	-	L	SHM	
Mother-of-pearl pipefish	*Vanacampus margaritifer*	-	-	L	SHM	SHM
Port Phillip pipefish	*Vanacampus phillipi*	-	-	L	SHM	SHM
Pug-nosed pipefish	*Pugnaso curtirostris*	-	-	L	SHM	SHM
Red pipefish	*Notiocampus ruber*	-	-	L	SHM	SHM
Rhino pipefish	*Histiogamphelus cristatus*	-	-	L	SHM	SHM
Ring-backed pipefish	*Stipecampus cristatus*	-	-	L	SHM	SHM
Robust pipehorse	*Solegnathus robustus*	-	-	L	SHM	SHM
Sawtooth pipefish	*Maroubra perserrata*	-	-	L	SHM	SHM
Short-head seahorse	*Hippocampus breviceps*	-	-	L	SHM	SHM
Southern pygmy pipehorse	*Acentronura austral*	-	-	L	SHM	
Spiny pipehorse	*Solegnathus spinosissimus*	-	-	L	SHM	SHM

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (500 m)
		Listed Threatened	Listed Migratory	Listed marine		
Spotted pipefish	*Stigmatopora argus*	-	-	L	SHM	SHM
Trawl pipefish	*Kimblaeus bassensis*	-	-	L	SHM	
Tryon's pipefish	*Campichthys tryoni*	-	-	L	SHM	
Tucker's pipefish	*Mitotichthys tuckeri*	-	-	L	SHM	SHM
Upside-down pipefish	*Heraldia nocturna*	-	-	L	SHM	SHM
Verco's pipefish	*Vanacampus vercoi*	-	-	L	SHM	

Listed Threatened	Likely Presence
V: Vulnerable	SHM: Species or species habitat may occur within area.
Listed Migratory	SHL: Species or species habitat likely to occur within area.
M: Migratory	SHK: Species or species habitat known to occur within area.
Listed Marine	BK: Breeding known to occur within area.
L: Listed	

^ The type of presence may vary between the different areas; e.g. an important behaviour (e.g. foraging, breeding) may be present in the spill EMBA, but not present in the other smaller EMBAs or operational area.

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 NSW, Victoria and Tasmania, migrating between streams and the ocean. Spawning occurs in freshwater, with timing dependant on many variables including latitude and temperature regimes. Most of its life is spent in fresh water, with parts of the larval or juvenile stages spent in coastal marine waters (Department of Sustainability and Environment, 2008a), though its precise marine habitat requirements remain unknown (Department of Sustainability and Environment, 2008b). They are a short-lived species, usually dying after their second year soon after spawning (a small proportion may reach four or five years) (Department of Sustainability and Environment, 2008a).

The Australian grayling has been recorded from the Gellibrand River (Department of Sustainability and Environment, 2008b), making it likely that it occurs in coastal waters. As marine waters are not part of the species' spawning grounds, the spill EMBA is not likely to represent critical habitat for the species.

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 spill EMBA in low numbers.

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 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 (GAB) between 2008 and 2011 investigated habitat and migration patterns. It revealed GAB and south east of Kangaroo Island near the norther extent of the Bonney coast upwelling region, to be areas of highest fidelity and indicating critical habitats for juvenile shortfin mako (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 sharks were also analysed from specimens collected by game fishing competitors in Port Mac Donnell, South Australia and Portland, Victoria from 2008 and 2010 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 operational area and spill EMBA in low numbers.

Syngnathids

All of the marine ray-finned fish species identified in the EPBC PMST Report are syngnathids, which includes seahorses and their relatives (sea dragon, pipehorse and pipefish). The majority of these fish 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 33 species of syngnathids identified in the EPBC PMST Report, only one (*Hippocampus abdominalis*, big-belly seahorse) 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 syngnathid species listed in the spill EMBA are widely distributed throughout southern, south-eastern and south-western Australian waters.

Whale shark

The whale shark (*Rhincodon typus*) is most commonly seen in waters off Western Australia, Northern Territory and Queensland however is occasionally seen off Victoria and South Australia (DoE, 2017w). It is generally found in areas where the surface temperature is 21–25 °C, preferably with cold water of 17 °C or less upwelling into it. It is generally observed singularly at the surface but can occasionally be in schools or aggregations of up to hundreds of sharks (Compagno, 1984). The whale shark is a suction filter feeder and feeds on a variety of planktonic and nektonic prey, including small crustaceans, small schooling fishes and, to a lesser extent, on small tuna and squid. The whale shark (Rhincodon typus) is listed as Vulnerable and Migratory under the EPBC Act (TSSC, 2015b) and is not likely to occur in the operational area but may be present in the spill EMBA in low numbers.

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 including all coastal areas except the Northern Territory (DotEE, 2010). Studies of white sharks indicate that they are largely transient. However, individuals are known to return to feeding grounds on a seasonal basis (Klimley and Anderson, 1996). In the Australasian region, white sharks differ genetically from other populations and data suggest there are two populations in southern Australia east and west by 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− spring (June−November) and southern region during summer−autumn (December−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 spill EMBA and operational area (Figure 5-25). 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 New South Wales (NSW). They are more likely to be found between the 60–120 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 are present in the spill EMBA.

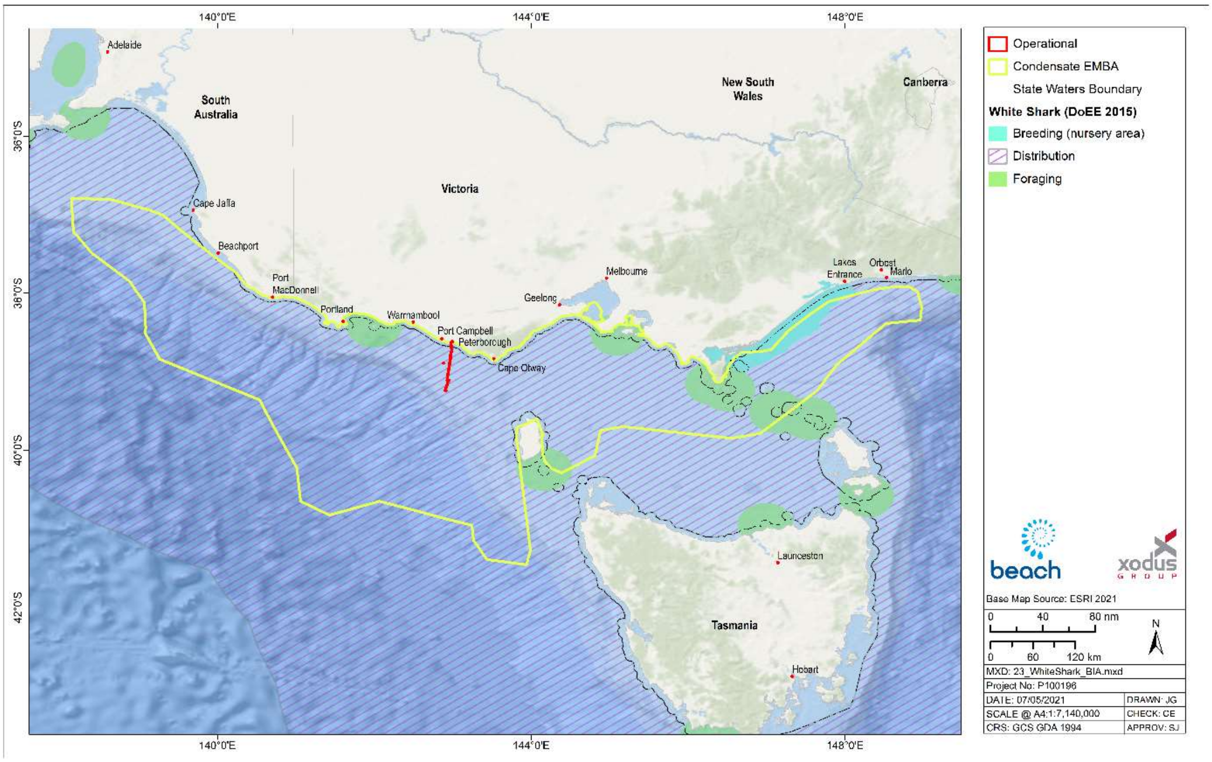


Figure 5-25: BIAs for the white shark within the spill EMBA

5.6.7.4 Birds

A diverse array of seabirds and terrestrial birds utilise the Otway region and may potentially forage within or fly over the operational area and spill EMBA, resting on islands during their migration. Infrequently and often associated with storm events, birds that do not normally cross the ocean are sometimes observed over the Otway shelf, suggesting the birds have been blown off their normal course or are migrating.

Bird species listed in the PMST reports, as possibly or known to occur in the operational area and spill EMBA (this includes species or species habitat), are shown in Table 5-11. Threatened or migratory species that are likely or known to occur in the area or have an intercepting BIA with the operational area and spill EMBA are discussed in more detail.

Table 5-11: Listed bird species identified in the PMST report

* species BIA identified see Section 5.6.7.2 and Table 5-9 for information as to which species have identified BIAs within the operational area and spill EMBA

Common name	Species name	EPBC Act status			LOC Spill EMBA	Operational area (500 m)
		Listed Threatened	Listed Migratory	Listed marine		
Albatrosses						
Antipodean albatross*	*Diomedea antipodensis*	V	M	L	FL	FL
Black-browed albatross*	*Thalassarche melanophris*	V	M	L	FL	FL
Buller's albatross*	*Thalassarche bulleri*	V	M	L	FL	FL
Campbell albatross*	*Thalassarche impavida*	V	M	L	FL	FL
Chatham albatross	*Thalassarche eremita*	E	M	L	FL	
Gibson's albatross	*Diomedea antipodensis gibsoni* *Diomedea gibsoni*	V	-	L	FL	
Grey-headed albatross	*Thalassarche chrysostoma*	E	M	L	SHM	SHM
Northern buller's albatross	*Thalassarche bulleri platei*	V	-	-	FL	FL
Northern royal albatross	*Diomedea sanfordi*	E	M	L	FL	FL
Pacific albatross	*Thalassarche sp. nov.*	V	-	L	FL	FL
Salvin's albatross	*Thalassarche salvini*	V	M	L	FL	FL
Shy albatross*	*Thalassarche cauta*	E	M	L	FL	FL
Sooty albatross	*Phoebetris fusca*	V	M	L	SHL	SHL
Southern royal albatross	*Diomedea epomophora*	V	M	L	FL	FL

Common name	Species name	EPBC Act status			LOC Spill EMBA	Operational area (500 m)
		Listed Threatened	Listed Migratory	Listed marine		
Wandering albatross*	*Diomedea exulans*	V	M	L	FL	FL
White-capped albatross	*Thalassarche steadi*	V	M	L	FL	FL
Shearwaters						
Flesh-footed shearwater	*Ardenna carneipes*	-	M	L	SHK	FL
Short-tailed shearwater*	*Ardenna tenuirostris* *Puffinus tenuirostris*	-	M	L	BK	
Sooty shearwater	*Ardenna grisea* *Puffinus griseus*	-	M	L	SHM	SHM
Petrels						
Blue petrel	*Halobaena caerulea*	V	-	L	SHM	SHM
Common diving petrel*	*Pelecanoides urinatrix*	-	-	L	BK	
Gould's petrel	*Pterodroma leucoptera*	E	-	-	SHM	SHM
Great-winged petrel	*Pterodroma macroptera*	-	-	L	FK	
Northern giant-petrel	*Macronectes halli*	V	M	L	SHM	SHM
Soft-plumaged petrel	*Pterodroma mollis*	V	-	L	FL	SHM
Southern giant-petrel	*Macronectes giganteus*	E	M	L	FL	SHM
White-bellied storm-petrel	*Fregetta grallaria grallaria*	V	-	-	BK	
White-faced storm petrel*	*Pelagodroma marina*	-	-	L	BK	
Other						
Australasian bittern	*Botaurus poiciloptilus*	E	-	-	SHK	
Australasian gannet*	*Morus serrator*	-	-	L	BK	

Common name	Species name	EPBC Act status			LOC Spill EMBA	Operational area (500 m)
		Listed Threatened	Listed Migratory	Listed marine		
Australian fairy tern	*Sternula nereis nereis*	V	-	-	SHK	FL
Australian painted-snipe	*Rostratula australis*	E	-	-	SHK	
Bar-tailed godwit	*Limosa lapponica*	-	W	L	SHK	SHL
Black currawong	*Strepera fuliginosa colei*	V	-	-	BL	
Black-eared cuckoo	*Chrysococcyx osculans*	-	-	L	SHK	
Black-faced cormorant*	*Phalacrocorax fuscescens*	-	-	L	BK	
Black-faced monarch	*Monarcha melanopsis*	-	T	L	SHK	
Black-tailed godwit	*Limosa limosa*	-	W	L	RK	
Broad-billed sandpiper	*Limicola falcinellus*	-	W	L	RK	
Cape gannet	*Morus capensis*	-	-	L	BK	
Caspian tern	*Hydroprogne caspia* *Sterna caspia*	-	M	L	BK	
Cattle egret	*Bubulcus ibis*	-	-	L	SHM	
Common greenshank	*Tringa nebularia*	-	W	L	SHK	
Common noddy	*Anous stolidus*	-	M	L	SHL	
Common sandpiper	*Actitius hypoleucos*	-	W	L	SHK	SHM
Crested tern	*Thalasseus bergii* *Sterna bergii*	-	W	L	BK	
Curlew sandpiper	*Calidris ferruginea*	CE	W	L	SHK	SHM
Double-banded plover	*Charadrius bicinctus*	-	W	L	RK	
Eastern curlew	*Numenius madagacariensis*	CE	W	L	SHK	SHM

Common name	Species name	EPBC Act status			LOC Spill EMBA	Operational area (500 m)
		Listed Threatened	Listed Migratory	Listed marine		
Eastern hooded plover	*Thinornis cucullatus cucullatus*	V	-	L	SHK	SHL
Fairy prion	*Pachyptila turtur*	-	-	L	SHK	SHK
Fairy prion (southern)	*Pachyptila turtur subantarctica*	V	-	-	SHK	SHK
Fairy tern	*Sterna nereis*	-	-	L	BK	
Fork-tailed swift	*Apus pacificus*	-	M	L	SHL	SHL
Great knot	*Calidris tenuirostris*	CE	W	L	RK	
Great skua	*Catharacta skua*	-	-	L	SHM	SHM
Greater sand plover	*Charadrius leschenaultii*	V	W	L	RK	
Green rosella *King Island)	*Platycercus caledonicus brownie*	V	-	-	SHL	
Grey falcon	*Falco hypoleucos*	V	-	-	SHL	
Grey plover	*Pluvialis squatarola*	-	W	L	RK	
Grey-tailed tattler	*Heteroscelus brevipes*	-	W	-	RK	
Hooded plover	*Thinornis rubricollis*		-	L	SHK	SHM
Hooded plover (eastern)	*Thinornis cucullatus cucullatus* *Thinornis rubricollis rubricollis*	V	-	L	SHK	SHL
Kelp gull	*Larus dominicanus*	-	-	L	BK	
King Island brown thornbill	*Acanthiza pusilla archibaldi*	E	-	-	SHL	
King Island scrubtit	*Acanthornis magna greeniana*	CE	-	-	SHK	
Latham's snipe	*Gallinago hardwickii*	-	W	L	SHK	

Common name	Species name	EPBC Act status			LOC Spill EMBA	Operational area (500 m)
		Listed Threatened	Listed Migratory	Listed marine		
Lesser sand plover	*Charadrius mongolus*	E	W	L	RK	
Little curlew	*Numenius minutus*	-	W	L	RL	
Little penguin*	*Eudyptula minor*	-	-	L	BK	
Little tern	*Sternula albifrons*	-	M	L	BK	SHM
Magpie Goose	*Anseranas semipalmata*	-	-	L	SHM	
Marsh sandpiper	*Tringa stagnatilis*	-	W	L	RK	
Nunivak bar-tailed godwit	*Limosa lapponica baueri*	V	-	-	SHK	SHM
Orange-bellied parrot	*Neophema chrysogaster*	CE	-	L	MK	ML
Osprey	*Pandion haliaetus*	-	W	L	SHK	SHM
Pacific golden plover	*Pluvialis fulva*	-	W	L	RK	
Pacific gull	*Larus pacificus*	-	-	L	BK	
Painted honeyeater	*Grantiella picta*	V	-	-	SHK	
Painted snipe	*Rostratula benghalensis (sensu lato)*	E	-	L	SHK	
Pectoral sandpiper	*Calidris melanotos*	-	W	L	SHK	SHM
Pied stilt	*Himantopus himantopus*	-	-	L	RK	
Pin-tailed snipe	*Gallinago stenura*	-	W	L	RL	
Plains-wanderer	*Pedionomus torquatus*	CE	-	-	SHL	
Rainbow bee-eater	*Merops ornatus*	-	-	L	SHM	
Red knot	*Calidris canutus*	E	W	L	SHK	SHM
Red-capped plover	*Charadrius ruficapillus*	-	-	L	RK	

Common name	Species name	EPBC Act status			LOC Spill EMBA	Operational area (500 m)
		Listed Threatened	Listed Migratory	Listed marine		
Red-necked avocet	*Recurvirostra novaehollandiae*	-	-	L	RK	
Red-necked phalarope	*Phalaropus lobatus*	-	W	L	RK	
Red-necked stint	*Calidris ruficollis*	-	W	L	RK	
Regent honeyeater	*Anthochaera Phrygia*	CE	-	-	FL	
Ruddy turnstone	*Arenaria interpres*	-	W	L	RK	
Ruff (Reeve)	*Philomachus pugnax*	-	M	L	SHK	
Rufous fantail	*Rhipidura rufifrons*	-	T	L	SHK	
Sanderling	*Calidris alba*	-	W	L	RK	
Satin flycatcher	*Myiagra cyanoleuca*	-	T	L	BK	
Sharp-tailed sandpiper	*Calidris acuminata*	-	W	L	RK	SHM
Silver gull	*Larus novaehollandiae*	-	-	L	BK	
Sooty tern	*Sterna fuscata*	-	-	L	BK	
South-eastern Red-tailed Black-Cockatoo	*Calyptorhynchus banksii graptogyne*	E	-	-	SHK	
Swift parrot	*Lathamus discolour*	CE	-	L	SHK	
Swinhoe's snipe	*Gallinago megala*	-	W	L	RL	
Tasmanian azure kingfisher	*Ceyx azureus diemenensis*	E	-	-	SHL	
Tasmanian wedge-tailed eagle	*Aquila audax fleayi*	E	-	-	SHL	
Terek sandpiper	*Xenus cinereus*	-	W	L	RK	
Wandering tattler	*Heteroscelus incana*	-	W	-	RK	
Whimbrel	*Numenius phaeopus*	-	W	L	RK	

Common name	Species name	EPBC Act status			LOC Spill EMBA	Operational area (500 m)
		Listed Threatened	Listed Migratory	Listed marine		
White-bellied sea-eagle	*Haliaeetus leucogaster*	-	-	L	BK	
White-faced storm-petrel	*Pelagodroma marina*	-	-	L	BK	
White-throated needletail	*Hirundapus caudacutus*	V-	T	L	SHK	
Wood sandpiper	*Tringa glareola*	-	W	L	RK	
Yellow wagtail	*Motacilla flava*	-	T	L	SHK	

Listed Threatened	Likely Presence
CE: Critically Endangered	SHM: Species or species habitat may occur within area.
E: Endangered	SHL: Species or species habitat likely to occur within area.
V: Vulnerable	SHK: Species or species habitat known to occur within area.
Listed Migratory	FL: Foraging, feeding or related behaviour likely to occur within area.
M: Migratory	RK: Roosting known to occur within area.
T: Migratory Terrestrial	ML: Migratory route likely to occur in area.
W: Migratory Wetlands	BK: Breeding known to occur within area.
Listed Marine	
L: Listed	

^ The type of presence may vary between the different areas; e.g. an important behaviour (e.g. foraging, breeding) may be present in the spill EMBA, but not present in the other smaller EMBAs or operational area.

Albatross and petrels

Albatrosses 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. The National Recovery Plan for threatened albatross and giant petrels (DSEWPaC, 2011a). 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 threatened albatross and giant petrels (DSEWPaC, 2011a). 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 (DSEWPaC, 2011b). There are no islands with colonies of threatened marine seabirds within the operational area and spill EMBA. Albatross Island, supporting a breeding population of approximately 5,000 shy albatross (*Thallassarche cauta*), is the closest breeding colony of threatened seabirds to the spill EMBA.

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 degrees where most species spend most of their foraging time. The Antipodean albatross, black-browed albatross, Buller's albatross, Campbell albatross, Indian yellow-nosed albatross, shy albatross and wandering albatross, have BIAs for foraging that overlap the operational area or spill EMBA (Figure 5-26 and Figure 5-27). These BIAs cover either most or all the SEMR (Commonwealth of Australia, 2015c). Therefore, it is likely that these will be present and forage in the EMBA.

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 (DoE, 2015b). 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) (DoE, 2015e). There are 15 sites with significant breeding colonies in Tasmania, and three sites with Victoria, for the white-faced storm petrel (DoE, 2015e). A BIA for foraging has been identified for the common diving-petrel that overlaps with the operational area and spill EMBA. The common-diving petrel also has a breeding BIA that overlaps the spill EMBA. The white-faced storm petrel has a foraging BIA that overlaps the operational area and spill EMBA. The white-faced storm petrel also has a breeding BIA that overlaps the spill EMBA.

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 (DSEWPaC, 2011b). 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. 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 (DSEWPaC, 2011b). 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 & 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 (DSEWPaC, 2011b). 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 (EA, 2001; Marchant & Higgins 1990). Therefore, it is likely that these along with the Tasmanian shy albatross will be present and forage in the spill EMBA and potentially the operational 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 (Birdlife International, 2019)

Terns and shearwaters

The flesh-footed shearwater 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. The species breeds in burrows on sloping ground in coastal forest, scrubland, shrubland 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. 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. 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') (DotEE, 2014). This species is likely to be an uncommon visitor to the operational area or spill EMBA.

The short-tailed shearwater has foraging and breeding BIAs within the spill EMBA (Figure 5-28). The short-tailed shearwater is migratory, and breeding is restricted to southern Australia being most abundant in Victoria and Tasmania (Skira et al., 1996). 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 & Higgins, 1990). Short-tailed shearwaters have been identified as a conservation value in the temperate east and south-west marine areas.

The wedge-tailed shearwater has a foraging BIA within the operational area and spill EMBA (Figure 5-28 and Appendix A). A review of the DotEE 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 DotEE SPRAT profile does not show any locations for the wedge-tailed shearwater in Victoria and Beaver (2018) 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.

Caspian tern is the largest turn 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, Corner Inlet, Mud Island and Mallacoota (Minton & Deleyev, 2001). Breeding occurs between September to December are resident and occur throughout the year at breeding sites. The Caspian tern usually forages in open wetlands and prefers shallow waters but is also found in open coastal waters, title channels and mud flaps. They can forage 60 km from their nesting site (Higgins & Davis, 1996). 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 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. Nest 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 & Davis, 1996; Taylor & Roe, 2004; Van de Kam et al., 2004).

The sooty tern has a much larger foraging range, encompassing open shelf waters, shelf edge and deep water (DSEWPaC, 2012b). 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 New South Wales (Higgins & Davis, 1996). Foraging diet consists of pelagic fish, cephalopods, crustaceans and insects.

Osprey and white bellied sea eagle

The white-bellied sea eagle is a large raptor generally seen singly or in pairs, distributed along the coastline of mainland Australia and Tasmania. 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 & 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 & Higgins, 1993). Recorded decline in numbers have been recorded across Australia, with a decline numbers in Victoria recorded in Gippsland Lakes, Phillip Island and the Sunraysia district (Bilney & Emison, 1983; Quinn, 1969). White-bellied sea eagles 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 & Higgins, 1993). White-bellied sea eagles 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). Breeding is known to occur within the spill EMBA, so they are likely to be common visitor.

The osprey is a medium sized raptor extending around the northern coast of Australia from Albany, Western Australia to Lake Macquarie in New South Wales 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 & 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 operational area or spill EMBA.

Australasian gannet

The Australasian gannet generally feeds over the continental shelf or inshore waters. Their diet is comprised mainly of pelagic fish, but also squid and garfish. Prey is caught mainly by plunge-diving, but it is also seen regularly attending trawlers. Breeding is highly seasonal (October–May), nesting on the ground in small but dense colonies (DoE, 2015a). Important breeding locations for the Australasian gannet within the Environment Sectors include Pedra Branca, Eddystone Rocks, Sidmouth Rocks, and Black Pyramid (Tasmania) and Lawrence Rocks (Victoria). A BIA, for foraging, has been established in the spill EMBA with substantial foraging sites within port Philip Bay and Port Fairy (Figure 5-26).

Little penguin

The little penguin 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 (DoE, 2015a). Bass Strait has the largest proportion (approximately 60%) of the known breeding colonies in Australia; however, breeding populations are also found on the New South Wales coast. 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). 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. A BIA for breeding and foraging, has been identified for the Little Penguin within the spill EMBA (Figure 5-27). Their main breeding site within the spill EMBA is in Western Port Bay. Little penguins are also an important component of the Australian and New Zealand fur-seals' diet (Parliament of South Australia, 2011).

Orange-bellied parrot

The orange-bellied parrot (*Neophema chrysogaster*) (listed as critically endangered under the EPBC Act) breeds in Tasmania during summer, migrates north across Bass Strait in autumn and spends winters on the mainland. The migration route includes the west coast of Tasmania and King Island (Figure 5-29). 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 & Davies, 1996). The orange-bellied parrot is protected under the National Recovery Plan for the orange-bellied parrot (DELWP, 2016a). 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*) (DotEE, 2019a). There are also non-breeding orange-bellied parrots on mainland Australia, between Goolwa in

Australia and Corner Inlet in Victoria. The orange bellied parrot may overfly the coastal waters of the spill EMBA (Figure 5-30). However, parrots rarely land or forage out at sea.

Other shorebirds

A number of species listed in Table 5-11 use coastal shoreline habitats such as Australian fairy tern, fairy prion, red knot, pectoral sandpiper, fork-tailed swift, sharp-tailed sandpiper, curlew sandpiper, eastern curlew, little curlew, yellow wagtail, Australasian bittern 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). This species is unlikely to be present in the operational area or spill EMBA due to the distance offshore.

Many sandpipers including the common, marsh, terek, wood and the broad-billed sandpiper 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 & Higgins, 1993; Higgins & 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 & Higgins, 1993). The wandering tattler and 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 & 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 & 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. The black-faced cormorant has a breeding and foraging BIA off King Island within the spill EMBA. Many of these waders 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 & Davies, 1996). These species are unlikely to be present in the operational area and spill EMBA 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 critically endangered 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 & Davies 1996). These species are critically endangered and may occur within the spill EMBA.

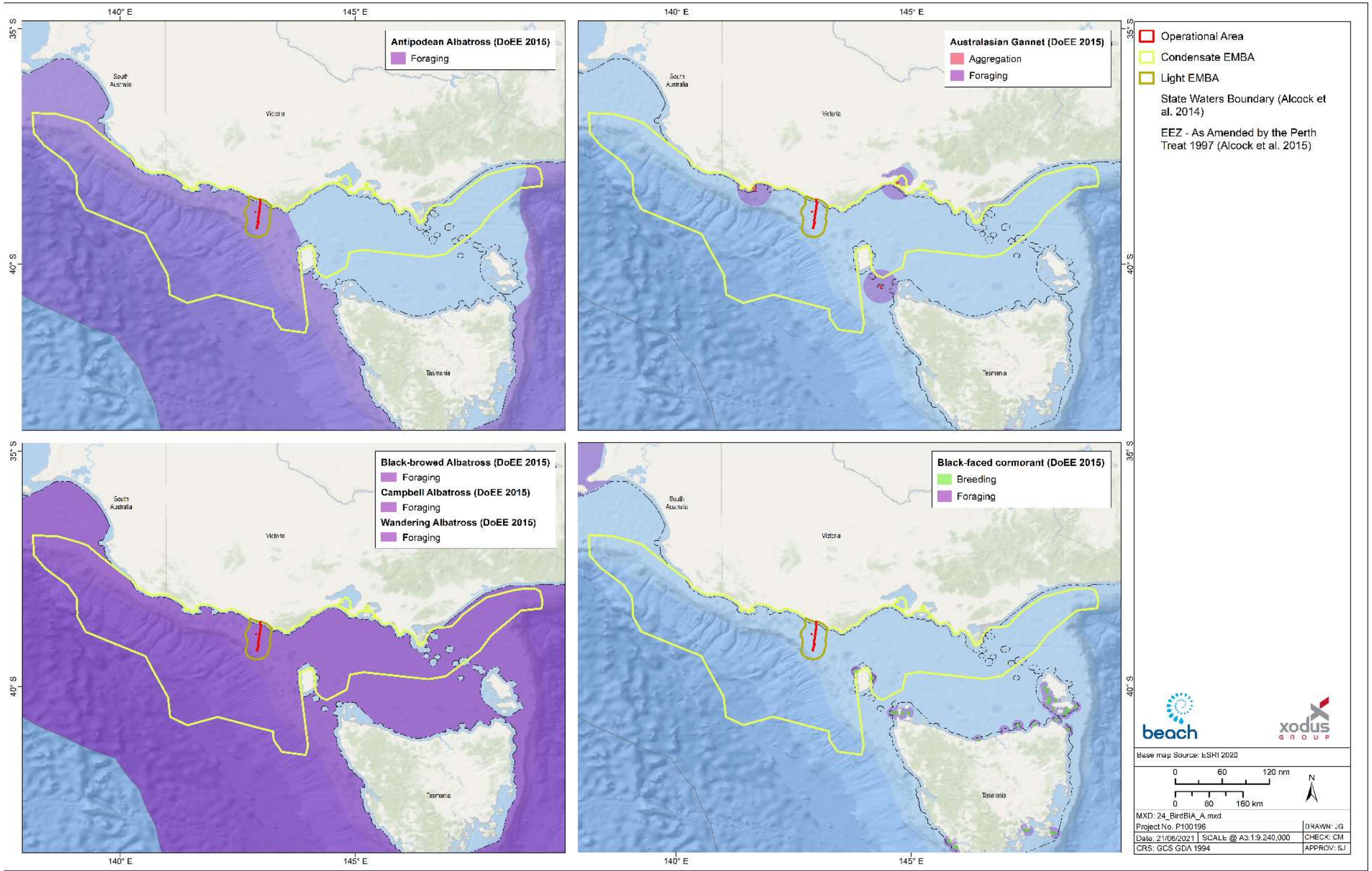


Figure 5-26: BIAs for antipodean albatross, Australasian gannet, black-browed albatross, Campbell albatross, wandering albatross and black-faced cormorant within the spill EMBA

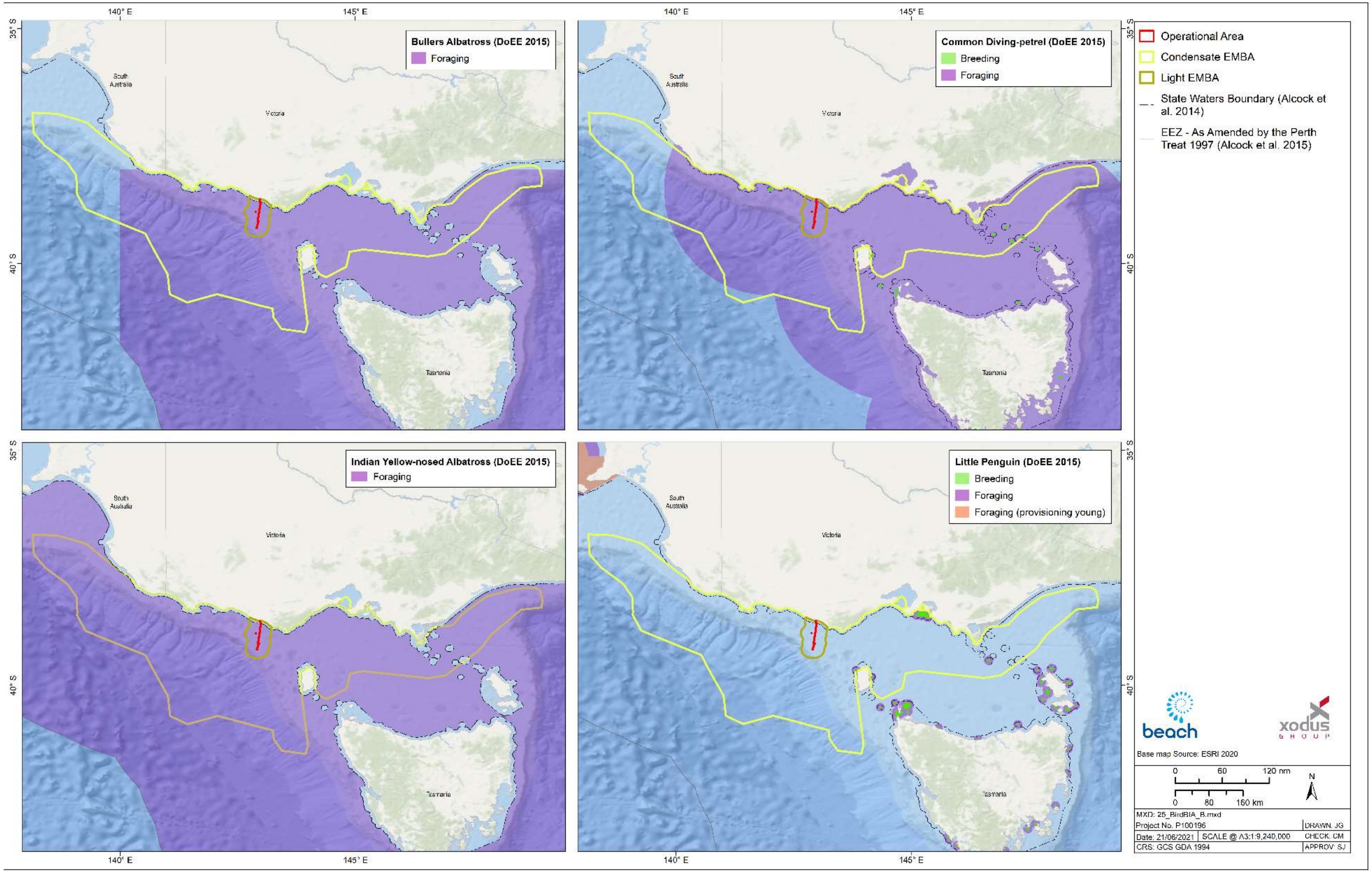


Figure 5-27: BIAs for the Buller's albatross, common diving-petrel, Indian yellow-nosed albatross and little penguin within the spill EMBA

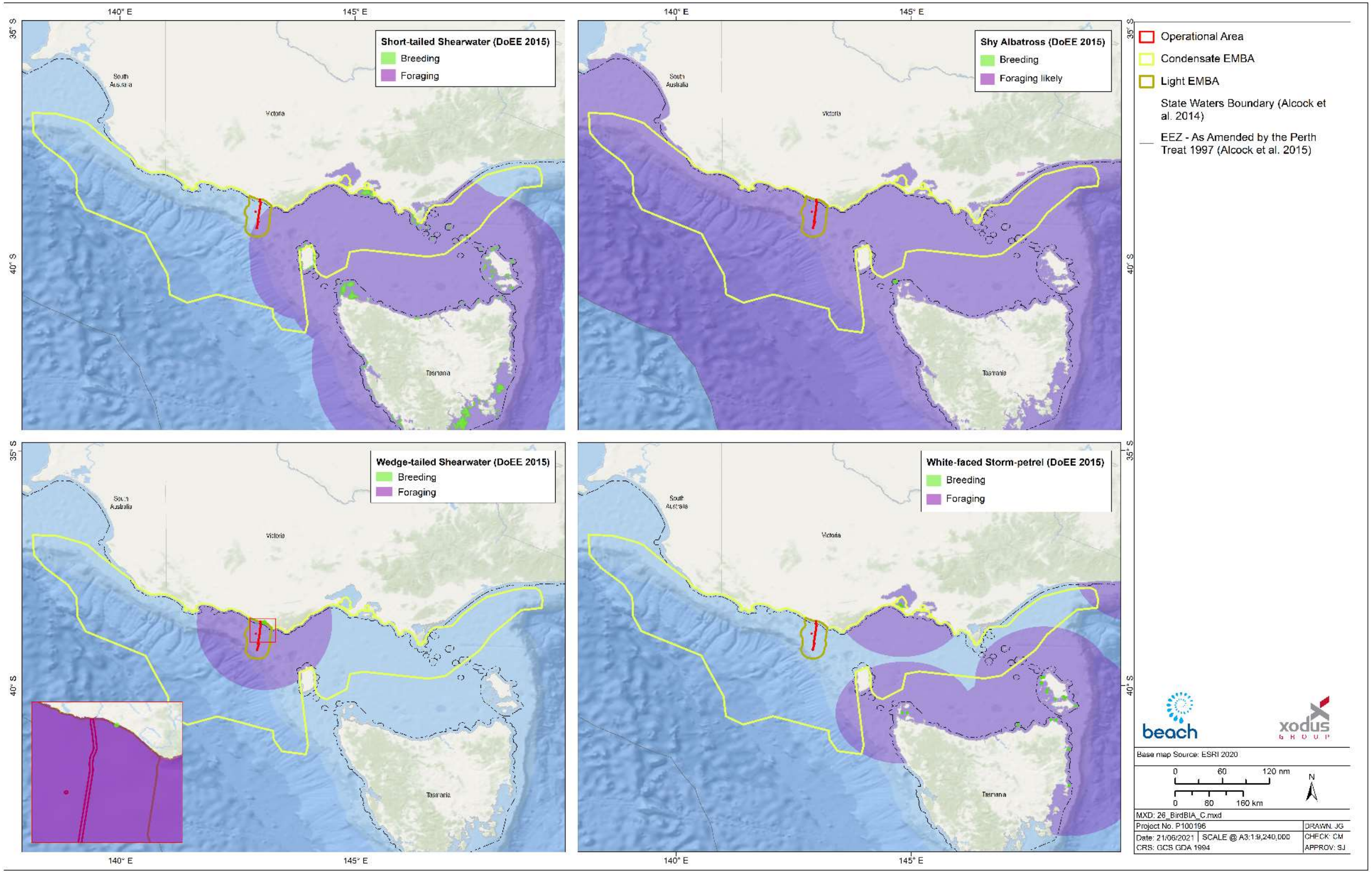


Figure 5-28: BIAs for short-tailed shearwater, shy albatross, wedge-tailed shearwater and white-faced storm petrel within the spill EMBA

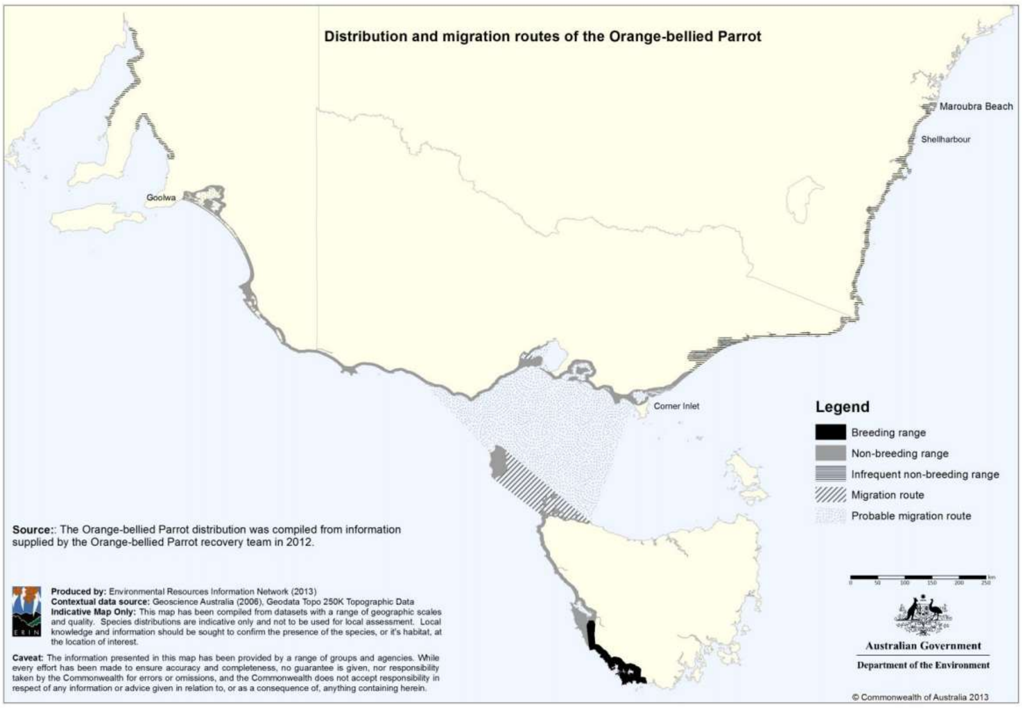


Figure 5-29: Migration routes and breeding ranges for the orange-bellied parrot (DELWP, 2016a)

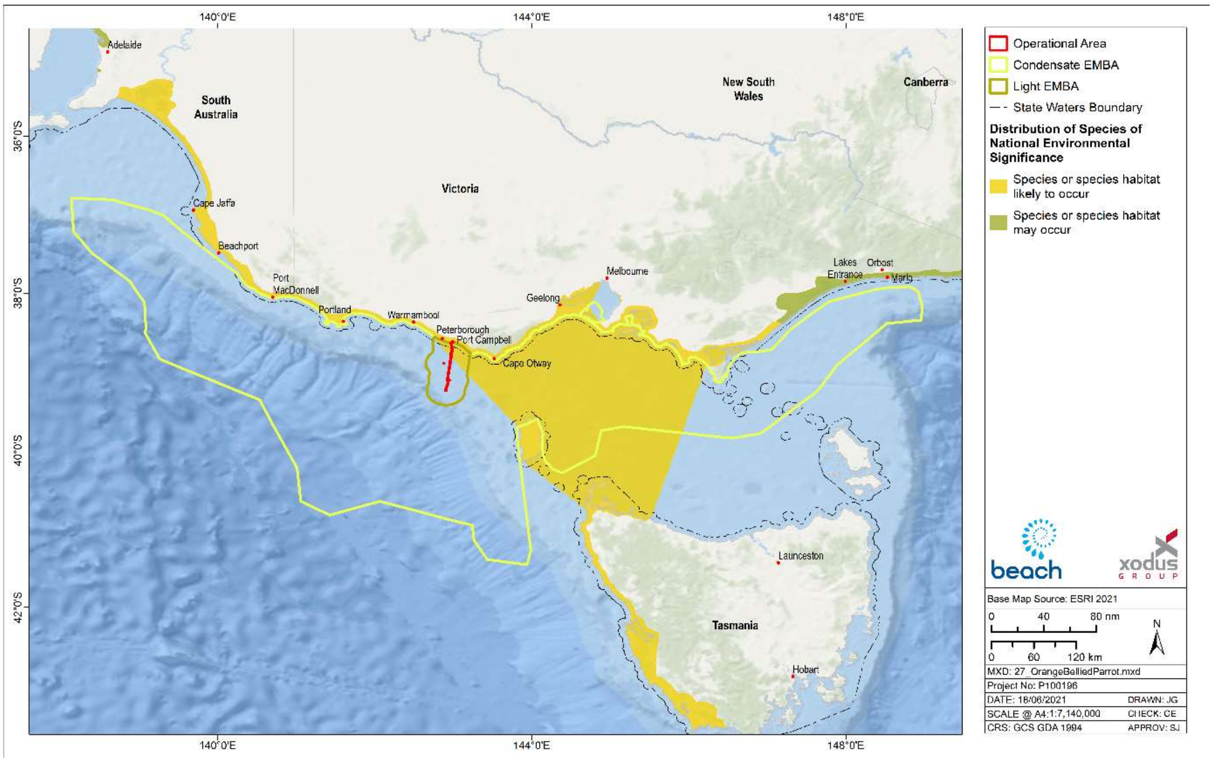


Figure 5-30: Distribution of the orange bellied parrot within the spill EMBA

5.6.7.5 Marine reptiles

The PMST reports for the operational area and spill EMBA identified four marine turtle species likely to occur (Table 5-12, Appendix A). All four species of marine turtles are protected by the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). The spill EMBA PMST report identifies that feeding is known to occur in the spill EMBA for all species. There are no identified BIAs for marine reptiles in the operational area or spill EMBA.

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 5-10 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 NSW, Victoria and South Australia. There are no known nesting or foraging grounds for green turtles offshore Victoria; they occur only as rare vagrants in these waters (DotEE, 2019m), therefore it is expected they would only be occasional visitors in the spill EMBA.

Hawksbill turtle

Hawksbill turtles typically occur in tidal and sub-tidal coral and rocky reef habitats throughout tropical waters, extending into warm temperate areas as far south as northern New South Wales. In Australia the main feeding area extends along the east coast, including the Great Barrier Reef. Other feeding areas include Torres Strait and the archipelagos of the Northern Territory and Western Australia, possibly as far south as Shark Bay or beyond. Hawksbill turtles also feed at Christmas Island and the Cocos (Keeling) Islands.

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, southeast Australia (Tasmania, Victoria and eastern SA), and southern WA (Commonwealth of Australia, 2017b). 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, particularly to the southwest of Cape Otway. It is mostly a pelagic species, and away from its feeding grounds is rarely found inshore (Commonwealth of Australia, 2017b). 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 leatherbacks (DSE, 2009). The major threat to leatherback turtles is by-catch and habitat pollution. In the Bass Strait, leatherbacks are at risk of entanglement from crayfish and pot float lines, ingestion of marine debris as ocean currents and wind can accumulate floating debris where turtles feed (DSE, 2009).

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 spill EMBA.

Loggerhead turtle

The loggerhead turtle (*Caretta caretta*) is globally distributed in tropical, sub-tropical waters 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 (Commonwealth of Australia, 2017b). Due to waters depths it is unlikely loggerhead turtles would be present in the spill EMBA.

Table 5-12: Listed turtle species identified in the PMST

Common name	**Species name**	**EPBC Act status**			**Spill EMBA**	**Operational area (500 m)**
		Listed threatened	**Listed migratory**	**Listed marine**		
Green turtle	*Chelonia mydas*	V	M	L	FK	SHL
Hawksbill turtle	*Eretmochelys imbricate*	V	M	L	SHL	
Leatherback turtle	*Dermochelys coriacea*	E	M	L	FK	SHL
Loggerhead turtle	*Caretta caretta*	E	M	L	FK	SHL
Listed Threatened E: Endangered V: Vulnerable Listed Migratory M: Migratory Listed Marine L: Listed		Likely Presence FK: Foraging, feeding or related behaviour likely to occur within area SHL: Species or species habitat likely to occur within area				

^ The type of presence may vary between the different areas; e.g. an important behaviour (e.g. foraging, breeding) may be present in the spill EMBA, but not present in the operational area.

5.6.7.6 Cetaceans

The PMST reports identified several cetaceans that potentially occur in the operational area and spill EMBA (Appendix A). Table 5-13 details cetaceans identified in the PMST reports. Threatened or migratory species that are likely or known to occur in the area or have an intercepting BIA with the operational area or spill EMBA are discussed in more detail in the sections below.

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) (See Section on blue whales).

These surveys recorded 133 sightings of 15 identified cetacean species consisting of seven mysticete (baleen) whale species, eight odontocete (toothed) species and 384 sightings of dolphins (Table 5-14 and Table 5-15). 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.

The Bass Strait and the Otway Basin is 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 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.

Origin Energy conducted a survey for cetaceans focused on Origin operations and permit in the Otway basin from June 2012 through to March of 2013. Table 5-15 lists the species present in the area Origin surveyed.

Table 5-13: Listed cetacean species identified in the PMST report

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (500 m)
		Listed threatened	Listed migratory	Listed marine		
Whales						
Andrew's beaked whale	*Mesoplodon bowdoini*	-	-	L	SHM	SHM
Antarctic minke whale	*Balaenoptera bonaerensis*	-	M	L	SHL	
Arnoux's beaked whale	*Berardius arnuxii*	-	-	L	SHM	SHM
Blainville's beaked whale	*Mesoplodon desirostris*	-	-	L	SHM	SHM
Blue whale	*Balaenoptera musculus*	E	M	L	FK	FK
Bryde's whale	*Balaenoptera edeni*	-	M	L	SHM	
Curvier's beaked whale	*Ziphius cavirostris*	-	-	L	SHM	SHM
Dwarf sperm whale	*Kogia simus*	-	-	L	SHM	SHM
False killer whale	*Pseudorca crassidens*	-	-	L	SHL	SHL
Fin whale	*Balaenoptera physalus*	V	M	L	FK	FL
Gray's beaked whale	*Mesoplodon grayi*	-	-	L	SHM	
Hector's beaked whale	*Mesoplodon hectori*	-	-	L	SHM	SHM
Humpback whale	*Megaptera novaeangliae*		M		SHK	SHL
Killer whale, orca	*Orcinus orca*	-	M	L	SHL	SHL
Long-finned pilot whale	*Globicephala melas*	-	-	L	SHM	SHM
Minke whale	*Balaenoptera acutorostrata*	-	-	L	SHM	SHM
Pygmy right whale	*Caperea marginata*	-	M	L	FL	FM
Pygmy sperm whale	*Kogia breviceps*	-	-	L	SHM	SHM
Sei whale	*Balaenoptera borealis*	V	M	L	FK	FL
Shepherd's beaked whale	*Tasmacetus shepherdi*	-	-	L	SHM	

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (500 m)
		Listed threatened	Listed migratory	Listed marine		
Short-finned pilot whale	*Globicephala macrorhynchus*	-	-	L	SHM	SHM
Southern bottlenose whale	*Hyperoodon planifrons*	-	-	L	SHM	
Southern right whale	*Eubalaena australis* *Balaena glacialis australis*	E	M	L	BK	SHK
Sperm whale	*Physeter macrocephalus*	-	M	L	SHM	SHM
Strap-toothed beaked whale	*Mesoplodon layardii*	-	-	L	SHM	SHM
True's beaked whale	*Mesoplodon mirus*	-	-	L	SHM	SHM
Dolphins						
Bottlenose dolphin	*Tursiops truncates*	-	-	L	SHM	SHM
Common dolphin	*Delphinus delphis*	-	-	L	SHM	SHM
Dusky dolphin	*Lagenorhynchus obscures*	-	M	L	SHL	SHM
Indian ocean bottlenose dolphin	*Tursiops aduncus*	-	-	L	SHL	SHL
Risso's dolphin	*Grampus griseus*	-	-	L	SHM	SHM
Southern right whale dolphin	*Lissodelphis peronii*	-	-	L	SHM	SHK

Listed Threatened	Likely Presence
E: Endangered	SHM: Species or species habitat may occur within area.
V: Vulnerable	SHL: Species or species habitat likely to occur within area.
Listed Migratory	SHK: Species or species habitat known to occur within area.
M: Migratory	FK: Foraging, feeding or related behaviour known to occur within area. FL: Foraging, feeding or related behaviour likely to occur within area
Listed Marine	
L: Listed	FM: Foraging, feeding or related behaviour may to occur within area.

^ The type of presence may vary between the different areas; e.g. an important behaviour (e.g. foraging, breeding) may be present in the spill EMBA, but not present in the operational area.

Table 5-14: Cetacean species recorded during aerial surveys 2002–2013 in southern Australia

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	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

SRW = southern right whales; ROR = rorquals; ODO = other odontocetes; DOL = dolphins.

Table 5-15: Temporal occurrence across months of cetaceans sighted during aerial surveys from November 2002 to March 2013 in southern Australia

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

*Species sighted 2 or fewer times.

Note: Numbers denote animals sighted per 1,000 km survey distance for each month, pooled for all years (i.e. the 12-month period from Oct–Sep).

Table 5-16: Observed cetaceans in the Otway Basin

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

*September values averaged over two surveys on 1 and 11 September 2012. Totals include individuals from both September surveys

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 (DotEE, 2019e). 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 (DotEE, 2019e). The species primarily feeds in the Antarctic during summer on Antarctic krill and does not appear to feed much while in the breeding grounds of lower latitudes (DotEE, 2019e).

The Antarctic minke whale has been observed within the region however there are no BIAs in the operational area or spill EMBA. Therefore, it is likely that they would be uncommon visitors in the spill EMBA.

Blue whale

The pygmy blue whale has a foraging (annual high use area) BIA within the operational area and spill EMBA (Figure 5-38).

Status

The blue whale (*Balaenoptera musculus*) is listed as an endangered species under the Australian Government 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 blue whale has a recovery plan that identifies threats and establishes actions for assisting the recovery of blue whale populations using Australian waters (Commonwealth of Australia, 2015b).

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.

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. 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. The Otway region is an important migratory and foraging area for blue whales, as shown by passive acoustic monitoring and aerial surveys (Gavrilov, 2012; McCauley et al., 2018; Gill et al., 2011).

Underwater acoustic monitoring programs have detected Antarctic and pygmy blue whale calls in the Otway Region. Acoustic detection of Antarctic blue whales indicates that they occur along the entire southern coastline of Australia (McCauley et al., 2018). Pygmy and Antarctic blue whales were acoustically detected by Origin Energy between February and October 2011 in the Otway Basin, east of the Thylacine-A wellhead platform. The presence of Antarctic blue whales in the area is considered rare (Gavrilov, 2012). However, recent acoustic studies have estimated an increase in the abundance of blue whales off Portland, Victoria (McCauley et al., 2018). From 2009-2016 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).

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 5-32). 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) 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.

Several aerial and noise studies of blue whales within the Otway Basin have been conducted and are summarised below.

Gill et al., (2011) undertook 69 seasonal aerial surveys for blue whales between Cape Jaffa and Cape Otway over six seasons (2001-02 to 2006-07). This study found that the general pattern of seasonal movement of blue whales is from west to east, with whales foraging in between the Great Australian Bight and Cape Nelson in November and spreading further east in December. Whales are typically widely distributed throughout Otway shelf waters from January through to April (Gill et al., 2011) (Figure 5-34 and Figure 5-35).

Blue whale encounter rates in the central and eastern study (Cape Nelson to Cape Otway) area by month is shown in Figure 5-33 with sighting and effort data presented geographically in Figure 5-34 and Figure 5-35. Data is pooled for all seasons, for central and eastern areas, overlaid on gridded aerial survey effort (10 km x 10 km squares), represented as minutes flown per grid square (key, upper right). 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). The spill EMBA is within the central and eastern areas and the operational area on the outer edge of the eastern area.

There had been fewer than 50 sightings of blue whales in Bass Strait up to the year 1999, but since that time feeding blue whales have been more regularly observed in the Discovery Bay area and more generally along the Bonney coast from Robe to Cape Otway. 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 5-34).

Based on the pooled aerial survey data (2001-2007), 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.

The data from Gill et al. (2011) shows:

- 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 during November for any season despite significant effort. Pooled monthly encounter rates increased from 1.6 whales 1,000 km–1 in December, 5 whales 1,000 km–1 in January, peaked at 9.8 whales 1,000 km–1 in February, dropped slightly to 8.8 whales 1,000 km–1 in March, then declined sharply to a single sighting for May (0.4 whales 1,000 km–1).
- encounter rates in central and eastern zones peaked in February, coinciding with peak upwelling intensity and primary productivity.

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. 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 commissioned by Origin undertaken during 2011 and 2012 by the Blue Whale Study found that blue whales were common in the eastern upwelling zone during November-December 2012. 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. 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.

From 2009-2016 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). McCauley et al. (2018) suggests that acoustic detection of Antarctic blue whales indicate they predominantly occur along the entire southern coastline.

McCauley et al. (2018) analysed data from passive acoustic recorders that were located around Australia to look at blue whale presence, distribution and population parameters. The primary sites comprised central Bass Strait, western Tasmania, the southeast Australian coast and the Great Australian Bight area. Each study area had multiple receivers and may have had several sites sampled within the area. Temporal sampling focussed on the southern Australian site south west of Portland, Victoria. Data was used from 2004 to 2016. The study concluded:

- pygmy blue whales have three migratory stages around Australia; the "southbound migration stage" were predominantly between October to December (sometimes into January) whales travel from Indonesian waters down to the WA coast, the "southern Australian stage" where between January and June whales spread across the southern Australian waters, and the "northbound migration stage" 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.
- along the southern Australian coastline pygmy blue whales are most frequently detected towards the east along the Bonney coast over late February to early June, utilising secondary productivity produced by a seasonal upwelling event.
- within a season it is difficult to predict whale numbers and their specific locations, but when correlated across seasons the strength and persistence of this upwelling event as given by time integrated water temperature south of Portland, significantly correlates with time integrated number of individual whales calling from the same site.
- the Bonney coast upwelling is a strong predicator of pygmy blue whale presence at Portland where whale presence in the area is linked to prey availability
- sea noise data was available from the Portland site from 2009 to early 2017 detailed:
  - in 2009 and 2011 pygmy blue whales arrived in November or December whereas in the other years, calls were not detected until January or February (Figure 5-34). There was substantial variation in presence within a season, with some whales remaining in the Portland detection area until mid-June each year.
  - there was considerable variability in whale persistence and presence within a season (Figure 5-35) with no consistent trend other than a peak in presence somewhere over February to June.
- 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. 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.

- the number of pygmy blue whale calling in Portland could be expected in increase yearly with whale population growth.

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). During the Beach Otway Development Seabed Survey (November 2019 to January 2020) there were four 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.

Möller et al. 2020 analysis data from the tags of 13 pygmy blue whales who were tagged in the Bonney upwelling region in January 2015 with tags transmitting up to March 2016. 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 (Figure 5-36).

- 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.

Beach commenced a 22 month drilling program in February 2021 in the Otway Development Area. The Blue Whale Study was engaged to undertaken aerial surveys from February to May 2021 to identify blue whale and krill surface swarms within the Otway Development 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.

- Peak blue whale sightings was on 7 April with 19 blue whales sighted.

- First blue whale was sighted 25 February and final blue whale sighted 7 April.

- Blue whales and krill surface swarms were distributed throughout the area surveyed.

In addition, marine mammal observer data from January 2021 to April 2022 for the drilling program in the Otway Development Area identified the majority of blue whale sightings where during March and April as shown in Figure 5-31.

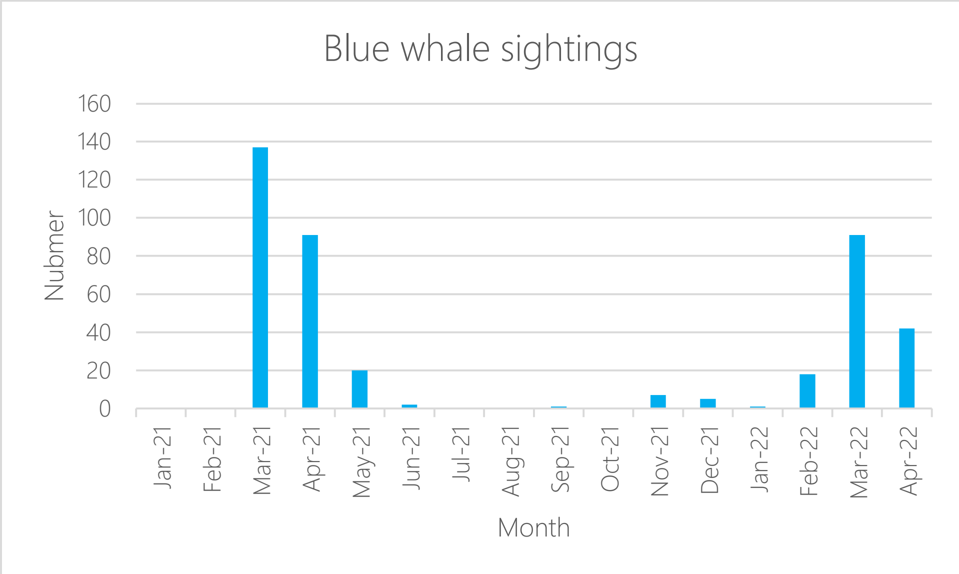


Figure 5-31: Blue whale sightings for the Otway drilling campaign

As detailed in Section 5.5.5, JASCO completed a monitoring study for Beach in relation to exploration drilling activities at the Artisan-1 well from the 1 Feb 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.

The seasonal distribution and abundance of blue whales are variable across years and influenced by climate variables. 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 the coast (the Bonney coast upwelling) and the associated aggregations of krill that they feed on (Gill and Morrice, 2003). The Bonney coast 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.

There are two known seasonal feeding aggregations areas in Australia, the Bonney Coast Upwelling KEF and adjacent waters off South Australia and Victoria (Figure 5-36), and the Perth Canyon KEF and adjacent waters in Western Australia. The abundance of pygmy blue whales varies within and between seasons, but they typically forage in the Otway region between January and April. 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 (Commonwealth of Australia. 2015). McCauley et al. (2018) suggests that acoustic detection of pygmy blue whales indicate they predominantly occur west of Bass Strait (Figure 5-37). Acoustic detections of pygmy blue whales off Portland Victoria correlated with upwelling indicators in the Bonney coast upwelling in late summer to autumn (February-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. One occasion all three types were detected between April and June with more commonly two calls present over this period during other years (Figure 5-37).

Pygmy blue whales have three migratory stages around Australia; the "southbound migration stage" where predominantly between October to December (sometimes into January) whales travel from Indonesian waters down to the WA coast, the "southern Australian stage" where between January and June whales spread across the southern Australian waters, and the "northbound migration stage" where whales travel back up to Indonesia between April and August. The "southern stage" involves animals searching for prey. The Bonney coast upwelling is a strong predicator of pygmy blue whale presence at Portland where whale presence in the area is linked to prey availability (McCauley et al., 2018). Passive acoustic monitoring in southern Australia during 2000-2017 focused on the distribution and population parameters of both subspecies of blue whales in southern and western Australia. In Portland sea noise data was available from 2009 to early 2017. In 2009 and 2011 pygmy blue whales arrived in November or December whereas in the other years, calls were not detected until January or February. There was substantial variation in presence within a season, with some whales remaining in the Portland detection area until mid-June each year. Acoustic loggers located east of the Thylacine platform from February to October 2011 detected pygmy blue whales between February and early June, with the greatest abundance from March to mid-May.

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. 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. The number of pygmy blue whale calling in Portland could be expected in increase yearly with whale population growth (McCauley et al., 2018).

Photo identification, genetics and telemetry studies provide information on whale movements and connectivity. 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.

BIAs for pygmy blue whales have been identified around Australia with the foraging BIA intersecting the operational area and spill EMBA (Figure 5-38). Surveys data 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.

Foraging

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 (Figure 5-32). 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, 2015d). 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 zig-zagging '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 the blues have finished feeding, they will move from the feeding area to commence searching for another area.

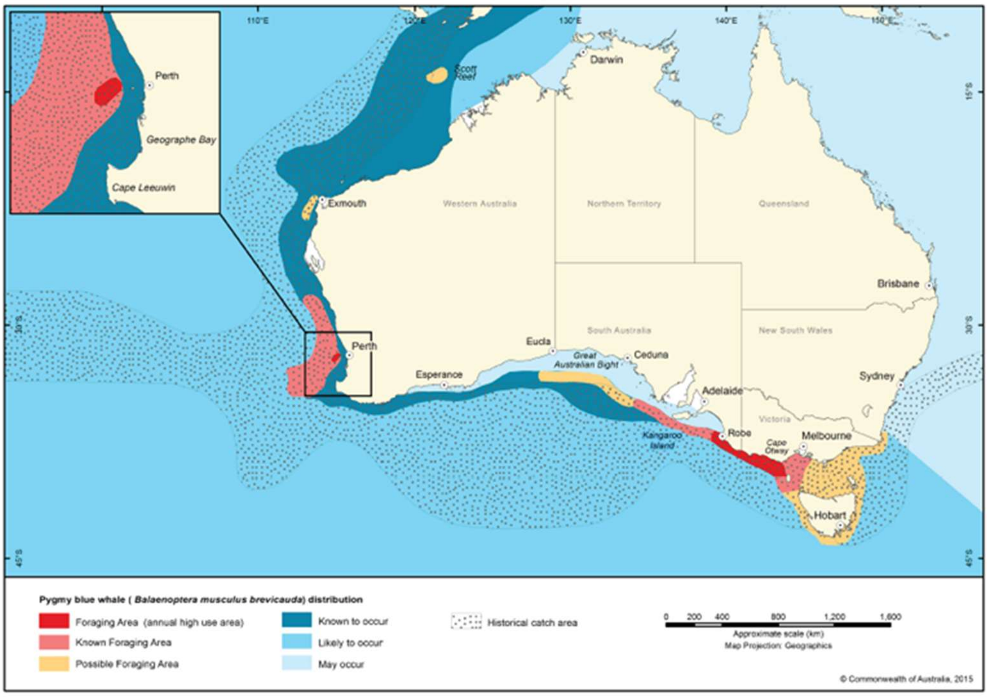
Diving behaviour of blue whales associated with feeding at depth was observed by Gill & Morris (2003) in the Otway region, who note that blue whales dived steeply, submerging for 1 – 4 minutes, then returned to the surface. Tagging of a pygmy blue whale at the Perth Canyon identified 1677 dives over 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):

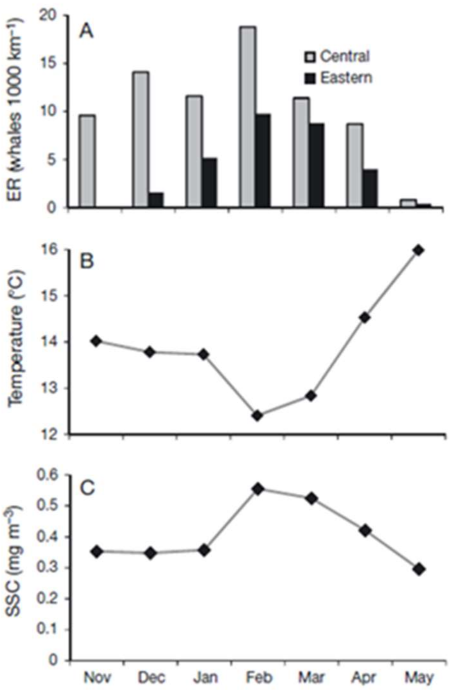
- Whales predominantly carried out area-restricted search (presumably foraging) with generally shallow and short dives. However, dives were generally deeper at night compared to during the day.
- Whales performed mostly square shaped dives that were shallow in depth and short in duration.
- Dives recorded 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).

Although the maximum recorded dive time was 112 minutes, the mean dive time of 6.1 minutes ± 5.2 provides confidence that the typical dive time is less than 30 minutes (Möller et al., 2015). Tagging of eight blue whales off California (Irvine et al., 2019) identified that dive durations were as long as 30.7 minutes and no feeding lunges were recorded during dives >20 minutes in duration.



Foraging Area (Annual high use area)	Blue whales are regularly observed feeding on a seasonal basis	Known to occur	Blue whales are known to occur based on direct observations, satellite tagged whales or based on acoustic detections
Known Foraging Area	Known foraging occurs in these areas but is highly variable both between and within seasons	Likely to occur	Blue whales are likely to occur based on occasional observations in the area and nearby areas
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	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 5-32: Pygmy blue whale foraging areas around Australia (Commonwealth of Australia, 2015b)



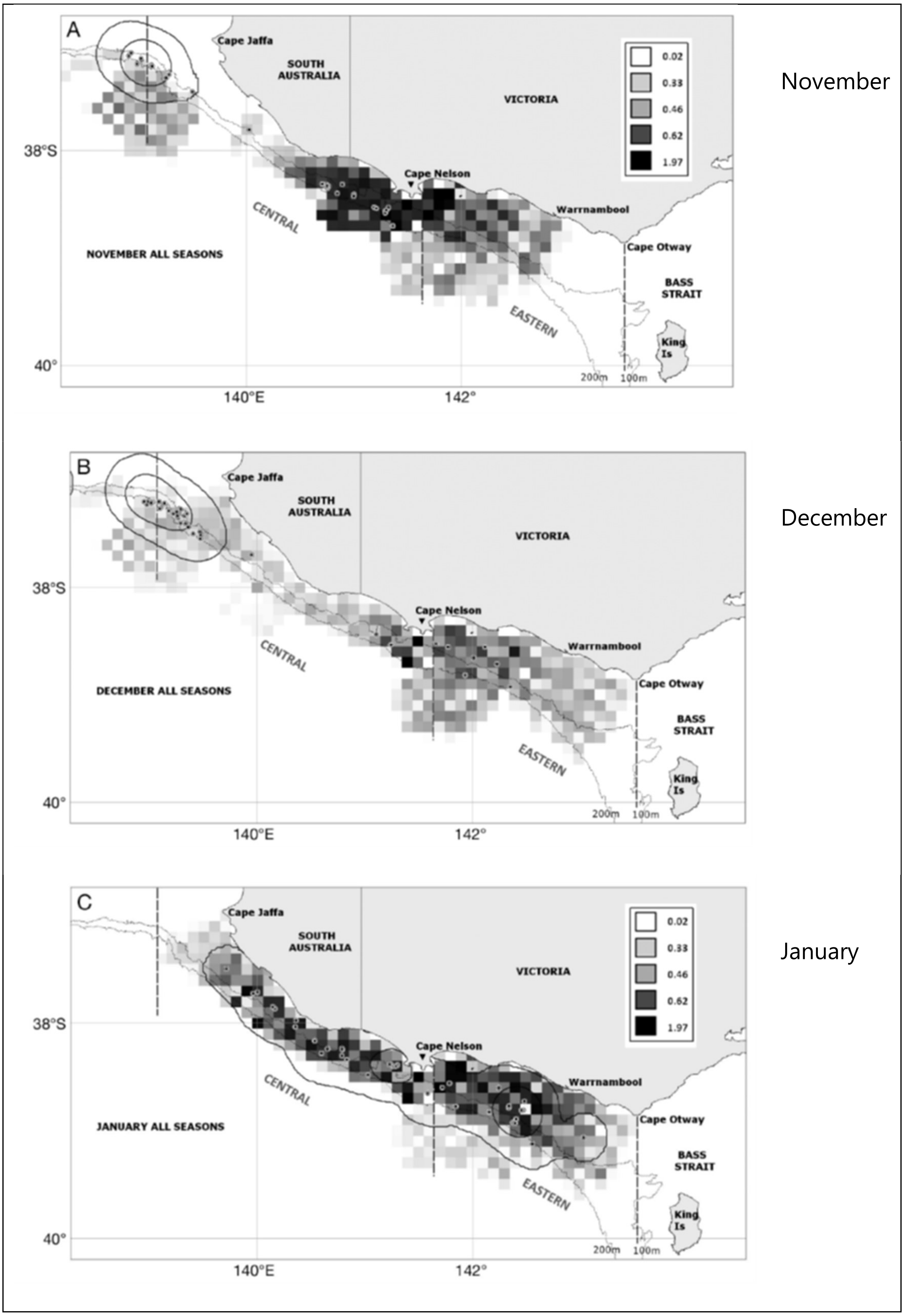


Figure 5-33: Blue whale encounter rates in the central and eastern study (Cape Nelson to Cape Otway) area by month (Gill et al., 2011)

Figure 5-34: 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 x 10 km squares) represented as minutes flown per grid square (key, upper right corner of the November and January figures).

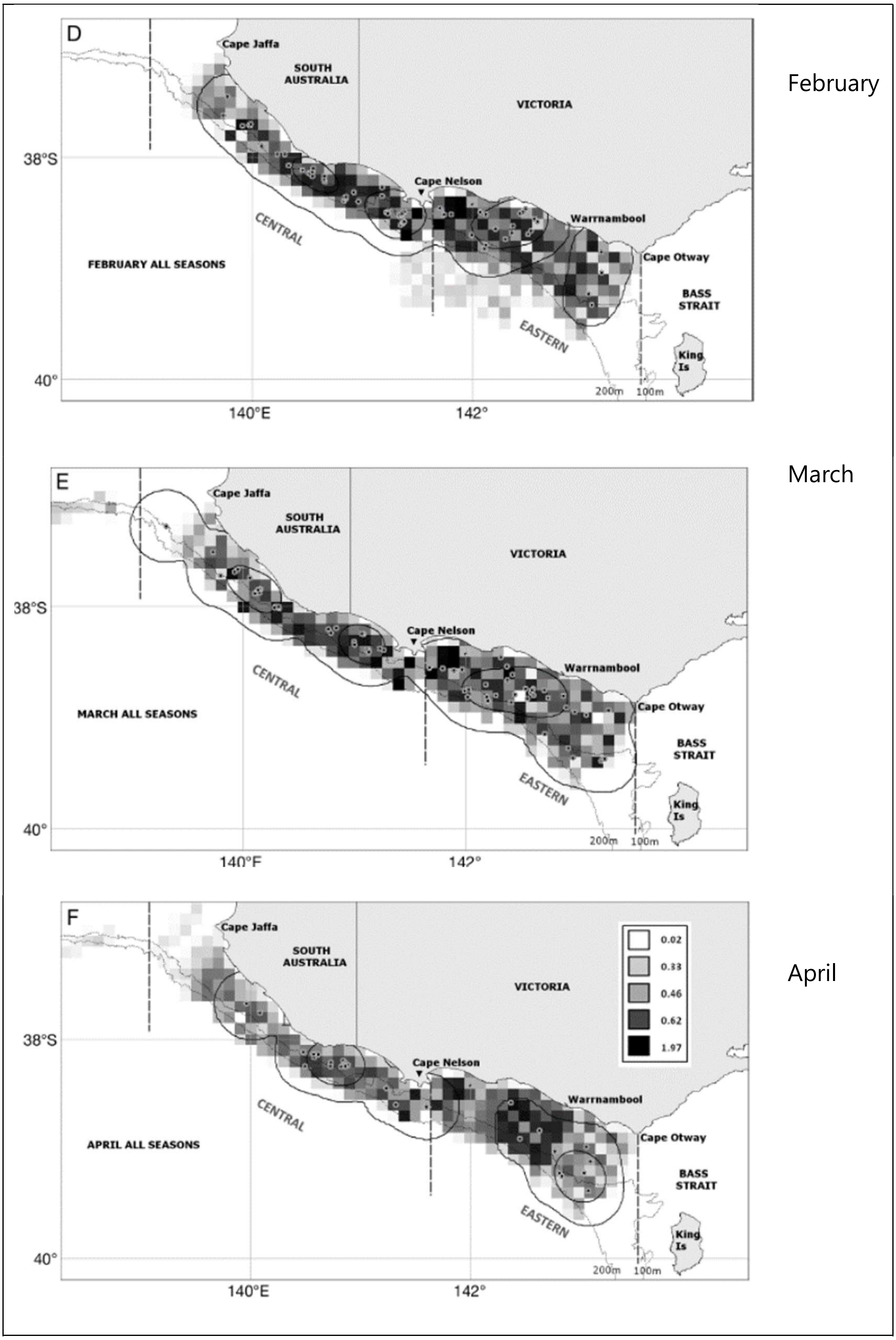


Figure 5-35: Blue whale sightings in the Otway Basin (Feb, Mar, Apr) (Gill et al., 2011)

Note: Dots represent blue whale sightings while squares are aerial survey effort (10 km x 10 km squares) represented as minutes flown per grid square (key, upper right corner of the April figure).

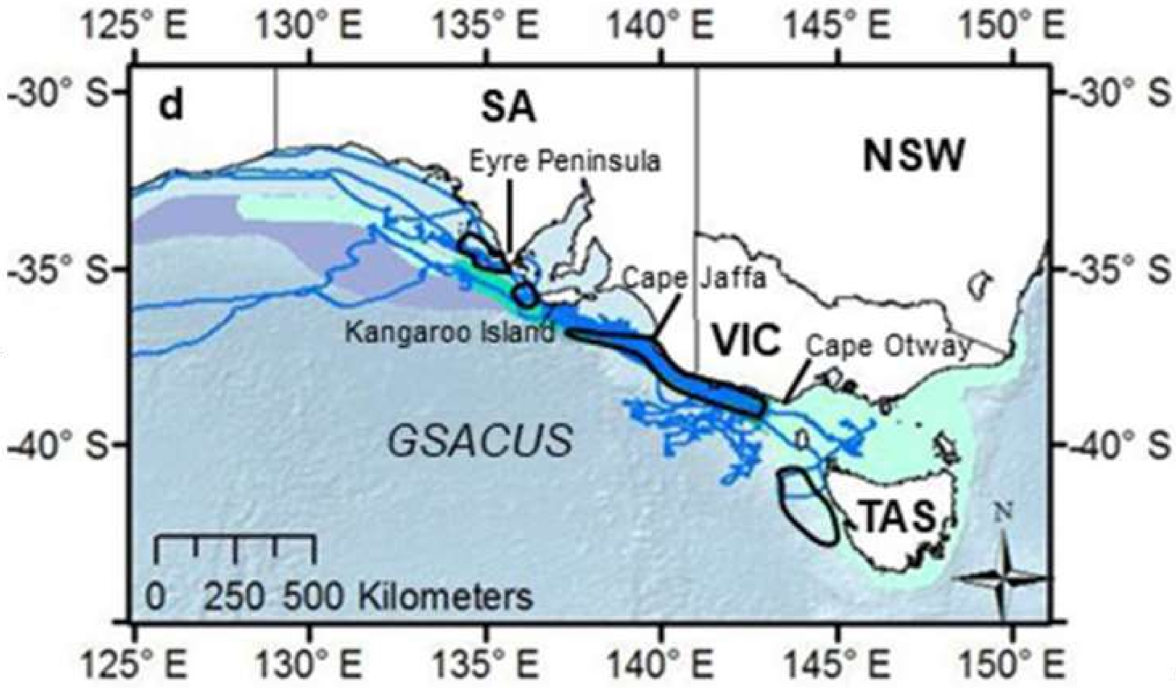


Figure 5-36: Tracks of 13 pygmy blue whales in the Great Southern Australian Coastal Upwelling System (GSACUS) (Möller et al. 2020)

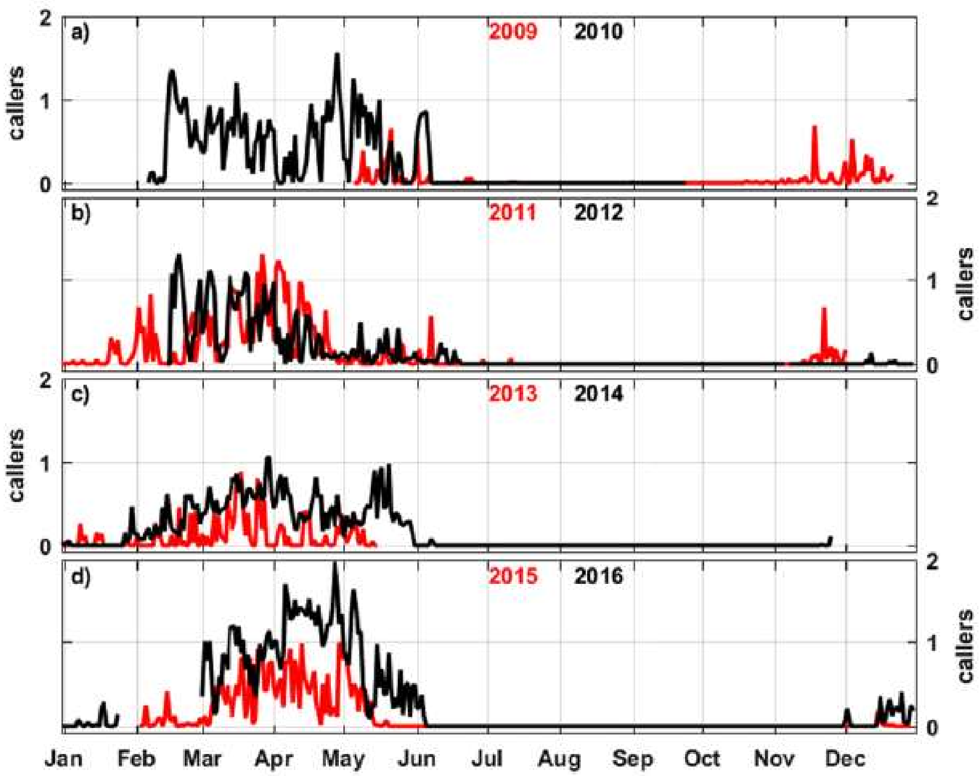


Figure 5-37: Mean number of individual pygmy blue whales calling (McCauley et al. 2018)

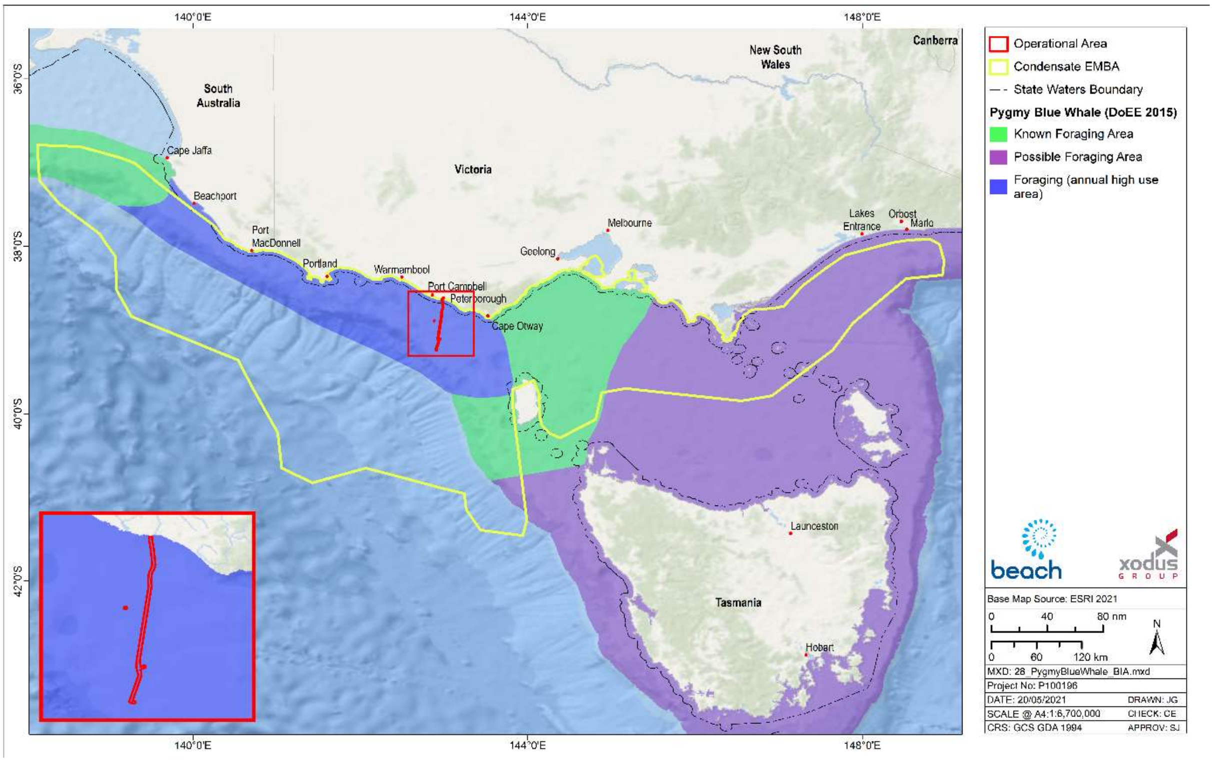


Figure 5-38: BIA for the pygmy blue whale within the spill EMBA.

Fin whale

Fin whales are 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 coast upwelling, Victoria, along the continental shelf in summer and autumn months (Gill, 2002). Fin whales in the Bonney coast 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 2002-2013 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 coast 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.

As there are no BIAs for the fin whale in the operational area or spill EMBA, they are likely to be uncommon visitors to the operational area and spill EMBA.

Humpback whale

Humpback whales (*Megaptera novaeangliae*) 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. Along the southeast coast of Australia, the northern migration starts in April and May while the southern migration peaks around November and December (TSSC, 2015a). 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 operational 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 (TSSC, 2015a). Feeding occurs where there is a high krill density, and during the migration this primarily occurs in Southern Ocean waters south of 55°S (TSSC, 2015a).

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 thirty 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 are no known feeding, resting or calving grounds for humpback whales in the spill EMBA, although feeding may occur opportunistically where sufficient krill density is present (Commonwealth of Australia, 2015). The nearest BIA which is important habitat for migrating humpback whales is Twofold Bay, a resting area off the NSW coast (DAWE, 2021).

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.

Killer whale

Killer whales (*Orcinus orca*) are 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 (DotEE, 2019d).

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 operational area or spill EMBA. Therefore, it is likely that they would be uncommon visitors in the operational area or spill EMBA.

Long-finned pilot whale

The long-finned pilot whale (*Globicephala melas*) is distributed throughout the northern and southern hemispheres in circumpolar oceanic temperate and subantarctic waters containing zones of higher productivity along the continental slope. They sometimes venture into the shallower waters of the shelf (<200 m) in pursuit of prey species. Stomach contents confirm that squid are the main prey of long-finned pilot whales in Australian waters, although some fish are also taken (DotEE, 2019f). No key localities have been identified in Australia (Bannister et al., 1996) however they are considered reasonably abundant (DotEE, 2019f).

There is some (inconclusive) evidence that suggests the species moves along the edge of the continental shelf in southern Australian waters (Bannister et al., 1996) in response to prey abundance at bathymetric upper slopes and canyons (DoE, 2016g). Records from Tasmania indicate mating occurs in spring and summer with 85% of calves born between September and March although births do occur throughout the year.

No calving areas are known in Australian waters (DotEE, 2019f).

The long-finned pilot whale has been identified in surveys over the Bass Strait and eastern Great Australian Bight; however, there are no BIAs in the operational area or spill EMBA. During works undertaken by Origin Energy, long-finned pilot whales have been seen sporadically, such as, a sighting of approximately 30 whales occurred during the 2014 Enterprise MSS. It is likely that they would be uncommon visitors to the operational area or spill EMBA.

Minke whale

The minke whale (*Balaenoptera acutorostrata*) is a widely distributed baleen whale that has been recorded in all Australian waters except the Northern Territory. The whales can be found inshore although they generally prefer deeper waters. In summer they are abundant feeding throughout the Antarctic south of 60°S but appear to migrate to tropical breeding grounds between 10°S and 20°S during the Southern Hemisphere winter (Kasamatru, 1998; Reilly et al., 2008). Although the exact location of breeding grounds is unknown, mating occurs between August to September with calving between May and July (Bannister et al., 1996). A few animals have been sighted during aerial surveys of the Bonney coast upwelling. The minke whale has been observed within the region however there are no BIAs in the operational area or spill EMBA. Therefore, it is likely that they would be uncommon visitors in the operational area or spill EMBA.

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. 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, Kangaroo Island (SA) and southern Eyre Peninsula (SA) 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 Energy did not observe it during the 2010 Speculant MSS and 2014 Enterprise MSS. Also, there are no BIAs identified in the operational area or spill EMBA. Therefore, it is likely to be an uncommon visitor in the operational area or spill EMBA.

Sei whale

Sei whales 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; subantarctic 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; Thiele et al., 2000; Chatto and Warneke 2000; Bannister 2008a).

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. The sei whale is likely to be an uncommon visitor to the operational area or spill EMBA.

Southern right whale

The spill EMBA overlaps the southern right whale (*Eubalaena australis*) aggregation, connecting habitat and migration BIAs and current core coastal range (Figure 5-40). The operational area overlaps the known core coastal range and the migration and resting on migration BIA. The operational area is ~22 km from the aggregation BIA, ~90 km from the connecting habitat BIA (Figure 5-40) and overlaps with the Port Campbell emerging aggregation area (Figure 5-41).

The southern right whale is listed as endangered under the EPBC Act in Australia and as critically endangered on the Victorian Threatened Species Advisory List. 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 (7% per annum (p.a.)) 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 (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).

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). They are distributed across thirteen primary aggregation areas along the southern coast of

Australia (Figure 5-41) (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 (DSEWPaC, 2012a). There are occasional sightings further north, with the extremities of their range recorded at Hervey Bay and Exmouth (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 (DSEWPaC, 2012a) (Figure 5-41). 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 (DSEWPaC, 2012a) (Figure 5-41).

Coastal connecting habitat, which may also serve a migratory function or encompass locations that will emerge as calving habitat as recovery progresses (some locations within connecting habitat are occupied intermittently but do not yet meet criteria for aggregation areas) (DSEWPaC, 2012a). A portion of the King Island connecting habitat BIA is within the spill EMBA.

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 (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 (DSEWPaC, 2012a). The Victorian and Tasmania coastal waters are known to include migrating habitat and SRW 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 four southern right whales as shown in Figure 5-39.

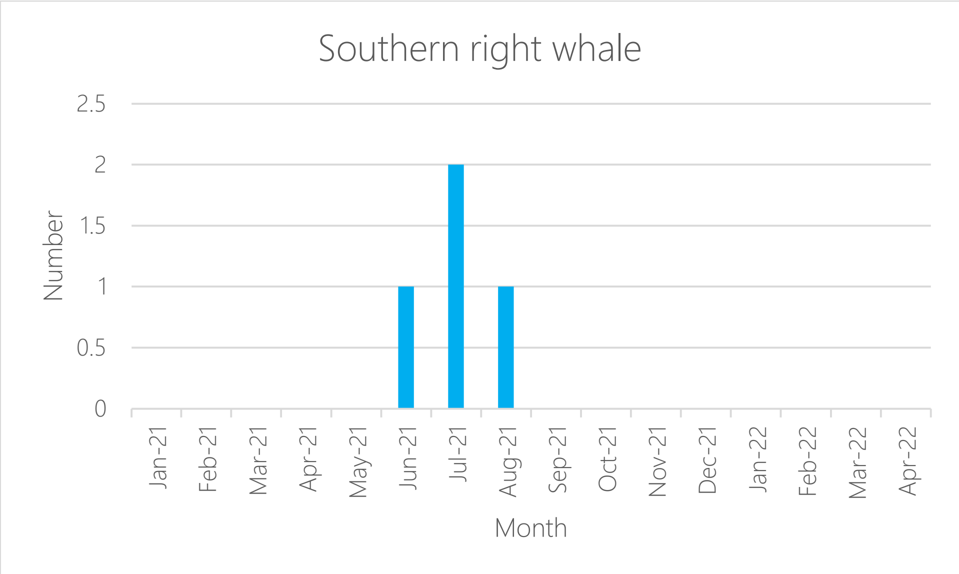


Figure 5-39: Southern right whale sightings for the Otway drilling campaign

The Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a) reports that known and potential threats that may have individual or population level impacts to southern right whales include: entanglement in fishing gear, vessel disturbance, climate variability and change, noise interference, habitat modification and overharvesting of prey.

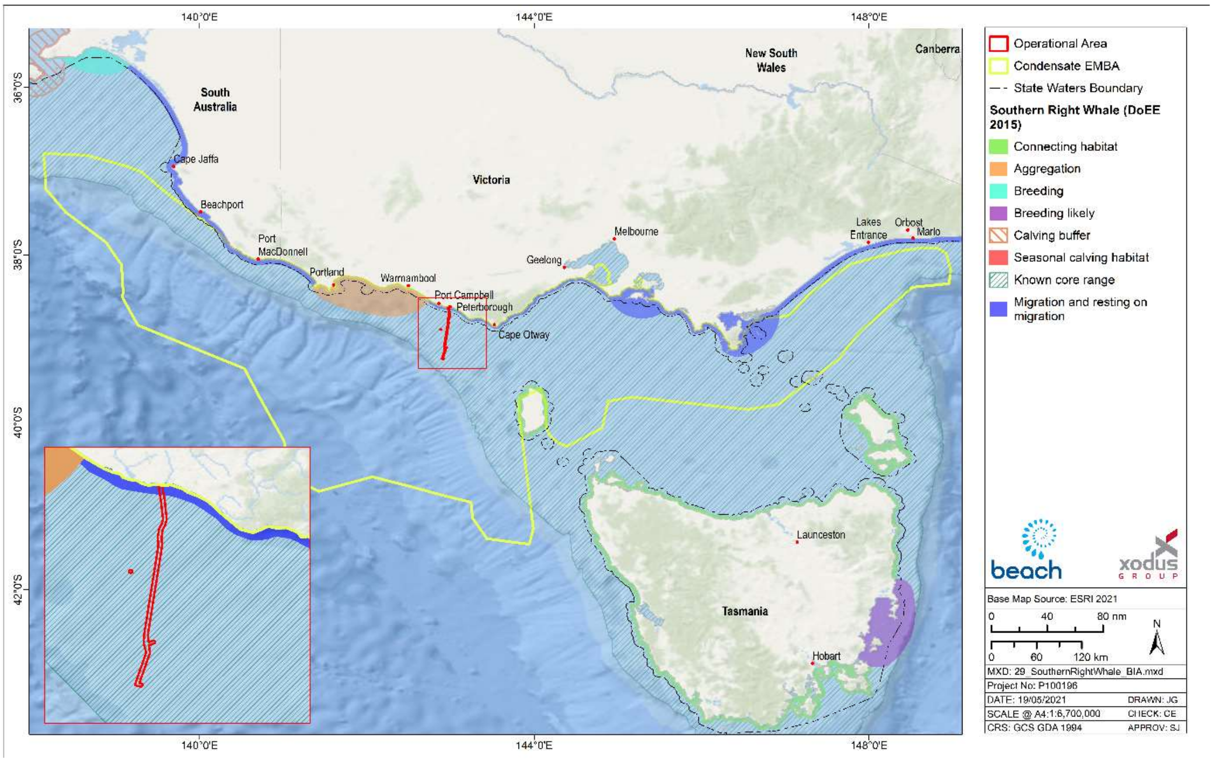


Figure 5-40: Southern right whale BIAs within the spill EMBA.

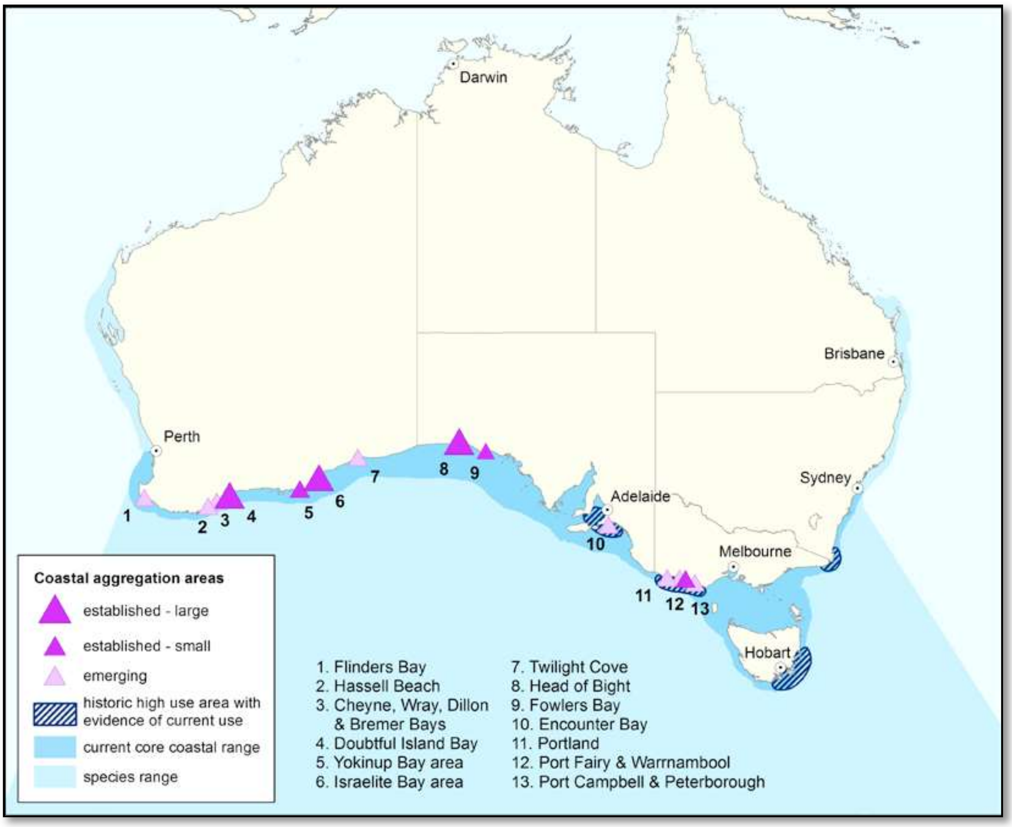


Figure 5-41: Aggregation areas for southern right whales (DSEWPaC, 2012a)

Sperm whale

The sperm whale (*Physeter macrocephalus*) has a worldwide distribution and has 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 (DotEE, 2019f). Key locations for the species include the area between Cape Leeuwin to Esperance (WA); southwest of Kangaroo Island (SA), deep waters of the Tasmanian west and south coasts, areas off southern NSW (e.g., Wollongong) and Stradbroke Island (Qld) (DotEE, 2019f). Concentrations of sperm whales are generally found where seabeds 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 (DotEE, 2019f).

Females and young males are restricted to warmer waters (i.e., north of 45oS) and are likely to be resident in tropical and sub-tropical waters year-round. 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. For species in oceanic waters, there is a more generalised movement of sperm whales' southwards in summer and northwards in winter (DotEE, 2019f).

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 east near Kangaroo Island in South Australia. Therefore, it is likely they would be uncommon visitors in the operational area or spill EMBA.

Bottlenose dolphin

The bottlenose dolphin (*Tursiops truncates*) has a worldwide distribution from tropical to temperate waters. While the species is primarily coastal, they are also found inshore, on the shelf and open oceans.

They are associated with many types of substrate and habitats, including mud, sand, seagrasses, mangroves and reefs (DotEE, 2019j). Bottlenose dolphins are known to associate with several cetacean species such as pilot whales, white-sided, spotted, rough-toothed and Risso's dolphins, and humpback and right whales (DotEE, 2019j).

There are two forms of bottlenose dolphin, a nearshore form and an offshore form. The nearshore form occurs in Southern Australia including the Otway Basin area, while the offshore form is found north of Perth and Port Macquarie in NSW. Most populations are relatively discrete and reside in particular areas, such as individual resident populations in Port Phillip Bay, Westernport Bay, Spencer Gulf, Jervis Bay and Moreton Bay. There may be some migration and exchange between the populations, but it is likely that most encountered near the Victorian coasts are local residents.

The bottlenose dolphin has been observed in the region; however, no BIAs have been identified in the operational area or spill EMBA. Therefore, it is likely they would be uncommon visitors in the operational area or spill EMBA.

Common dolphin

The common dolphin (*Delphinus delphis*) is an abundant species, widely distributed from tropical to cool temperate waters, and generally further offshore than the bottlenose dolphin, although small groups may venture close to the coast and enter bays and inlets. They have been recorded in waters off all Australian states and territories. Stranding statistics indicate that common dolphins are active in Bass Strait at all times of the year, though less so in winter (DotEE, 2019k).

Common dolphins are usually found in areas where surface water temperatures are between 10°C and 20°C, and in habitats also inhabited by small epipelagic fishes such as anchovies and sardines.

In many areas around the world common dolphins show shifts in distribution and abundance, suggesting seasonal migration. The reason for this seasonal migration is unknown however in New Zealand the shift appears to be correlated with sea surface temperature and in South Africa, the species occurrence appears to be correlated with the annual sardine run (DotEE, 2019k). They are abundant in the Bonney coast upwelling during the upwelling season, and very scarce outside the season.

Dusky dolphin

The dusky dolphin (*Lagenorhynchus obscures*) is rare in Australian waters and has been primarily reported across southern Australia from Western Australia to Tasmania with a handful of confirmed sightings near Kangaroo Island and off Tasmania (DotEE, 2019i). 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). 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 (DotEE, 2019i).

Indian Ocean bottlenose dolphin

The Indian Ocean bottlenose dolphins are found in tropical and sub-tropical coastal and shallow offshore waters of the Indian Ocean, Indo-Pacific Region and the western Pacific Ocean bottlenose dolphins are distributed continuously around the Australian mainland, but the taxonomic status of many populations is unknown. Indian Ocean bottlenose dolphins have been confirmed to occur in estuarine and coastal waters of eastern, western and northern Australia and it has also been suggested that the species occurs in southern Australia (Kemper, 2004).

In south-eastern Australia, inshore Indian Ocean bottlenose dolphins show a high degree of site fidelity to some local areas and appear to belong to relatively small communities or populations (Möller et al., 2002).

Risso's dolphin

The Risso's dolphin (*Grampus griseus*) is a widely distributed species found in deep waters of the continental slop and outer shelf from the tropics to temperate regions. The species prefer warm temperate to tropical waters with depths greater than 1,000 m, although they do sometimes extend their range into cooler latitudes in summer (Bannister et al., 1996). They are thought to feed on cephalopods, molluscs and fish. The Risso's dolphin has been observed in the region, however no BIAs have been identified in the operational area or spill EMBA. Therefore, it is likely they would be uncommon visitors in the operational area or spill EMBA.

Southern right whale dolphin

The southern right whale dolphin (*Lissodelphis peronnii*) is a pelagic species found in Southern Australian waters but generally well offshore in deep water or on the outer edges of the continental shelf between the subtropical and subantarctic convergence (DotEE, 2019h). No key localities have been identified in Australian waters however preferred water temperatures range from approximately 2-20°C (DotEE, 2019h). Of the limited southern right whale dolphin stomachs examined, myctophids and other mesopelagic fish, squid and crustaceans have been recorded, and euphausiids are also thought to be potential prey (DotEE, 2019h). It is unknown whether the southern right whale dolphin is a surface or deep-layer feeder (Bannister et al., 1996).

Calving areas are not known, however there is evidence that the calving season occurs between November to April (DotEE, 2019h).

The southern right whale dolphin has been observed in the region; however, no BIAs have been identified in the operational area or spill EMBA. Therefore, it is likely they would be uncommon visitors in the operational area or spill EMBA.

5.6.7.7 Pinnipeds

The PMST reports identified three pinnipeds that potentially occur in the operational area and spill EMBA (Appendix A). The spill EMBA overlaps a foraging BIA for the Australian sea lion.

Table 5-17: Listed pinniped species identified in the PMST search

Common name	Species name	EPBC Act status			Spill EMBA	Operational area (500 m)
		Listed threatened	Listed migratory	Listed marine		
Australian fur-seal	*Arctocephalus pusillus*	-	-	L	BK	SHM
New Zealand fur-seal	*Arctocephalus forsteri*	-	-	L	SHM	SHM
Australian sea lion	*Neophoca cinereal*	E	-	L	SHK	
Listed Threatened		Likely Presence				
E: Endangered		SHM: Species or species habitat may occur within area.				
Listed Marine		SHK: Species or species habitat known to occur within area.				
L: Listed		BK: Breeding known to occur within area				

^ The type of presence may vary between the different areas; e.g. an important behaviour (e.g. foraging, breeding) may be present in the spill EMBA, but not present in the operational area.

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.

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 (Figure 5-44). 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. Australian fur-seals are present in the region all year, with breeding taking place during November and December.

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 & 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 – 80 m and generally within 100 – 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 nine days (Kirkwood et al., 2009; Hume et al., 2004).

As there are breeding and haul out sites within the spill EMBA it is likely that Australian fur-seal would be present in the spill EMBA

New Zealand fur-seal

New Zealand fur-seal (*Arctocephalus forsteri*) are found in the coastal waters and offshore islands of South and 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 and, Kanowna Island (near Wilsons Promontory) and The Skerries in eastern Victoria.

Figure 5-43 illustrates the known breeding colonies of New Zealand fur-seal (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). Known sites for New Zealand Fur-seal breeding colonies within the spill EMBA include Seal Rocks (off King Island) and Judgement Rocks (Kent Group Islands) (Figure 5-43).

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 spill EMBA 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 spill EMBA overlaps an Australian sea lion foraging BIA (Figure 5-42). The Australian sea lion is a specialised benthic forager; i.e. it feeds primarily on the sea floor (DSEWPaC, 2013). 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, 2013). They typically feed on a range of prey including fish, cephalopods (squid, cuttlefish and octopus), sharks, rays, rock lobster and penguins (DSEWPC, 2013) They typically forage up to 60 km from their colony but can travel up to 190 km when over shelf waters (Shaughnessy, 1999).

Figure 5-42: Australian sea lion foraging BIA within the spill EMBA

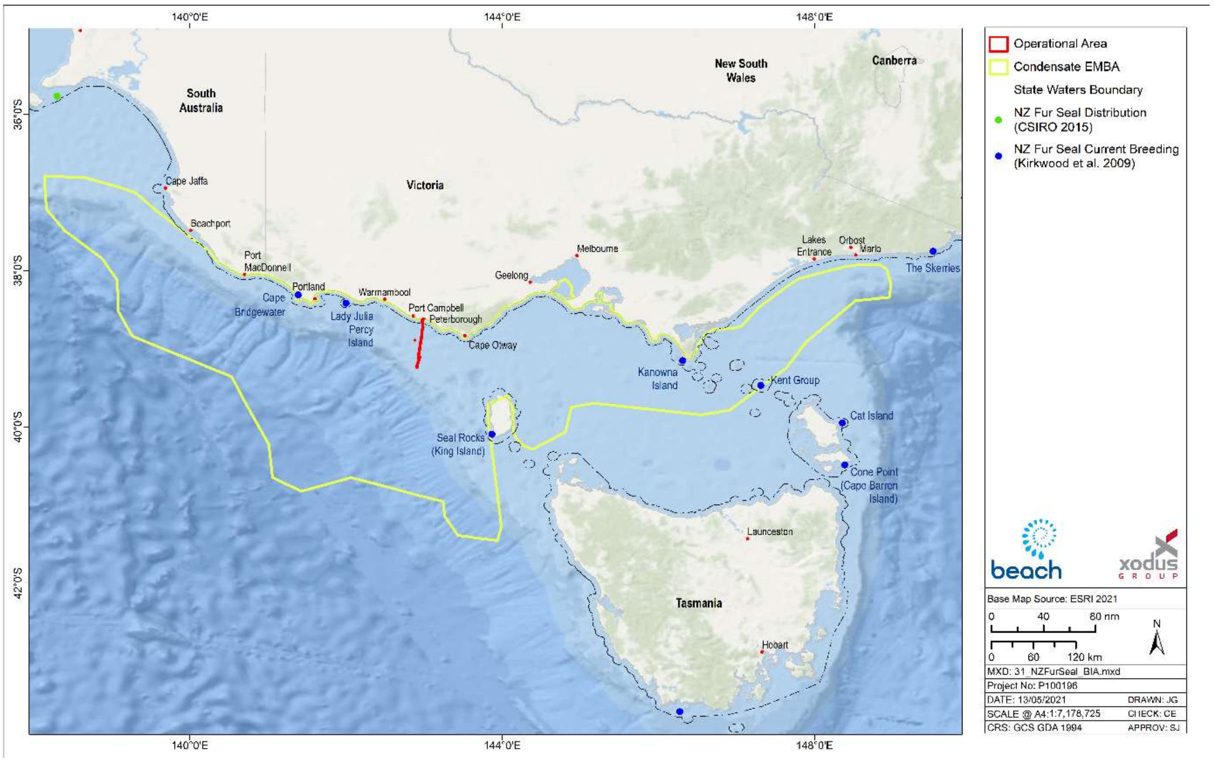


Figure 5-43: Locations of New Zealand fur-seal breeding colonies (Kirkwood et al., 2009).

Figure 5-44: Locations of Australian fur-seal breeding colonies and haul out sites (Kirkwood et al., 2010)

5.6.7.8 Pest species

Invasive marine species (IMS) are marine plants or animals that have been introduced into a region beyond their natural range and have the ability to survive, reproduce and establish. More than 200 non-indigenous marine species including fish, molluscs, worms and a toxic alga have been detected in Australian coastal waters.

It is widely recognised that IMS can become pests and cause significant impacts on economic, ecological, social and cultural values of marine environments. Impacts can include the introduction of new diseases, altering ecosystem processes and reducing biodiversity, causing major economic loss and disrupting human activities (Brusati & Grosholz, 2006).

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, 2002). Several introduced species have become pests either by displacing native species, dominating habitats or causing algal blooms.

Key known pest species in the South-East Marine Region include (NOO, 2001):

- northern pacific sea star (*Asterias amurensis*).
- fan worms (*Sabella spallanzannii* and Euchone sp).
- bivalves (*Crassostrea gigas* (Pacific oyster) Corbulagibba and Theorafragilis).
- crabs (*Carcinus maenas* (European shore crab) and *Pyromaia tuberculata*).
- macroalgae (*Undaria pinnatifida* (Japanese giant kelp) and *Codium fragile tormentosoides*).
- the introduced New Zealand screw shell (*Maoricolpus roseus*).

Other introduced species tend to remain confined to sheltered coastal environments rather than open waters (Hayes et al. 2005).

The Marine Pests Interactive Map (DotEE, 2019) indicates that the ports likely to be used for the survey (Warrnambool, Apollo Bay or Port Fairy) do not currently harbour any marine pests.

5.6.7.9 Viruses

A virus, the Abalone Viral Ganglioneuritis (AVG), has been detected in wild abalone populations in southwest Victoria and was confirmed as far east as White Cliffs near Johanna, and west as far as Discovery Bay Marine Park (DPI, 2012). The virus can be spread through direct contact, through the water column without contact, and in mucus that infected abalone produce before dying. The last confirmation of active disease in Victoria was from Cape Otway lighthouse in December 2009 (Victoria State Government, 2016).

Strict quarantine controls need to be observed with diving or fishing activities in south-west Victoria when the virus has been detected in the area. Given the lack of detected AVG in Victorian State waters, controls outlined in the Biosecurity Control Measures for AVG: A Code of Practice (Gavine et al., 2009) are not active.

5.7 Socio-economic environment

This section describes the socio-economic environment within the operational area and spill EMBA.

5.7.1 Coastal settlements

There are no coastal settlements within the operational area.

Australian's have a strong affinity to the coast, with over 80% of the population living within 50 km of the coast. The coastal settlements that lie within the EMBA and are subject to potential impact are (from west to east) Discovery Bay, Cape Nelson, Portland, Port Fairy, Warrnambool, Peterborough, Childers Cove, Bay of Islands, Port Campbell, Princetown, Moonlight Head, Cape Otway, Apollo Bay, Cape Patton, Lorne, Anglesea, Torquay, Port Phillip, Mornington Peninsula, Western Port, French Island, Kilcunda, Venus Bay, Cape Liptrap, Waratah Bay, Wilsons Promontory, Corner Inlet and Eurobodalla. All settlements are within Victoria, apart from Eurobodalla in NSW. These settlements are administered by different councils, with some of the larger councils including the Glenelg Shire Council (Portland), Moyne Shire Council (Port Fairy, Peterborough), Warrnambool City Council, Shire of Corangamite (Port Campbell, Princetown) and the Shire of Colac Otway (Apollo Bay).

The largest settlement within the spill EMBA is Mornington Peninsula, with a population just under 300,000 (Table 5-18). The Warrnambool, Peterborough, Childers Cove, Bay of Islands, Port Campbell, Princetown, Moonlight Head, Cape Otway, Apollo Bay, Cape Patton, Lorne and Anglesea settlements are along the Great Ocean Road, a National Heritage listed stretch along the Victorian coastline, with Warrnambool marking the western end. Warrnambool is another large settlement within the EMBA, with a population just under 30,000 (Table 5-18) and is a former port for the state of Victoria. The Port of Warrnambool has a breakwater and yacht club and provides shelter for commercial fishing boats. Portland and Port Fairy are the next largest centres with populations of 9,712 and 3,340, respectively (Table 5-18). Portland is Victoria's western-most commercial port and is a deep-water port with breakwaters sheltering a marina and boat ramp. Port Fairy has both harbour and fish processing facilities, but is not suitable for use by large vessels, nor is Port Campbell.

The coastal settlements within the EMBA all provide services to the commercial and recreational fishing industries in south-west Victoria and rely on fishing and tourism to contribute to their economies through income and employment. In Portland and Princetown, the largest employment industries are the agriculture, forestry and fishing industries, accounting for 59 and 28%, respectively (Table 5-18). In all but the two largest centres, accommodation and food services (which are heavily reliant on tourism) is either the first or second largest employment industry (Table 5-18).

Table 5-18: Coastal settlement population estimates and employment figures

Settlement	Population1	% of employment in industries relevant to potential impacts2	
		Agriculture, forestry & fishing	Accommodation & food services
Discovery Bay	N/A	N/A	N/A
Cape Nelson	N/A	N/A	N/A
Portland	9,712	2.8	8.8
Port Fairy	3,340	6.5	12.8
Warrnambool	29,661	2.1	9.1

Settlement	Population1	% of employment in industries relevant to potential impacts2	
		Agriculture, forestry & fishing	Accommodation & food services
Peterborough	247	6.7	13.3
Childers Cove	N/A	N/A	N/A
Bay of Islands	N/A	N/A	N/A
Port Campbell	478	28.4	16.6
Princetown	241	59.3	10.5
Moonlight Head	N/A	N/A	N/A
Cape Otway	15	N/A	N/A
Apollo Bay	1,598	3.6	27.9
Cape Patton	N/A	N/A	N/A
Lorne	1,114	0	0
Anglesea	2,545	0	4.8
Torquay	13,258	0	0
Port Phillip	100,872	0	0
Mornington Peninsula	289,142	0	0
Western Port	N/A	N/A	N/A
French Island	119	N/A	N/A
Kilcunda	396	0	0
Venus Bay	944	0	0
Cape Liptrap	N/A	N/A	N/A
Waratah Bay	56	N/A	N/A
Wilsons Promontory	13	N/A	N/A
Corner Inlet	N/A	N/A	N/A
Eurobodalla (NSW)	92	N/A	N/A

[1] Data from Australian Bureau of Statistics 2016 census, available at www.censusdata.abs.gov.au

[2] Data from Australian Bureau of Statistics 2016 census, available at www.censusdata.abs.gov.au

5.7.2 Petroleum exploration

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.

From a review of the NOPSEMA website and engagement with other oil and gas exploration companies (as at 6 Jan 2022) a summary of exploration activities that may occur within the Otway

Basin are detailed in Table 5-19. There is no overlap of known seismic surveys with the operational area and the Otway Deep Marine Seismic Survey is ~17 km away (Figure 5-45).

Table 5-19: Petroleum exploration potentially within the operational area

Titleholder	Activity	Timing and Duration	Proximity to development well locations
TGS (Previously Spectrum Geo Australia Pty Ltd	Otway Deep Marine Seismic Survey	October 2020 to end February 2021 October 2021 to end February 2022 120 days	Figure 5-45 shows the Spectrum survey area is ~17 km from the operational area with the closest point being the Thylacine-A Wellhead Platform. TGS confirmed they have not committed to undertaking the survey in 2021/2022 and are looking at 2022/2023 season. (See Stakeholder Record TGS 30).

5.7.3 Petroleum production

There is no non-Beach oil and gas infrastructure within the operational area. The Cooper Energy Casino and Henry gas fields and Casino-Henry pipeline and the Minerva gas field and pipeline are within the northern portion of the spill EMBA.

Beach is undertaking or planning the following development activities over the next two years:

- Development drilling and well abandonment programme in the Geographe and Thylacine fields in 2021-2022.
- Tie in of the G-4 and G-5 production wells in 2021. This is complete.
- Tie-in of the Thylacine subsea wells in 2022

Update with new operational area as per Base Map. Redo both EMBAs to cover the Thylaince wells Operational Area.

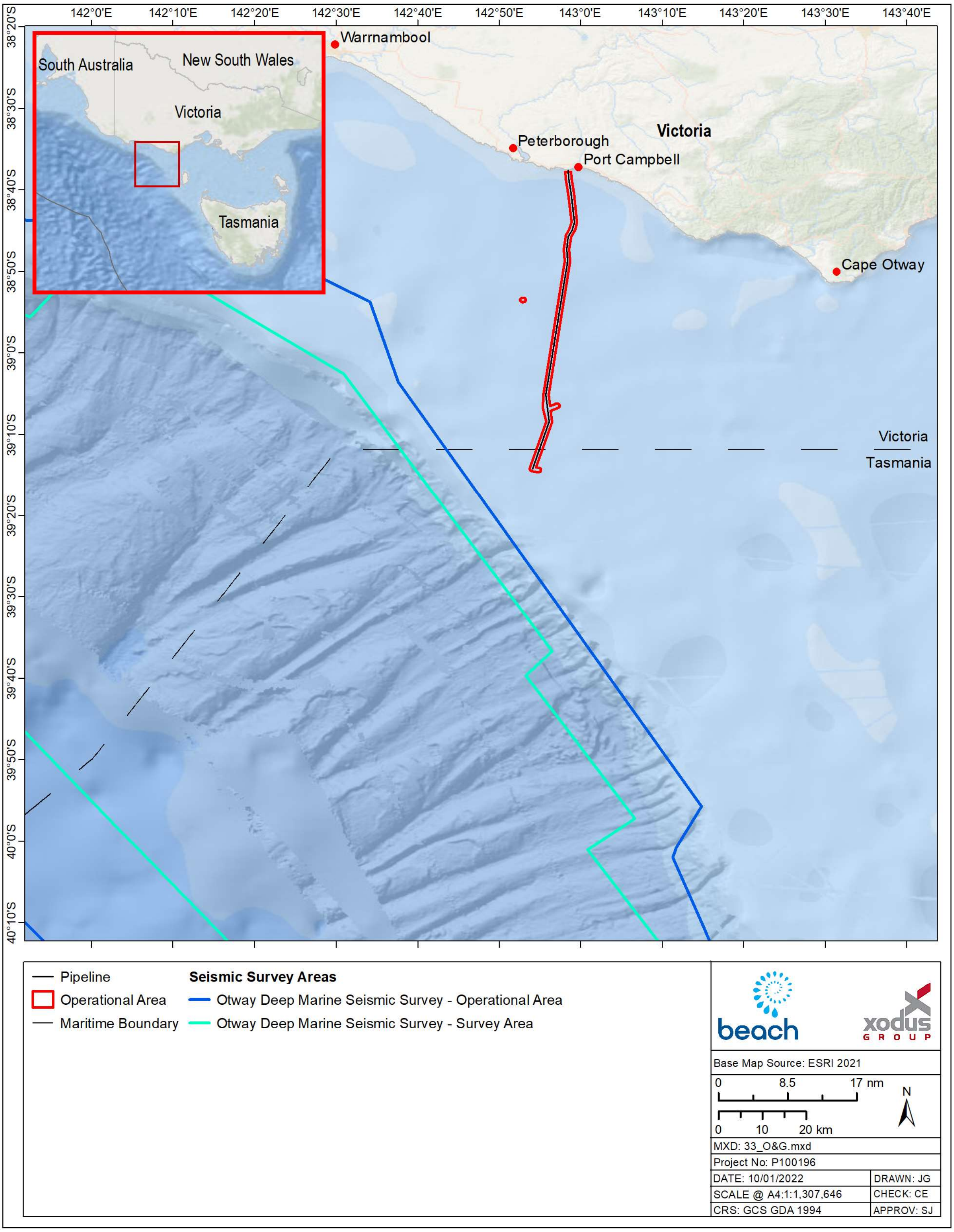


Figure 5-45: Oil and gas exploration and production

5.7.4 Shipping

The SEMR is one of the busiest shipping regions in Australia and Bass Strait is one of Australia's busiest shipping routes (Figure 5-46). 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.

Ports Australia (2019) provide statistics for port operations throughout Australia's main commercial ports. Based on the latest information (2018 – 2019 financial year) the majority of commercial shipping traffic transiting to and from Victorian ports were bulk liquid carriers (696,261), bulk gas (445,230), other cargo (3,800), container (1,057), general cargo (716), car carrier (384) and livestock (36).

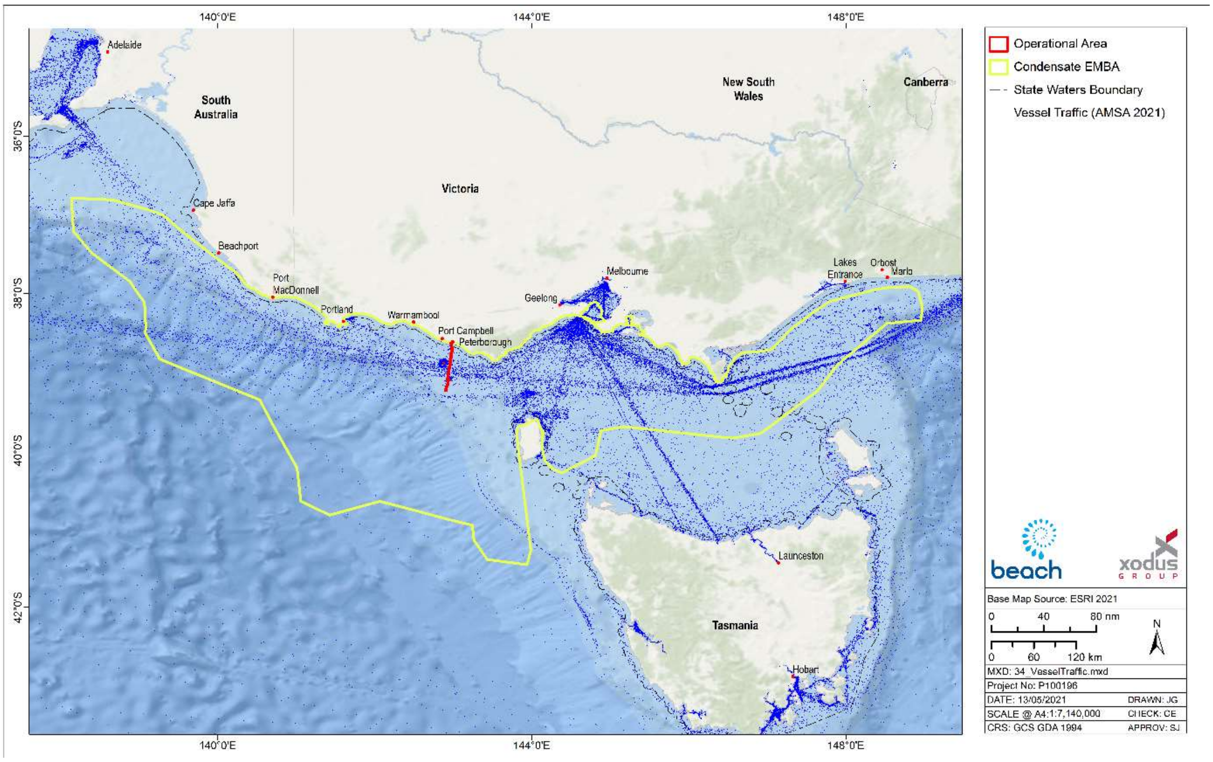


Figure 5-46: Vessel traffic within the spill EMBA and operational area

5.7.5 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.

5.7.6 Recreational diving

Recreational diving occurs along the Otway coastline. Popular diving sites near Peterborough include several shipwrecks such as the Newfield, which lies in 6 m of water and the Schomberg in 8 m of water. Peterborough provides several 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 (4-11 m of water) which can be accessed from shore or via boat.

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.

5.7.7 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.

The recreational fisheries that occur within the spill EMBA 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 EMBA. Recreational scallop and squid fishing primarily occurs within Port Phillip Bay and Western Port and as such fishing for these species is unlikely within the EMBA. Pipi harvesting occurs in Venus Bay, in the eastern portion of the EMBA, 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 recreational fishing to occur within the near shore areas of the Otway Pipeline System.

Information relating to the target species, fishing locations, landed catch, value and other relevant aspects of each fishery is included in Table 5-20.

Table 5-20: Recreational fisheries within the EMBA

Fishery	Target species	Description	Fishing activity
Rock lobster	Southern rock lobster	Recreational catch is taken by hand from coastal inshore reefs in waters less than about 20 m deep. A daily bag limit of 2 lobster applies.	Yes

Fishery	Target species	Description	Fishing activity
Finfish	Snapper King George whiting Salmon Flathead Bream Tuna Sharks	Recreational fishing occurs along the Victorian coastline from beaches, jetties and vessels (privately owned and chartered). Artificial reefs have also been established in Port Phillip Bay and offshore from Torquay, to enhance recreational fishing opportunities.	Yes
Scallops	Commercial scallops Doughboy scallops	Scallops are collected by hand by recreational fishers while diving. Most recreational catch occurs within Port Phillip Bay.	Unlikely
Abalone	Blacklip abalone Greenlip abalone	A permanent closure is in place for greenlip abalone in Port Phillip Bay, and for both green- and blacklip abalone from the intertidal to 2 m water depth in all of Victoria. The central zone (which overlaps with the EMBA) is open to recreational abalone take only on nominated days between November and April.	Yes
Squid	Gould's squid	Recreational squid fishing predominantly occurs in Port Phillip Bay and Western Port, but also in other sheltered waters such as at Portland. Fishing is generally from jetties such as at Queenscliff (Port Phillip Bay) and Flinders (Mornington Peninsula, Western Port) or from boats.	Unlikely
Pipi	Pipi	Pipi are harvested from the intertidal zone. Currently the only recreational harvest occurs in Venus Bay, although the Victorian Fisheries Authority has advised that high levels of toxins are present in pipis and advises that they are unsafe for human consumption.	Unlikely (due to toxins)

5.7.8 Commonwealth managed fisheries

A review of the Australian Fisheries Management Authority (AFMA) website identified that the following Commonwealth managed fisheries overlap the spill EMBA:

- Bass Strait Central Zone Scallop Fishery (Bass Strait CZSF).
- 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.

Of these fisheries, the Bass Strait CZSF, ETBF, SBTF, SESSF and Southern Squid Jig Fishery have catch effort within the spill EMBA and SESSF and Southern Squid Jig Fishery have catch effort within the operational area based on ABARES reports data for fishing years 2013 – 2019 (Patterson et al. 2020, 2019, 2018, 2017, 2016, 2015 and Georgeson et al. 2014). 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 is included in Table 5-21. Detailed mapping is provided where there is overlap between recent fishing intensity and the spill EMBA (Figure 5-47 to Figure 5-50).

Table 5-21: Commonwealth managed fisheries within the spill EMBA

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Bass Strait Central Zone Scallop Fishery	Scallops	Fishery operates in the Bass Strait between the Victorian and Tasmanian and starts at 20 nm from their respective coastlines. Commercial scallops in the Bass Strait Central Zone Scallop Fishery are mainly found at depths of 35 - 100 m and are caught using a steel dredge that is towed by the vessel along muddy to coarse sand substrates. Fishing effort is concentrated around King and Flinders Islands. Currently 12 active boats using towed dredges. Fishing season is 1 April to 31 December. Actual catch in 2019 was 2,931 tonnes. The major landing ports in Victoria are Apollo Bay and Queenscliff. Total fishery value in 2016 was A$6.3 million. Fishing mortality: not subject to overfishing. Biomass: Not over fished. There has been fishing effort in the spill EMBA based on ABARES data for 2013 – 2019. There has been no fishing effort in the operational area based on ABARES data for 2013 – 2019. Figure 5-50 shows the total area fished with the highest fishing intensity occurring around King Island.	No	Yes
Eastern Tuna and Billfish Fishery	Albacore tuna Bigeye tuna Yellowfin tuna Broadbill swordfish Striped marlin	A longline and minor line fishery that operates in water depths > 200 m from Cape York to Victoria. Fishery effort is typically concentrated along the NSW coast and southern Queensland coast. No Victorian ports are used. In 2017 there was some fishing effort in Victoria at low levels. The number of active vessels has decreased within the fishery from around 152 in 1999 to 37 in 2019. Actual catch in the 2019 season was 4,341 tonnes. Total fishery value in 2019 was A$32.1 million. Fishing mortality: not subject to overfishing. Biomass: Over fished – striped marlin. All other species not overfished. There has been fishing effort within the spill EMBA in 2017 based on ABARES data for 2013 – 2019. There has been no fishing effort in the operational area based on ABARES data for 2013 – 2019.	No	Yes

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Skipjack Tuna Fishery (Eastern)	Skipjack tuna	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)	Jack mackerel Blue mackerel Redbait Australian sardine	The Small Pelagic Fishery extends from the southern Queensland to southern Western Australia. Fishers use midwater trawls and purse seine nets. Geelong is a major landing port. Total retained catch of the four target species was 16,093 tonnes in the 2019-20 season. Fishery effort generally concentrated in the near-shore Great Australian Bight to the west and south of Port Lincoln. Fishing mortality: not subject to overfishing. Biomass: Not over fished. There has been no fishing effort in the EMBA based on ABARES data for 2013 – 2019/2020. There has been no fishing effort in the operational area based on ABARES data 2013 – 2019/2020.	No	No

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Southern and Eastern Scalefish and Shark Fishery (SESSF) (Commonwealth Trawl Sector and Scalefish Hook Sector)	Blue-eye trevalla Blue grenadier Blue warehou Deepwater sharks Eastern school whiting Flathead Gemfish Gulper shark Jackass morwong John dory Mirror dory Ocean jacket Ocean perch Orange roughy Smooth oreodory Pink ling Red fish Ribaldo Royal red prawn Silver trevally Silver warehou	The Southern and Eastern Scalefish and Shark Fishery stretches south from Fraser Island in southern Queensland, around Tasmania, to Cape Leeuwin in southern Western Australia. The EMBA is within the Commonwealth Trawl Sector and Scalefish Hook Sector. A multi-sector, multi-species fishery that uses a range of gear year-round. Fishing is generally concentrated along the 200 m bathymetric contour. Total retained catch of the target species was 13,148 tonnes in the 2019-20 season. No value is provided for 2019-20 season. In 20118-19, the fishery value was A$49.47 million. Fishing mortality: some species subject to overfishing. Biomass: some species over fished. There has been fishing effort in the spill EMBA based on ABARES data for 2013 – 2019/20. There has been fishing effort in the operational area based on ABARES data for 2013 – 2019/20 (Figure 5-47 to Figure 5-49). The shark hook and trawl sectors have no fishing intensity within the operational area (Figure 5-48 and Figure 5-49), while the shark gillnet sector has high to medium fishing intensity closer to the shore but within the operational area (Figure 5-47).	Yes	Yes

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Southern Bluefin Tuna Fishery (SBTF)	Southern bluefin tuna	The SBTF covers the entire sea area around Australia, out to 200 nm from the coast. Southern bluefin tuna are also commonly caught off the NSW coastline. In this area, fishers catch these fish using the longline fishing method. A pelagic longline and purse seine fishery that was worth $43.41 million in 2018-19 (actual catch was 6,074 tonnes). The fishery operates year-round. Fishery effort is generally concentrated in the Great Australian Bight and off the southern NSW coast. Fishing mortality: not subject to overfishing. Biomass: Over fished. There has been fishing effort within the spill EMBA in 2017 based on ABARES data for 2013 – 2019. There has been no fishing effort in the operational area based on ABARES data for 2013 – 2019.	No	Yes
Southern Squid Jig Fishery	Gould's squid (arrow squid)	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 100m at night using large lights that illuminate the waters around a boat. In 2018-19, the actual catch of 722 tonnes was worth A$2.89 million. In 2019 there were eight active vessels in the fishery. Fishing mortality: not subject to overfishing. Biomass: Not over fished. There has been fishing effort in the spill EMBA based on ABARES data for 2013 – 2019. There has been fishing effort in the operational area based on ABARES data for 2013 – 2019. Figure 5-51 shows the total area fished with squid jig in 2019 within the operational area with the highest fishing intensity occurring on the East coast of Tasmania.	Yes	Yes

Data/information sources: Australian Fisheries Management Authority (www.afma.gov.au), ABARES Fishery Status Reports 2014 to 2020.

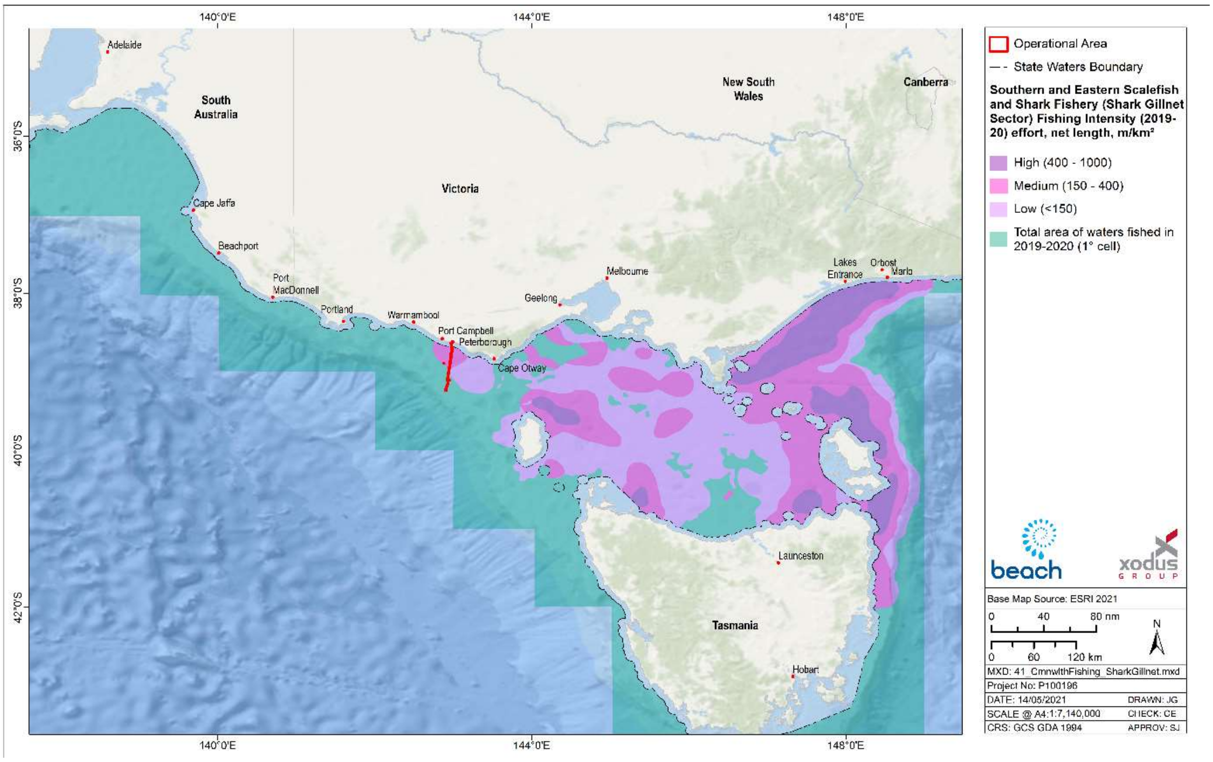


Figure 5-47: Southern and Eastern Scalefish and Shark Fishery (Shark Gillnet Sector) Fishing Intensity (effort, net length, m/km^2)

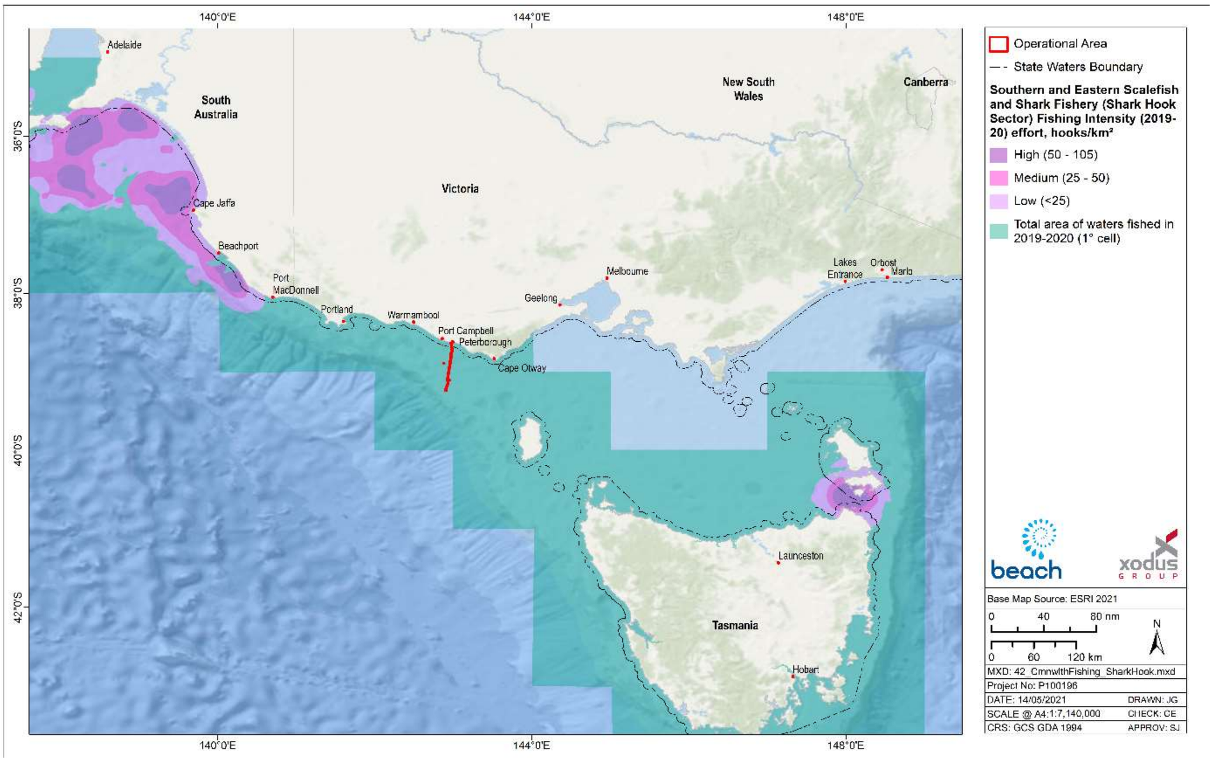


Figure 5-48: Southern and Eastern Scalefish and Shark Fishery (Shark Hook Sector) Fishing Intensity (effort, net length, m/km^2)

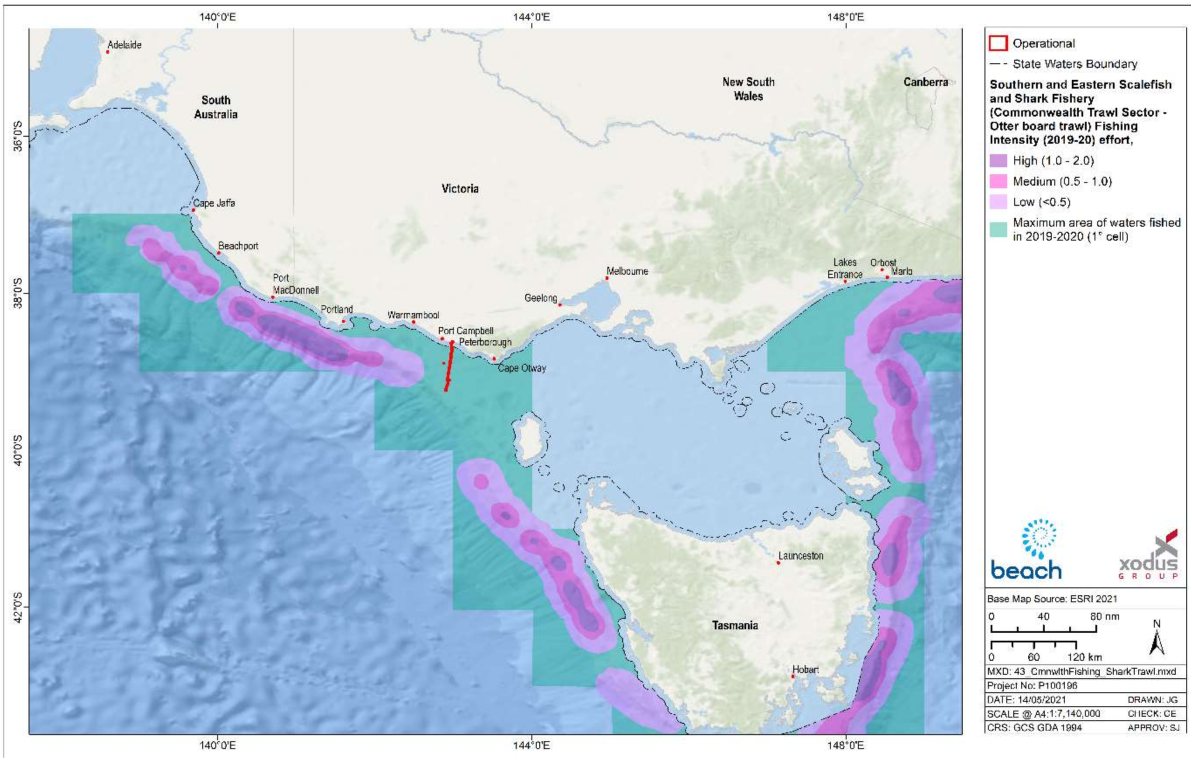


Figure 5-49: Southern and Eastern Scalefish and Shark Fishery (Commonwealth Trawl Sector) Fishing Intensity (effort, net length, m/km^2)

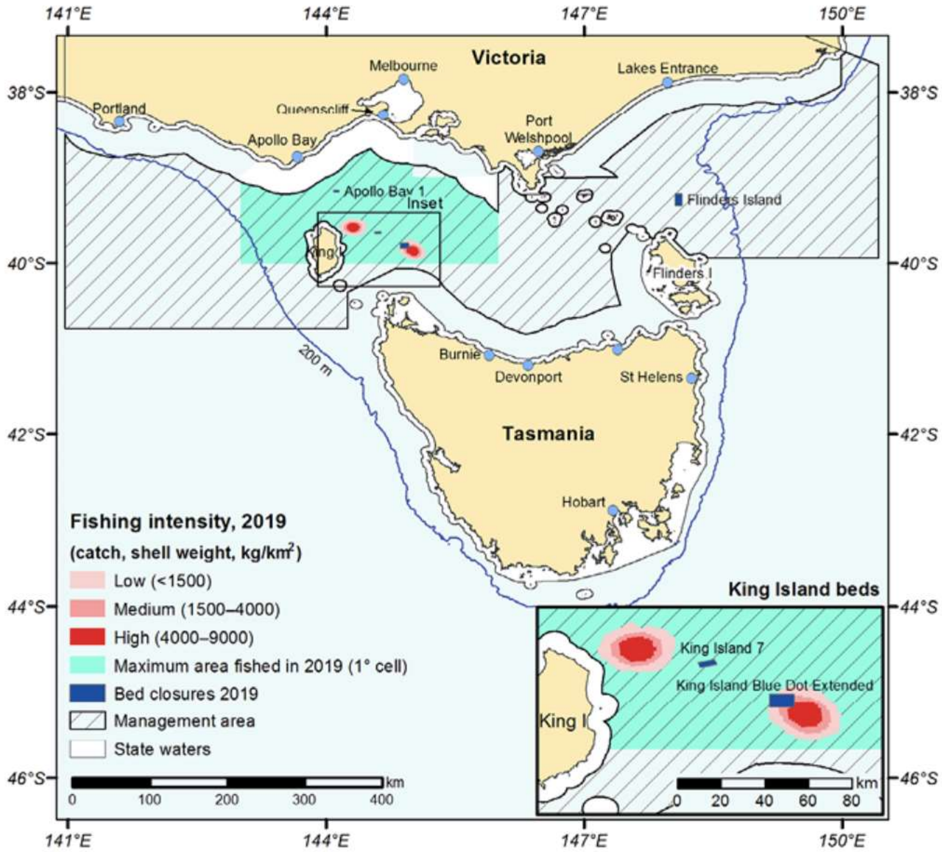


Figure 5-50: Jurisdiction of and fishing intensity of the Bass Strait Central Zone Scallop Fishery

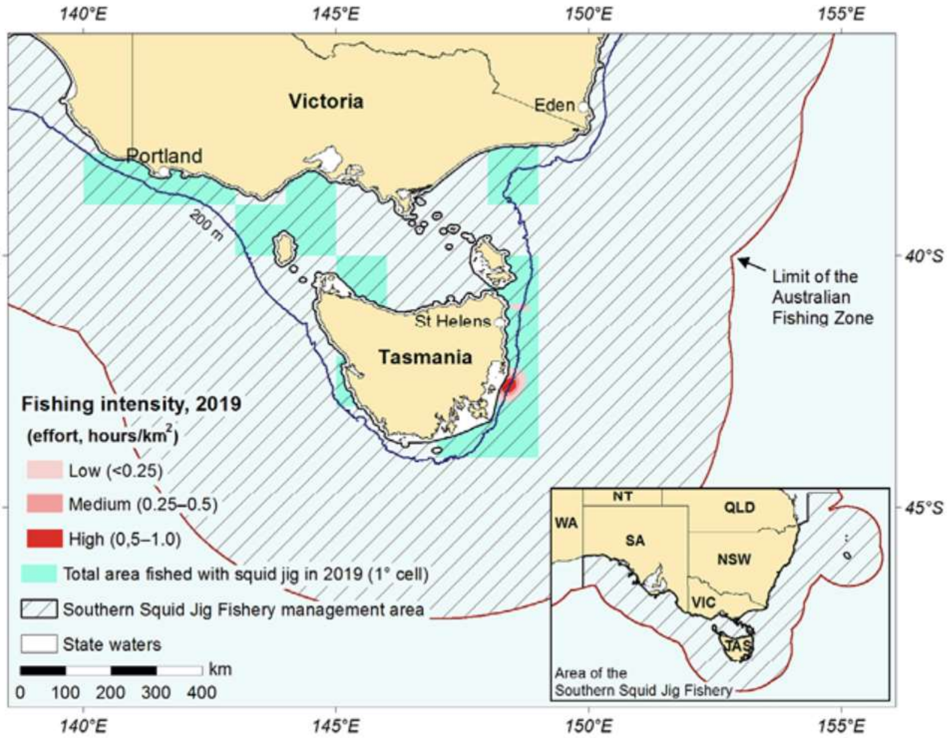


Figure 5-51: Jurisdiction of and fishing intensity of the Southern Squid Jig Fishery

5.7.9 Victorian managed fisheries

There are ten Victorian state-managed fisheries that overlap the spill EMBA:

- Abalone Fishery
- Bays and Inlet Fisheries
- Giant Crab Fishery
- Eel Fishery
- Octopus Fishery
- Pipi Fishery
- Rock Lobster Fishery
- Scallop (Ocean) Fishery
- Shark Fishery
- Snapper Fishery (Ocean fishery trawl)
- Wrasse (Ocean) Fishery

A description of these fisheries is detailed in Table 5-22.

Data was requested from VFA for the following grids. The grid numbers requested was based on where the operational area and spill EMBA lies within the grids.

- G10; G11; G12; G13
- H10; H11; H12; H13
- J10; J11; J12; J13
- K10; K11; K12; K13
- L10; L11; L12; L13
- M10; M11; M12; M13

A description of the fisheries that overlap the spill EMBA and operational area are detailed in Table 5-22 along with a description for the following fisheries that have monthly catch effort data within the operational area; fish (eel, snapper and wrasse fishers), octopus, shark, southern rock lobster and giant crab. Figure 5-52 to Figure 5-56 show the catch effort based on the maximum number of fishers in that area for each year from 2016-2020.

Table 5-22: Victorian managed fisheries in the spill EMBA

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Abalone Fishery (western zone)	Blacklip abalone Greenlip abalone	A highly valuable fishery (A$20 million in 2014-15) that operates along most of the Victorian shoreline, generally to 30 m depth. Abalone are harvested by divers. Total allowable commercial catch limits of blacklip abalone for the western zone are considerably less than the central and eastern zone (for 2017-18 season, 63.2 tonnes compared with 274.0 and 352.5 tonnes, respectively). There are 14 licences in the western zone. The water depths where abalone are fished are close to shore within the spill EMBA. No fishing effort was identified in the operational area.	No	Yes
Bays and Inlet Fisheries	Multi-species	Multi-species, multi gear fishery utilising octopus, fish and crab traps plus line fishing, seine nets mussel rakes and underwater breathing apparatus. Fisheries within Western Port and Port Phillip Bay are within the spill EMBA.	No	Yes
Eel Fishery	Eel	Target species are the short-finned eel (*Anguilla australis*) and long-finned eel (*A. reinhardtii*). Commercial fishers are only permitted to use fyke nets. Total catch for both species in 2016 was ~60 tonnes. Species spend the majority of their life cycle in fresh water or estuaries but travel to the ocean to spawn once before dying. Estuaries and migration routes are within the spill EMBA. Beach obtained fishing data from VFA for the years from 2016 – 2020 (see stakeholder record VFA_01). Figure 5-54 shows there is fishing effort within the spill EMBA and operational area. However, the wrasse, snapper and eel fishery have been combined in Figure 5-54. The catch data from VFA shows that the eel fishery is only present in grid G11 which is outside the operational area.	No	Yes

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Giant Crab Fishery	Giant crab	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 continental shelf edge (~200 m deep). 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 September to 15 November) and female (1 June to 15 November) giant crabs. Total landed catch in 2015-16 was 10 tonnes. Beach obtained fishing data from VFA for the years from 2016 – 2020. Figure 5-53 shows there is fishing effort within the spill EMBA and operational area (Figure 5-53). Within both the spill EMBA and operational area there is only a maximum of one giant crab fisher. The grids that show consistency with fishing data for all of the years from 2016-2020 are grids M12 and L11 which are outside of the operational area. Within the operational area K12 where Geographe field is located, there has only been one fisher recorded in August 2018. This is also similar to grid L12 where the Thylacine-A Wellhead Platform is located, there has been a maximum of one giant crab fisher for August 2017, May 2018, June 2018 and December 2018.	Yes	Yes

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
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. Beach obtained fishing data from VFA for the years from 2016 – 2020 (see stakeholder record VFA_01). Figure 5-55 shows there is fishing effort within the spill EMBA and operational area. Most catch effort for the octopus fishery occurs along the coastline near Peterborough and Port Campbell (Figure 5-55), with presence every year from 2016-2020, however this fishery has declined in maximum number of fishers from 2016 in both grids G12 and G13. Within grid J12 where Artisan-1 is located and the Otway Pipeline System traverses there has been a maximum of one octopus fisher present for March and April 2016, May and June 2017 and September 2018. Within Grid K12 where the Geographe field is located there has been a maximum of one octopus fisher present for March and April 2016 and February and March 2017. No fishing has been recorded in Grid L12 where the Thylacine-A Wellhead Platform is located.	Yes	Yes
Pipi Fishery	Pipi	Main commercial harvesting area is Discovery Bay with limited activity in Venus Bay. Harvested in the high impact beach zone using traditional dip nets. Total annual catches in 2016–17 and 2017–18 were 42 tonnes each year. Discovery Bay and Venus Bay are within the spill EMBA	No	Yes

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Rock Lobster Fishery (western zone)	Southern rock lobster	Victoria's second most valuable fishery with a production value of A$24 million in 2014-15. 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 September to 15 November) and female (1 June to 15 November) lobsters. Southern rock lobsters are found to depths of 150 m, with most of the catch coming from inshore waters less than 100 m deep. Beach obtained fishing data from VFA for the years from 2016 – 2020 (see stakeholder record VFA_01). Figure 5-52 shows there is fishing effort within the spill EMBA and operational area. The data shows that this fisheries presence has declined since 2016 with the maximum number of fishers close to the coastline in the vicinity of the Otway Pipeline System (grid G12) has been declining from 6 in 2016 to 2 in 2020 (Figure 5-52). Grid J12 where Artisan-1 is located and the Otway Pipeline System traverses has had a maximum of one fisher every year from 2016-2020. Grid K12 where the Geographe gas field is located has had a maximum of one fisher from 2016-2019 with the exception of two fishers present for 2018 and no southern rock lobster fishers present for 2020. For grid L12 where the Thylacine-A Wellhead Platform is located there has been a maximum of one fisher in 2017 and 2019.	Yes	Yes
Scallop (Ocean) Fishery	Scallops	Extends the length of the Victorian coastline from high tide mark to 20 nm offshore. Fishers use a scallop dredge. Temporary closures occur when stocks are low to allow scallop beds to recover. Total allowable commercial catch for 2015-16 was set at 135 tonnes. Scallops are mostly fished from Lakes Entrance and Welshpool. Fishing data from VFA for 2016 – 2020 did not identify scallop fishing effort within the grids provided which included the operational area. Based on the fishery location scallop fishing effort may occur within the spill EMBA.	No	Yes

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Shark Fishery	Gummy shark School shark Port Jackson shark Dog shark One-finned shark Broadnose shark	The wrasse, inshore trawl, southern rock lobster and giant crab fisheries are able to catch gummy shark (*Mustelus antarcticus*) and school sharks (*Galeorhinus galeus*) as part of their fishery. The combined catch limit for the gummy and school shark has been increased to 5 with no more than 1 shark being a school shark. Other shark species that may be caught is the Port Jackson shark (*Heterodontus portusjacksoni*), dog shark (*Squalus acanthias*), one-finned shark (*Heptranchias perlo*) and the broadnose shark (*Notorynchus cepedianus*). Beach obtained fishing data from VFA for the years from 2016 – 2020 (see stakeholder record VFA_01). Figure 5-56 shows there is fishing effort within the spill EMBA and operational area. The shark fishery has most of their recorded catch effort near the coastline in grids G11, 12 and 13. Grid G11 shows the most shark fishers present from 2016-2020 with two fishers present for 2020. Fishing effort (up to one fisher) has only been recorded in the operational area in G12 which overlaps the HDD and Otway Pipeline System. Fishing effort is low in G12 with fishing ranging from zero in 2019 to 5 months in 2016. 5 years	Yes	Yes
Snapper Fishery (western stock) (Ocean fishery trawl (inshore) licence)	Snapper	Snapper are caught using lines, nets and haul seine. Over 90% of the catch is from Port Phillip Bay, and around 5% from coastal waters. In 2014-15, 147 tonnes were landed at a value of A$1.38 million. Beach obtained fishing data from VFA for the years from 2016 – 2020 (see stakeholder record VFA_01). Figure 5-54 shows there is fishing effort within the spill EMBA and operational area. The wrasse, snapper and eel fishery have been combined in Figure 5-54. The catch data obtained from VFA shows that the fish fishery is mostly along the coast surrounding Port Campbell and Peterborough. The snapper fishery has a high presence along the Peterborough coastline from 2016-2020 (grids G11 and G12). Within grid J12 where Artisan-1 is located and the Otway Pipeline System traverses there was one snapper fisher March in 2020.	Yes	Yes

Fishery	Target species	Description	Fishing Effort Operational Area	Fishing Effort Spill EMBA
Wrasse (Ocean) Fishery	Bluethroat wrasse Purple wrasse Small catches of rosy wrasse, senator wrasse and southern Maori wrasse	Extends the length of the Victorian coastline from high tide mark to 20 nm offshore. Fishers mostly use hook and line. Limited entry fishery with 22 current licences. Total annual catches in 2014-15 and 2015-16 were ~30 tonnes. Beach obtained fishing data from VFA for the years from 2016 – 2020 (see stakeholder record VFA_01). Figure 5-54 shows there is fishing effort within the spill EMBA and operational area. The wrasse, snapper and eel fishery have been combined Figure 5-54. The catch data obtained from VFA shows that the fish fishery is mostly along the coast surrounding Port Campbell and Peterborough. The wrasse fishery is present close to shore with fishing only in grids G10, 11, 12 and 13. Grid G11, which does not overlap the operational area, shows the highest area of activity for this fishery along with catch effort for 2020 (Figure 5-54). Within grid J12 where Artisan-1 is located and the Otway Pipeline System traverses, fishing effort is low with up to one fisher ranging from no effort in 2018 up to 5 months in 2016 and 2017.	Yes	Yes

Data/information sources: Victorian Fisheries Authority (www.vfa.vic.gov.au), DoEE (2015), State Govt of Victoria (2015a, b)

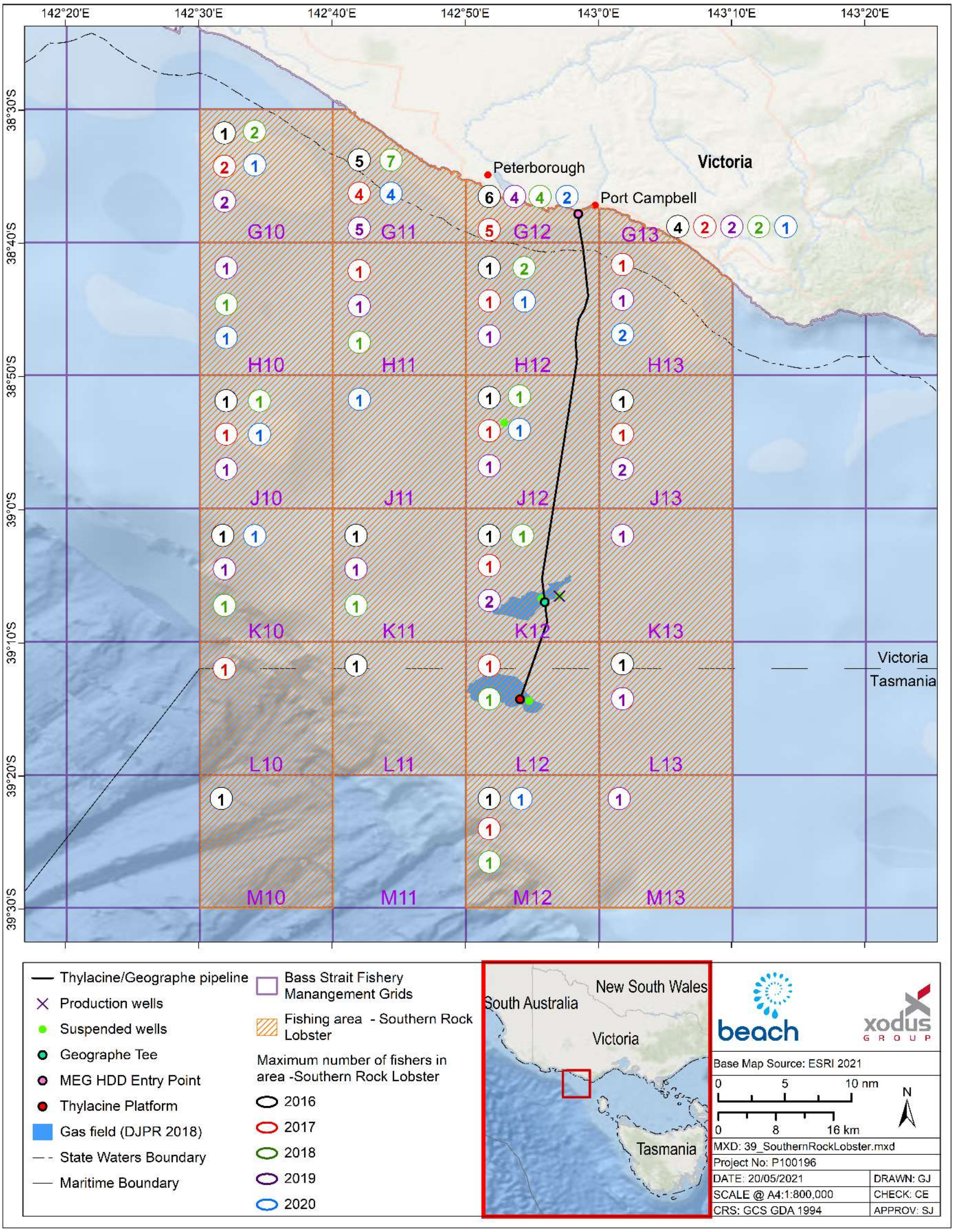


Figure 5-52: Maximum number of southern rock lobster fishers in the Otway region from 2016-2020. Data obtained from VFA, 2021.

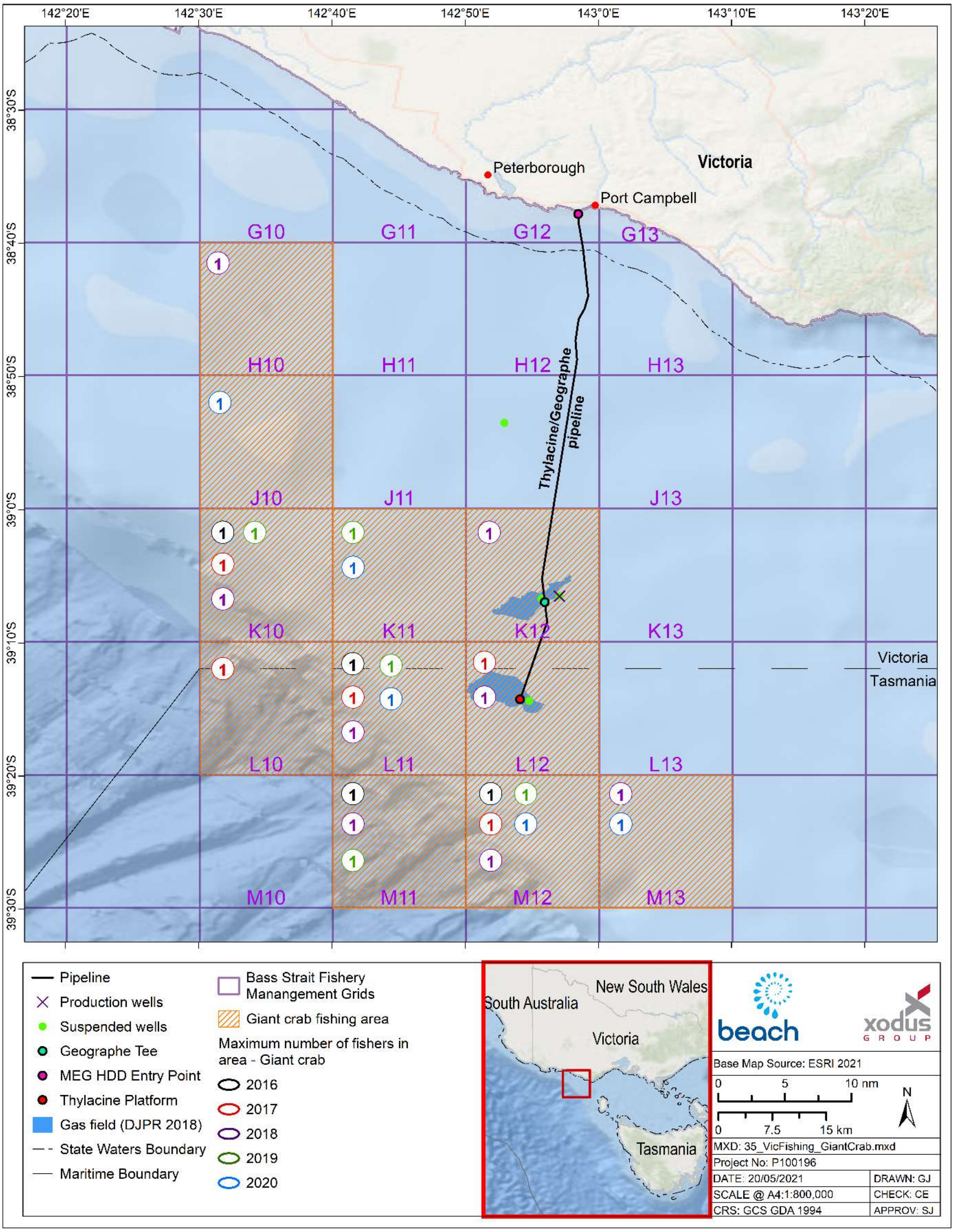


Figure 5-53: Maximum number of giant crab fishers in the Otway region from 2016-2020. Data obtained from VFA, 2021.

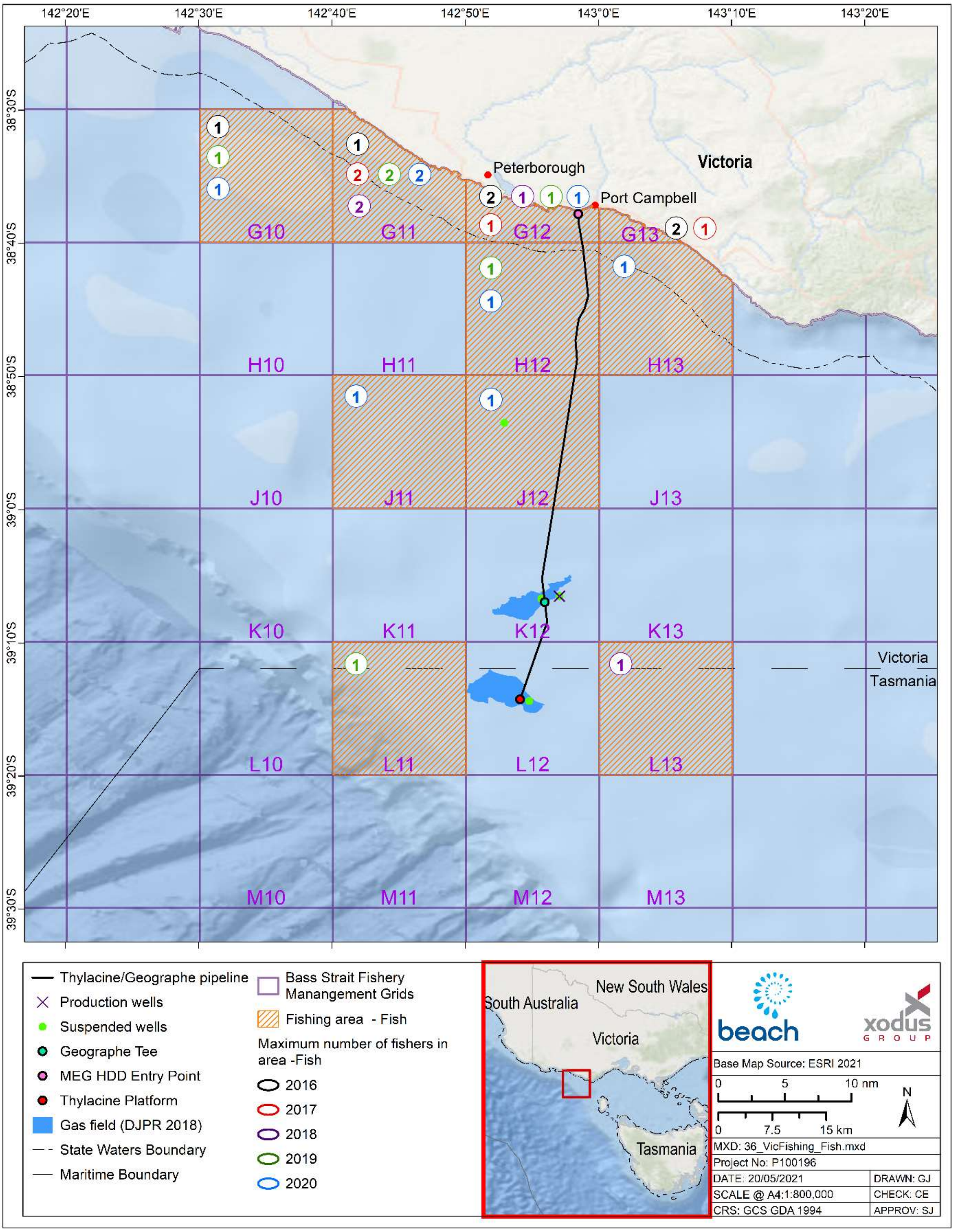


Figure 5-54: Maximum number of fish fishers (eel, snapper and wrasse fisheries) in the Otway region from 2016-2020. Data obtained from VFA, 2021.

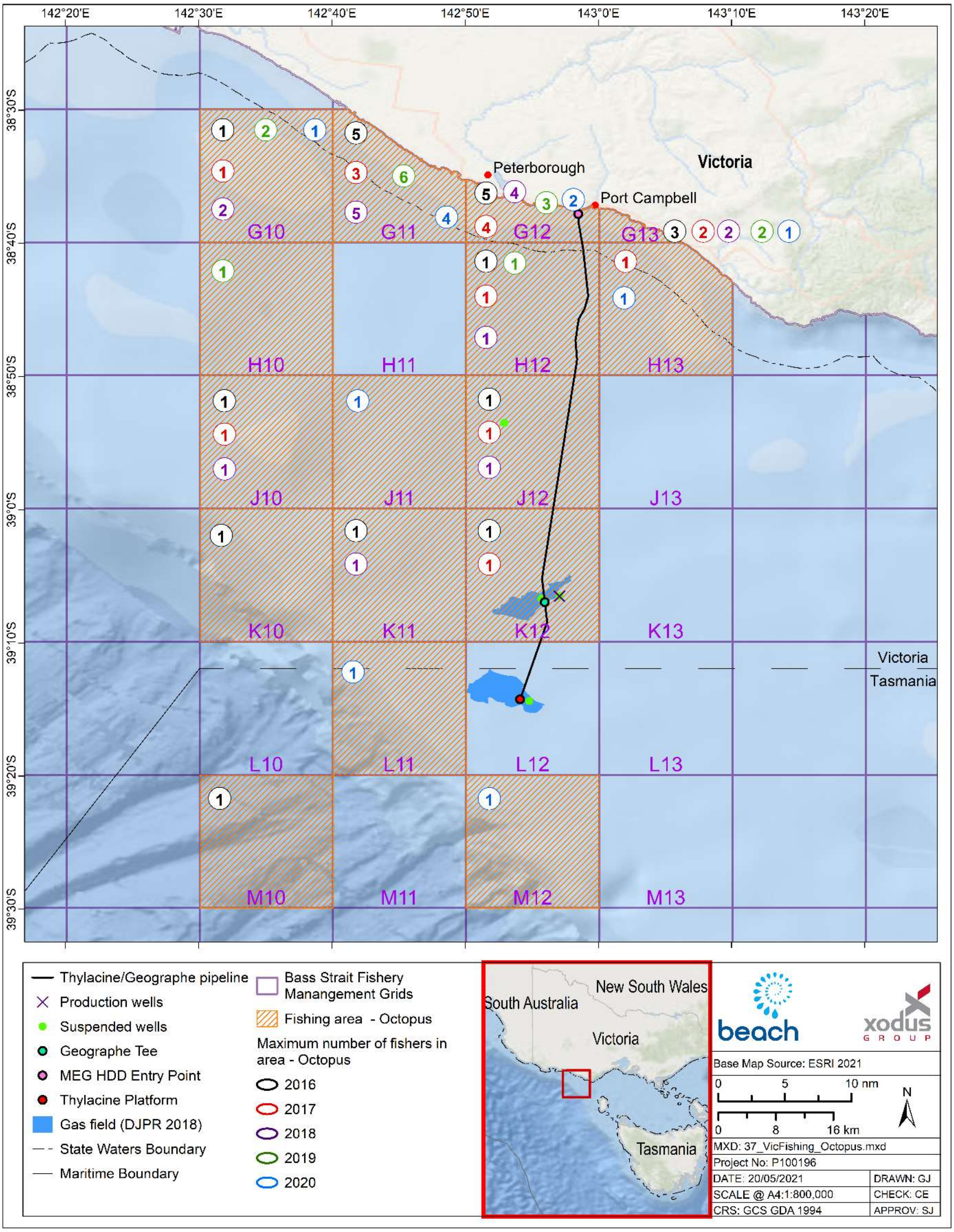


Figure 5-55: Maximum number of octopus fishers in the Otway region from 2016-2020. Data obtained from VFA, 2021.

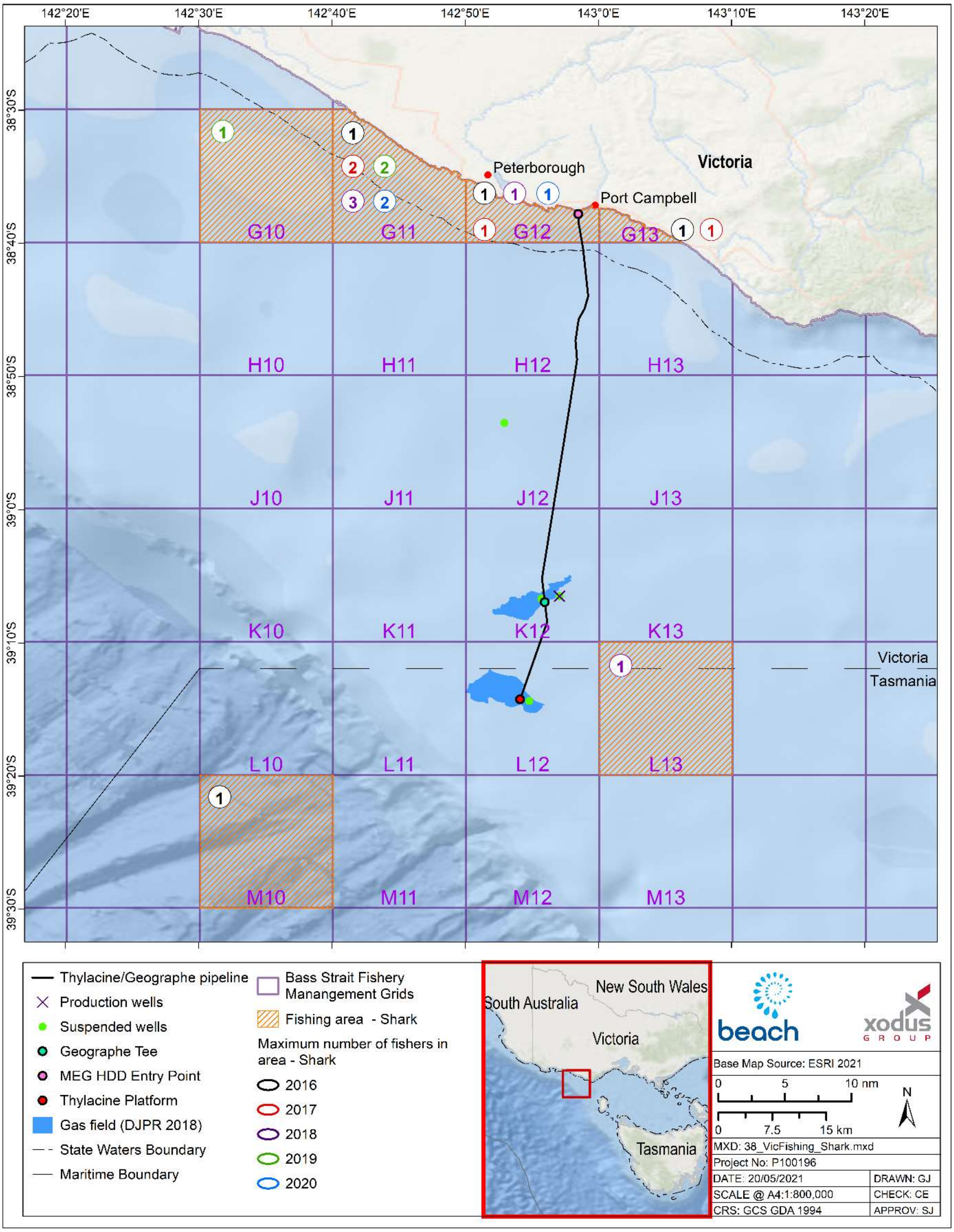


Figure 5-56: Maximum number of shark fishers in the Otway region from 2016-2020. Data obtained from VFA, 2021.

5.7.10 Tasmanian managed fisheries

No Tasmanian fisheries were identified within the operational area.

There are eight Tasmanian state managed commercial fisheries that occur within the spill EMBA:

- Abalone Fishery
- Commercial Dive Fishery
- Giant Crab Fishery
- Rock Lobster Fishery
- Scalefish Fishery
- Scallop Fishery
- Seaweed Fishery
- Shellfish Fishery

A description of these fisheries is in Table 5-23.

Historic catch assessments indicate that Commercial Dive, Scallop and Shellfish Fisheries activities are unlikely to occur in the spill EMBA, with fishing effort located in other areas of these fisheries. The Rock Lobster and Abalone Fisheries, which are by far the most productive and economically important Tasmanian fisheries accounting for 95% of the total value, are both expected to be active within the spill EMBA. Giant Crab, Scalefish, Scallop and Seaweed Fisheries are also likely to be active within the spill EMBA to varying degrees.

The jurisdictional area of the Seaweed Fishery extends to the limit of Tasmanian State waters coastal waters (3 nm). The jurisdictional area for the Scallop Fishery extends from the high water mark to 20 nm from Tasmanian state waters into the Bass Strait and out to the limits of the Australian Fishing Zone (200 nm) off the rest of the state, as defined in the 1986 Offshore Constitutional Settlement (OCS) arrangements for scallop stock. The Abalone, Rock Lobster, Giant Crab, Commercial Dive, Scalefish and Shellfish Fisheries apply throughout Tasmanian State waters as defined in the 1996 OCS arrangements for invertebrates and finfish stock.

Table 5-23: Tasmanian managed fisheries in the spill EMBA

Fishery	Target species	Description	Fishing Effort Spill EMBA
Abalone Fishery (Northern and Bass Strait Zones)	Black lip (*Haliotis rubra*) and greenlip abalone (*H. laevigata*)	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 main focus 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. Total landings were 1018.5 t for 2020, comprising 934.5 t of blacklip and 84 t of greenlip abalone. The spill EMBA intersects the Northern Zone (waters around King Island) and Bass Strait Zone (waters in the Northern Bass Strait Region) of the Abalone Fishery.	Yes
Commercial Dive Fishery (Northern Zone)	White sea urchin (*Heliocidaris urethrograms*), black sea urchin (*Centrostephanus rodgersii*) and periwinkles (*Lunella undulate*)	Dive 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 accounting 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 spill EMBA intersects the Northern Zone of the Commercial Dive Fishery at King Island and in the northern Bass Strait. The Northern Zone of the fishery is defined as the area of Tasmanian State waters on the east coast bounded by the line of latitude 42°20'40"S in the south and extending north to the line of latitude 41°00'26"S (from the southern point of Cape Sonnerat to Red Rocks).	Yes
Giant Crab Fishery	Giant crab (*Pseudocarcinus gigas*)	The giant crab fishery is a comparatively small fishery with the total allowable catch for 2019-20 at 19.18 t. 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. The spill EMBA potentially overlaps the area where giant crabs are fished for on the continental slope.	Yes

Fishery	Target species	Description	Fishing Effort Spill EMBA
Rock Lobster Fishery	Southern rock lobster (*Jasus edwardsii*)	Southern rock lobster are the other major wild-caught Tasmanian fishery. For 2020-21 the Total Allowable Catch has declined to 990.56 t. The quota for the year remains at 1050.7 t. Rock lobster made up a volume of 1,047 t or 25% percent of total fisheries production in 2015/16. Production value was $89 million or 51% of total fisheries value in 2014/15 (up 7% from 2013/14). Southern rock lobsters are found to depths of 150 m with most of the catch coming from inshore waters less than 100 m deep throughout state waters. There are 209 vessels active in the fishery. The spill EMBA potentially overlaps the Rock Lobster Fishery.	Yes
Scalefish Fishery (northwest coast)	Numerous species, but the majority of effort is on # species	Complex multi-species fishery harvesting a range of scalefish, shark and cephalopod species. Fourteen different fishing methods are used. The total catch was around 270 t in 2014/15, a decline of 20 t compared to the previous season. Due to the fishery being undercaught by 26.7% in the previous season 2020/21, the Total Allowable Catch for the 2021/22 season has increased to 30 kg quota unit. The spill EMBA potentially overlaps the Scalefish Fishery.	Yes
Scallop Fishery	Commercial scallop (*Pecten fumatus*)	Fishery area extends 20 nm from the high water mark of Tasmanian state waters into Bass Strait and out to 200 nm offshore from the remainder of the Tasmanian coastline. Eight vessels are active in the fishery. Fishers use a scallop dredge. Scallop beds are generally found along the east coast and Bass Strait in depths between 10-20 m but may occur in water deeper than 40 m in the Bass Strait. Scallop habitat is protected through a ban on dredging in waters less than 20 m and a network of dredge-prohibited areas around the state. There is high variability in abundance, growth, mortality, meat yield and condition of scallop stock in the fishery and recruitment is sporadic and intermittent. Managed using an adaptable strategy where surveys are undertaken to estimate abundance and decision rules are used to open an area (or areas) to fishing. When open the scallop fishery contributes significantly to total fisheries production. In 2015 the scallop fishing season ran from July to October and the catch was 781 t. At present the Tasmanian Commercial Scallop fishery remains closed. The spill EMBA does not overlap the area of effort for the Scallop Fishery.	No

Fishery	Target species	Description	Fishing Effort Spill EMBA
Seaweed Fishery	Bull kelp (*Durvillea Pototorum*), Japanese kelp (*Undaria pinnatifida*)	Components of this fishery include collection of cast bull kelp and harvesting of Japanese kelp, an introduced species. 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 3000 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 $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 spill EMBA potentially overlaps the Seaweed Fishery.	Yes
Shellfish Fishery	Katelysia cockles (*Katelysia scalarina*), Venerupis clam (*Venerupis largillierti*), native oyster (*Ostrea angasi*), Pacific oyster (*Crassostrea gigas*)	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 spill EMBA), 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 $345,538. The spill EMBA does not overlap the Shellfish Fishery.	No

Data/information sources: Department of Primary Industries, Water and Environment (DPIPWE, 2021). Australian fisheries and aquaculture statistics 2014-15 (Patterson et al, 2016), Department of the Environment and Energy (DotEE, 2017c), Fish Research and Development Corporation (FRDC, 2017)

5.8 Cultural environment

5.8.1 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 *Victorian Heritage Act 1995* (Vic) and in Tasmanian waters under the *Historic Cultural Heritage Act 1995*. 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. 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 spill EMBA 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, 2016b) 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 over 200 historic wrecks in the spill EMBA. Only one of these wrecks, the *SS Alert*, has a protection zone that is within the spill EMBA. There is no identified aircraft wreckage within the operational area.

Beach commissioned a seabed site assessment for the Otway Gas Development (Fugro, 2020a; Fugro, 2020b). The survey extent, including the Thylacine and Geographe gas fields and infrastructure routes, are shown in Figure 5-13. 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 ~100 cm, with the average thickness of the sand patches being ~20-30 cm; precluding burial of a shipwreck.

5.8.2 Aboriginal heritage

Aboriginal groups inhabited the southwest 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.

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, 2006b).

Aboriginal 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 Aboriginal peoples, leading to the relocation of people to missions on Bruny Island, Flinders Island and other sites, and finally to Oyster Cove, their numbers diminished drastically. The Aboriginal Heritage Register (AHR), lists over 13,000 sites; however, there is no searchable database to identify any sites in the operational area. It must be assumed that sites will be scattered along the coast of King Island within the spill EMBA.

5.8.3 Native title

A search of the National Native Title Tribunal (NNTT) database identifies two claims have been accepted for registration over the adjacent coastal shoreline (and terrestrial component of the spill EMBA). One claim is by the Eastern Maar people (VC2012/001), registered in 2013, and extends seaward 100 m from the mean low-water mark of the coastline (NNTT, 2016). There is currently no determination registered over the area of the claim (still active) in the National Native Title Register. There is also a registered claim (2014/001) over Wilson's Promontory by the Gunaikurnai people. There are no registered claims in Tasmania.

6 Environmental Impact and Risk Assessment Methodology

6.1 Overview

This section outlines the environmental impact and risk assessment methodology used for the assessment of the program activities. 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 6-1 outlines this risk assessment process.

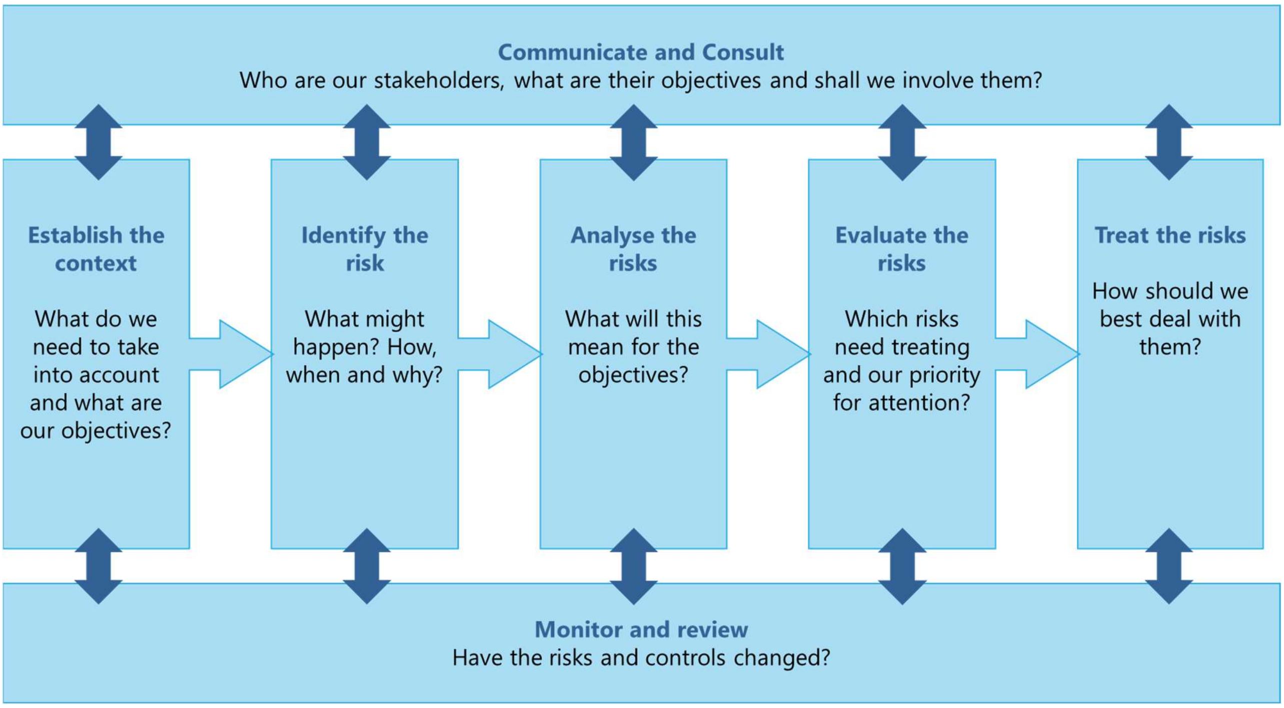


Figure 6-1: Risk assessment process

6.1.1 Definitions

Definitions of the term used in the risk assessment process are detailed in Table 6-1.

Table 6-1: Risk assessment process definitions

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: a. exercising a right conferred on a petroleum titleholder under the Act by a petroleum title; or, b. 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).

6.2 Communicate and consult

In alignment with Regulation 11A(2) of the OPGGS(E)R and 16 (8) and 19 (b) of the OPGGS Regulations (Vic), during the development of this EP, Beach has consulted with relevant person(s) (stakeholders) to obtain information in relation to their activities within the Operational Area and potential impacts to their activities. This information is used to inform the EP and the risk assessment undertaken for the activity. Stakeholder consultation is an iterative process that continues throughout the development of the EP and for the duration of a petroleum activity as detailed in Section 8.12.9.

6.3 Establish the context

Context for the risk assessment process is established by:

- understanding the regulatory framework in which the activity takes place (described in Section 0, 'Applicable Requirements');
- identifying the environmental aspects of the activity (and associated operations) that will or may cause environmental impacts or may present risks to the environment (based upon the 'Activity Description' in Section 4);
- identifying the environment that may be affected, either directly or indirectly, by the activity (based upon the 'Existing Environment' as described in Section 5.1); and
- understanding the concerns of stakeholders and incorporating those concerns into the design of the activity where appropriate (outlined in Section 8.12.9, 'Stakeholder Consultation').

6.4 Identify the potential impacts and risks

Potential impacts (planned) and risks (unplanned) associated with the environmental aspects of the activity are identified in relation to the EMBA, either directly or indirectly, by one or multiple aspects of the activity i.e., identifying the cause-effect pathway by which environmental and social receptors may be impacted. Table 7-1 details the aspects identified for the activity.

6.5 Analyse the potential impacts and risks

Once impacts and risks have been identified, an analysis of the nature and scale of the impact or risk is undertaken. This involves determining the possible contributing factors associated with the impact or risk. Each possible cause should be identified separately, particularly where controls to manage the risk differ. In this way, the controls can be directly linked to the impact or risk.

6.5.1 Establish environmental performance outcomes

Environmental performance outcomes (EPOs) are developed to provide a measurable level of performance for the management of environmental aspects of an activity to ensure that environmental impacts and risks will be of an acceptable level. EPOs have been developed based on the following:

- ecological receptors: MNES: Significant Guidelines 1.1 to identify the relevant significant impact criteria. The highest category for the listed threatened species or ecological communities likely to be present within the EMBA is used, for example: endangered over vulnerable. Where appropriate species recovery plan actions and/or outcomes.
- commercial fisheries: Victorian Fishing Authority core outcome of sustainable fishing and aquaculture (https://vfa.vic.gov.au/about).
- marine users: OPGGS Act 2006 (Cth) Section 280.

6.6 Evaluate and treat the potential impacts and risks

The following steps are undertaken using the Beach OEMS Element 8, BSTD 8.1 Risk Management Standard, Risk Matrix (Table 6-2) 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 as low as reasonably practicable (ALARP) (Section 6.7) and an acceptable level (Section 6.8); and
- establish environmental performance standards for each of the identified control measures.

Table 6-2: Environmental risk assessment matrix

CDN 14740489 Beach Risk Matrix & Risk Management Quick Reference Guide

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Risk Matrix

CONSEQUENCE	PEOPLE	ENVIRONMENT	REPUTATION	FINANCIAL	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.)**	**E.G. 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	> AUD$500m	Prolonged and complex civil and/or regulatory litigation; potential jail terms and/or very high fines and/or damages claim	HIGH	HIGH	SEVERE	SEVERE	EXTREME	EXTREME
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	>AUD$100m & ≤ $500m	Civil and/or regulatory litigation; potential significant fines and/or damages claim	MEDIUM	MEDIUM	HIGH	SEVERE	SEVERE	EXTREME
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	>AUD$10m & ≤ $100m	Civil and/or regulatory litigation; potential major fine and damages claim	MEDIUM	MEDIUM	MEDIUM	HIGH	SEVERE	SEVERE
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	>AUD$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	SEVERE
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	>AUD$100,000 & ≤ $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
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	≤AUD$100,000	Minor potential breach of law; not reportable to a regulator; on the spot fine or technical non-compliance	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM

6.7 Demonstration of ALARP

Beach's approach to demonstration of ALARP includes:

- systematically identify and assess all potential environmental impacts and risks associated with the activity;
- where relevant, apply industry 'good practice' controls to manage impacts and risks;
- assess the effectiveness of the controls in place and determine whether the controls are adequate according to the 'hierarchy of control' principle;
- for higher order impacts and risks undertake a layer of protection analysis and implement further controls if both feasible and reasonably practicable to do so.

NOPSEMA's EP decision making guideline (NOPSEMA, 2019) states that in order to demonstrate ALARP, a titleholder must be able to implement all available control measures where the cost is not grossly disproportionate to the environmental benefit gained from implementing the control measure.

For this EP, the guidance provided in NOPSEMA's EP decision making guideline (NOPSEMA, 2019) has been applied, whereby the level of ALARP assessment is dependent upon the:

- residual impact and risk level (high versus low); and
- the degree of uncertainty associated with the assessed impact or risk.

The following section details how the guidance provided in NOPSEMA's EP decision making guideline (NOPSEMA, 2019).

6.7.1 Residual impact and risk levels

Lower-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 to be lower-order and ALARP when, using the environmental risk assessment matrix, the impact consequence is rated as 'minor' or 'moderate' or risks are rated as 'low', 'medium' or 'high.' In these cases, applying 'good industry practice' (as defined in Section 6.7.2.1) is sufficient to manage the impact or risk to ALARP.

Higher-order environmental impacts and risks

All other impacts and risks are defined by NOPSEMA as higher-order environmental impacts and risks (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 to be higher-order when, using the environmental risk assessment matrix (Table 6-2), the impact consequence is rated as 'serious', 'major', 'critical' or 'catastrophic', or when the risk is rated as 'severe' or 'extreme'. In these cases, further controls must be considered as per Section 6.7.2.

An iterative risk evaluation process is employed until such time as any further reduction in the residual risk ranking is not reasonably practicable to implement. At this point, the impact or risk is reduced to ALARP. The determination of ALARP for the consequence of planned operations and the risks of unplanned events is outlined in Table 6-3.

Table 6-3: ALARP determination for consequence (planned operations) and risk (unplanned events)

Consequence ranking	Minor	Moderate	Serious	Major	Critical	Catastrophic
Planned operation	Broadly acceptable	Tolerable if ALARP		Intolerable		
Residual impact category	Lower order impacts		Higher order impacts			
Risk ranking	Low	Medium	High	Severe	Extreme	
Unplanned event	Broadly acceptable	Tolerable if ALARP		Intolerable		
Residual risk category	Lower order risks			Higher order risks		

6.7.2 Uncertainty of impacts and risks

In addition to the evaluation of residual impacts and risks as described above, the relative level of uncertainty associated with the impact or risk is also used to inform whether the application of industry good practice is sufficient to manage impacts and risks to ALARP, or if the evaluation of further controls is required.

In alignment with NOPSEMA's ALARP Guidance Note (NOPSEMA, 2015), Beach have adapted the approach developed by Oil and Gas UK (OGUK) (OGUK, 2014) for use in an environmental context to determine the assessment technique required to demonstrate that potential impacts and risks are ALARP (Figure 6-2). Specifically, the framework considers impact severity and several guiding factors:

- activity type;
- risk and uncertainty; and
- stakeholder influence.

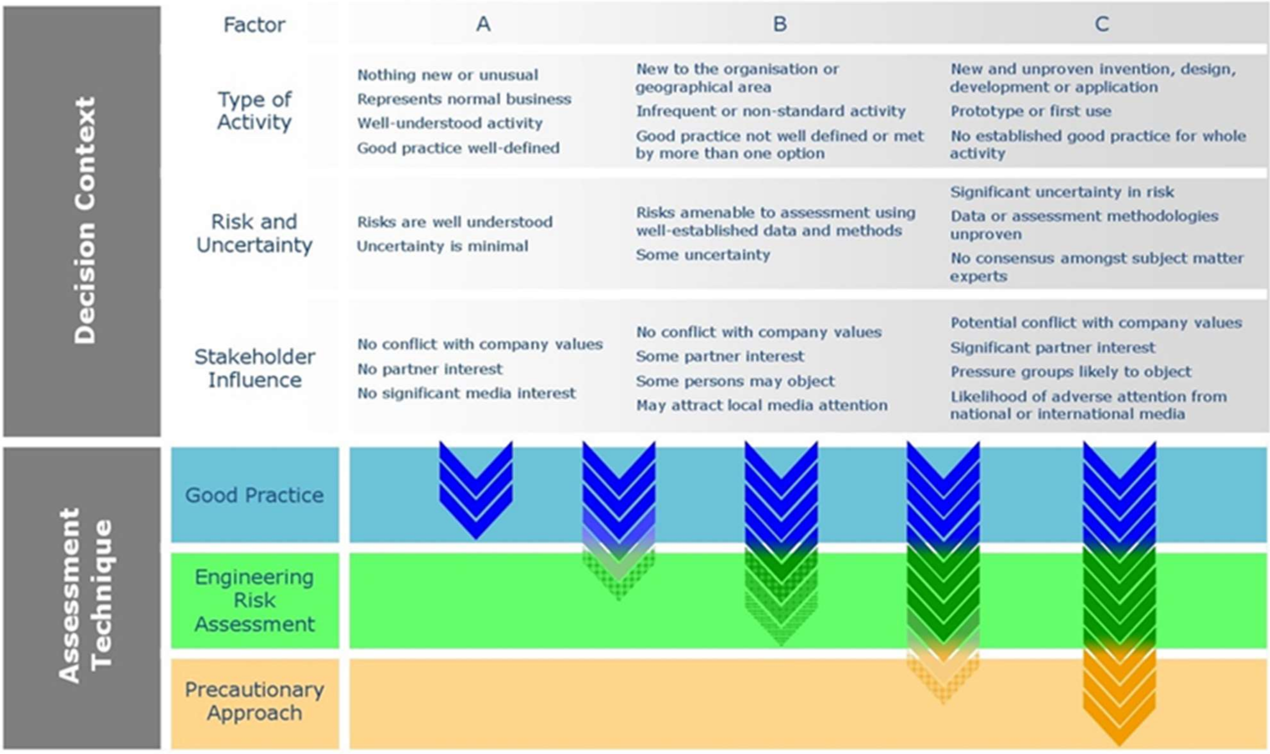

Figure 6-2: OGUK (2014) decision support framework

A **Type A** decision is made if the risk is relatively well understood, the potential impacts are low, activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. However, if good practice is not sufficiently well-defined, additional assessment may be required.

A **Type B** decision is made if there is greater uncertainty or complexity around the activity and/or risk, the potential impact is moderate, and there are no conflict with company values, although there may be some partner interest, some persons may object, and it may attract local media attention. In this instance, established good practice is not considered sufficient and further assessment is required to support the decision and ensure the risk is ALARP.

A **Type C** decision typically involves sufficient complexity, high potential impact, uncertainty, or stakeholder influence to require a precautionary approach. In this case, relevant good practice still must be met, additional assessment is required, and the precautionary approach applied for those controls that only have a marginal cost benefit.

In accordance with the regulatory requirement to demonstrate that environmental impacts and risks are ALARP, Beach has considered the above decision context in determining the level of assessment required.

The levels of assessment techniques considered include:

- good practice;
- engineering risk assessment; and

- precautionary approach.

6.7.2.1 Good practice

OGUK (2014) defines 'good practice' as the recognised risk management practices and measures that are used by competent organisations to manage well-understood impacts and risks arising from their activities.

'Good practice' can also be used as the generic term for those measures that are recognised as satisfying the law. For this EP, sources of good practice include:

- requirements from Australian legislation and regulations;
- relevant Australian policies;
- relevant Australian Government guidance;
- relevant industry standards and/or guidance material; and
- relevant international conventions.

If the ALARP technique is determined to be 'good practice', further assessment ('engineering risk assessment') is not required to identify additional controls. However, additional controls that provide a suitable environmental benefit for an insignificant cost are also identified at this point.

6.7.2.2 Engineering risk assessment

All potential impacts and risks that require further assessment are subject to an 'engineering risk assessment'. Based on the various approaches recommended in OGUK (2014), Beach believes the methodology most suited to this activity is a comparative assessment of risks, costs, and environmental benefit. A cost–benefit analysis should show the balance between the risk benefit (or environmental benefit) and the cost of implementing the identified measure, with differentiation required such that the benefit of the control can be seen and the reason for the benefit understood.

6.7.2.3 Precautionary approach

OGUK (2014) states that if the assessment, considering all available engineering and scientific evidence, is insufficient, inconclusive, or uncertain, then a precautionary approach to impact and risk management is needed. A precautionary approach will mean that uncertain analysis is replaced by conservative assumptions that will result in control measures being more likely to be implemented.

That is, environmental considerations are expected to take precedence over economic considerations, meaning that a control measure that may reduce environmental impact is more likely to be implemented. In this decision context, the decision could have significant economic consequences to an organisation.

6.8 Demonstration of acceptability

Regulation 13(5)(c) of the OPGGS(E)R requires demonstration that environmental impacts and risks are of an acceptable level.

Beach considers a range of factors when evaluating the acceptability of environmental impacts and risks associated with its activities. This evaluation works at several levels, as outlined in Section 6.8.1 which is based on Beach's interpretation of the NOPSEMA EP content requirements (NOPSEMA, 2019).

6.8.1 Acceptability Criteria

Beach has defined a set of criteria to determine acceptability of an impact or risk, following risk mitigation. Where an impact or risk is not considered acceptable, further control measures are required to lower the risk, or alternative options will be considered. The Beach acceptability criteria considers:

- principles of Ecological Sustainable Development (ESD)
- internal Context
- external Context
- other requirements.

These criteria are described in the following sections and are consistent with NOPSEMA EP content requirements (NOPSEMA, 2019).

6.8.1.1 Principles of Ecologically Sustainable Development

Section 3A of the EPBC Act defines ESD, which is based on Australia's National Strategy for Ecological Sustainable Development (1992) that defines ESD 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.'

Relevant ESD principles and how they are applied by Beach:

- decision making processes should effectively integrate both long term and short term economic, environmental, social and equitable considerations. This principle is inherently met through the EP development process, as such this principal is not considered separately for each acceptability evaluation.
- 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. If there is, the project shall assess whether there is significant uncertainty in the evaluation, and if so, whether the precautionary approach should be applied.
- the principle of inter-generational equity — that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. The EP risk assessment methodology ensures that potential impacts and risks are ALARP, where the potential impacts and risks are determined to be serious or irreversible the precautionary principle is implemented to ensure the environment is maintained for the benefit of future generations. Consequently, this principal is not considered separately for each acceptability evaluation.

- the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making. Beach considers if there is the potential to affect biological diversity and ecological integrity through the risk assessment process.

To meet this acceptance criteria, the activity must be carried out in a manner consistent with the relevant ESD principles above.

6.8.1.2 Internal Context

Beach's OEMS includes Elements and Standards relevant to the way Beach operates.

At the core of the OEMS are 11 Elements (see Section 8.1) which detail specific performance requirements for the implementation of Beach's Environmental Policy and management of potential HSE impacts and risks

Elements and Standards in the OEMS which are relevant to either the activity, impact, control or receptor will be described within the internal context and contribute towards the assessment of acceptability.

To meet this acceptance criteria, the impact or risk must be compliant with the objectives of Beach's Environment Policy. Where specific internal procedures, guidelines, expectations are in place for management of the impact or risk in question, acceptability is demonstrated.

6.8.1.3 External Context

External context considers stakeholder expectations, obtained from stakeholder consultation.

Beach has undertaken stakeholder consultation, which is described in detail in Section 8. Where objections or claims have been raised, these are considered in the assessment of acceptability of related impacts and risks.

To meet this acceptance criteria, the merits of claims or objections raised by a relevant stakeholder must have been adequately assessed and additional controls adopted where appropriate.

6.8.1.4 Other Requirements

Aside from internal and external context, other requirements must be considered in the assessment of acceptability. These include:

- environmental legislation (described in Section 0)
- policies and guidelines (described in Section 0)
- international agreements (described in Section 0)
- EPBC Management Plans (described in Section 3.1)
- Australian Marine Park designations (described in Section 5.4.2).

This acceptance criteria is met when: compliance with specific laws or standards is demonstrated; management of the impact or risk is consistent with relevant industry practices; and the proposed impact or risk controls, environmental performance objectives and standards are consistent with the nature of the receiving environment based upon formal management plans.

6.9 Monitoring and review

Monitoring and review activities are incorporated into the impact and risk management process to ensure that controls are effective and efficient in both design and operation. This is achieved through the environmental performance outcomes, environmental performance standards and measurement criteria that are described for each environmental impact or risk. Monitoring and review are described in detail in the Implementation Strategy (Section 8).

7 Environmental Impact and Risk Assessment

7.1 Overview

In alignment with Regulation 13 (5) of the OPGGS(E)R and Regulations 15 (3)(c), 15 (3)(d), 15 (3)(e) and 15 (4) of the OPGGS Regulations (Vic), this section of the EP details the potential environmental impacts and risks associated with the activity and provides an evaluation of all the impacts and risks appropriate to the nature and scale of each impact or risk. This evaluation includes impacts and risks arising directly or indirectly from the activity and includes potential oil pollution emergencies and the implementation of oil spill response strategies and oil spill monitoring.

In addition, this section details the control measures (systems, procedures, personnel or equipment) that will be used to reduce potential impacts and risks to ALARP and acceptable levels. Environmental performance outcomes (EPOs), environmental performance standards (EPSs) and measurement criteria associated with each of the identified control measures are provided in Section 7.18.

For oil spill response options aspects associated with the use of vessels are as per vessel operations in Table 7-1. Other related impacts and risks are described in Sections 7.17.

Table 7-1: Activity – Aspect Relationship

ACTIVITIES / ASPECT	Light emissions	Atmospheric emissions	Underwater sound emissions	Physical presence	Benthic disturbance	Planned marine discharges- Vessels	Planned marine discharges- Operations and IMR	Establishment of IMS	Disturbance to marine fauna	Unplanned Marine Discharge (Solids)	Loss of Containment
Thylacine-A Wellhead Platform operations											
Platform operations	✓	✓		✓					✓	✓	✓
Thylacine production wells											✓
Otway Pipeline System Operations											
Pipeline operations				✓							✓
Geographe Field Subsea Facilities Operations											
Subsea infrastructure operations				✓			✓				✓
Geographe production wells			✓	✓			✓				✓
Inspection, maintenance and repair											
Maintenance and Repair					✓		✓				
Support Operations											
Vessel operations	✓	✓	✓	✓		✓		✓	✓	✓	✓
Helicopter operations			✓								

7.2 Light emissions

7.2.1 Hazards

The Thylacine-A Wellhead Platform is normally unmanned, with lighting limited to that required for navigation which includes platform lighting remaining on when platform unmanned as per the Thylacine-A Platform Safety Case. The platform is not equipped with a flare.

During IMR and geophysical surveys, vessel activities may be undertaken 24 hours a day. Therefore, lighting is required at night for navigation and to ensure safe operations when working on vessels.

Light emissions from Thylacine-A Wellhead Platform and vessels will result in a change in ambient light.

7.2.2 Predicted environmental impacts

The predicted environmental impacts from light emissions are:

- Changes in ambient light leading to changes in fauna behaviour, through attraction of light-sensitive species

7.2.3 EMBA

The EMBA for light emissions is based on the National Light Pollution Guidelines for Wildlife (the Guidelines) (Commonwealth of Australia 2020). 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 (Commonwealth of Australia 2020). 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. Subsequently, the 20 km light EMBA adopted here is considered to be highly conservative.

The guidelines identify marine turtles, seabirds and migratory shorebirds as potentially being impacted by artificial light to a level significant enough to require assessment. Other species such as fish are discussed in the guidelines but have not been identified in the guidelines as requiring assessment and thus this is taken as impacts to them are not likely to be of a level that requires further assessment.

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 a distance of 20 km from the operational area was used to identify any areas where turtles, shorebirds and seabirds may be foraging, breeding, roosting, or migrating. This area (20 km around the operational area) is called the light EMBA. The EPBC Protected Matters Report for the light EMBA is in Appendix A.3.

Table 7-2 details the shorebirds and seabirds that may be foraging, breeding, roosting or migrating within the light EMBA. These were identified from the light EMBA PMST Report (Appendix A.3) and BIAs from the National Conservation Values Atlas. No roosting or breeding behaviours have been identified within the light EMBA.

Table 7-2: Light sensitive receptors within the light EMBA

Receptor	Biologically Important Behaviour
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	Foraging, feeding or related behaviour likely to occur within area
	Foraging BIA
Campbell 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 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 likely to occur within area
Other	
Common diving-petrel	Foraging BIA
Orange-bellied parrot	Migrating likely
Short-tailed shearwater	Foraging BIA
Wedge-tailed shearwater	Foraging BIA Breeding BIA

Artificial light can disrupt turtle nesting and hatching behaviours. Artificial light is listed as a key threat in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). Listed turtle species may occur within the light EMBA, however, no biologically important behaviours, BIAs, or habitat critical to survival for marine turtles were identified. Therefore, impacts to turtles from light emissions is not predicted.

The HDD entry point is located approximately 500 m from the shoreline, therefore vessels operating at the HDD entry point location will be visible from the coast. The nearest homes are located at Port Campbell; approximately 2.2 km from the HDD entry point. Whilst vessels operating at the HDD entry point will be visible from the shoreline, activities will be short-term inspection, maintenance, or repair activities with light levels equivalent to other vessel traffic in the area, and therefore impacts on coastal settlements are not considered further.

Therefore, the light-sensitive receptors that may occur within the light EMBA are:

- Seabirds and migratory shorebirds.

7.2.4 Consequence evaluation

For the light impact assessment, the process outlined in the guidelines is used. The aim of the guidelines is that artificial light will be managed so wildlife is:

1. not disrupted within, nor displaced from, important habitat
2. able to undertake critical behaviours such as foraging, reproduction and dispersal.

Identification of light-sensitive receptors was undertaken through definition of a 20 km light EMBA. The actual predicted area of impact at any one time will be significantly less than 20 km around each vessel operating within the operational area. Vessel activities will occur up to 500 m from the shoreline (at the HDD entry point), therefore impacts to seabird and migratory shorebird coastal habitats (such as roosting sites) could occur, however, no seabird and migratory shorebird coastal habitats for nesting or roosting are within the 20 km light EMBA.

The light EMBA PMST Report (Appendix A.3) identified likely foraging behaviour for a number of albatrosses in the light EMBA. Some of these species have foraging BIAs that the light EMBA overlaps (Table 7-2). These BIAs are shown in Figure 7-1 to Figure 7-3. Light emissions are not identified as a threat in National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). 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). Thus, impacts within the small area of overlap with albatross foraging BIAs are not predicted based on these species forage most actively during daylight.

The common diving-petrel was not identified in the light EMBA PMST Report (Appendix A.3). This species is listed as marine and does not have a recovery plan or conservation advice. The light EMBA overlaps a foraging BIA within the SEMR (Figure 7-2). Brooke (2004) cited on Animal Diversity Web (2020) details that common diving petrels spend the night in burrows during the breeding season and seem to forage mainly during the day, although they also forage 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 some studies suggest seasonal movements (Brooke, 2004 cited on Animal Diversity Web, 2020). Based on this information, common diving-petrels may forage at night within the light EMBA.

The light EMBA PMST Report (Appendix A.3) identified migration route likely for the orange-bellied parrot. No BIA or habitat critical to the survival of the species where identified. The orange-bellied parrot is a ground feeding parrot which breeds in south-west Tasmania between November and March and then overwinters on the coast of south-east mainland Australia between April and October (DELWP, 2016a). The orange-bellied parrot is classed as critically endangered and there are about 50 remaining in the wild (DELWP, 2016a). The orange-bellied parrot recovery plan identifies illuminated structures and illuminated boats as a potential barrier to migration and movement (DELWP, 2016a). IMR activities may overlap the period when orange-bellied parrots migrate between Tasmania and Victoria between late February to early April (Australian Museum, 2020). The light EMBA overlaps the likely distribution and probably migration route for the orange-bellied parrot (Figure 5-30).

The short-tailed shearwater was identified in the light EMBA PMST Report as foraging likely within the light EMBA. The light EMBA overlaps a foraging BIA within the SEMR (Figure 7-3). This species is listed as marine and migratory and does not have a recovery plan or conservation advice. No BIAs or habitat critical for the survival of the species occur within the light EMBA. Impacts to this species from light emissions are not predicted as the short-tailed shearwater returns to the colonies at dark after feeding at sea during the day (AAD, 2020).

The wedge-tailed shearwater was not identified in the light EMBA PMST Report (Appendix A.3). The light EMBA overlaps a foraging BIA and breeding BIA. The foraging and breeding BIAs intersected by the light EMBA are a buffer around Muttonbird Island, Victoria (Figure 7-3). 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 (DoEE, 2020d). A review of the DoEE 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 DoEE SPRAT profile does not show any locations for the wedge-tailed shearwater in Victoria and Beaver (2018) 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. However, impacts to this species from light emissions are not predicted as Warham, (1996) cited in Beaver (2018) details that the wedge-tailed shearwater forms 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.

The extent of the area of potential impact is predicted to be up to 20 km from the operational area with a maximum duration of 30 days for an IMR activity.

The severity (with no controls) is assessed as moderate based on:

- For IMR activities light will be generated by a single vessel for up to 30 days and for geophysical surveys for up to 10 days. Light may also be generated by a single vessel when providing standby support to the Thylacine-A Wellhead Platform for platform campaigns that take longer than a day. For these campaigns, personnel return to and from the platform each day but the vessel stays in the area of the platform rather than return to and from shore. In these cases, vessel lighting would be the minimum required for navigational lighting as no work is being undertaken at night.
- Lighting on the Thylacine-A Wellhead Platform is limited to that required for navigation which includes platform lighting remaining on when platform unmanned as per the Thylacine-A Platform Safety Case. Lights on the platform have been replaced with lower impact LED lighting.
- There are no roosting or breeding behaviours, or BIAs identified within the light EMBA.
- Light emissions are not identified as a threat in National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a).
- Of the seabirds that may potentially forage within the light EMBA only the common diving-petrel was identified as foraging at night.
- The orange-bellied parrot, which is classed as critically endangered, may migrate over the light EMBA during April to June. Illuminated structures and illuminated boats have been identified as a potential barrier to migration and movement for this species (DELWP, 2016a).

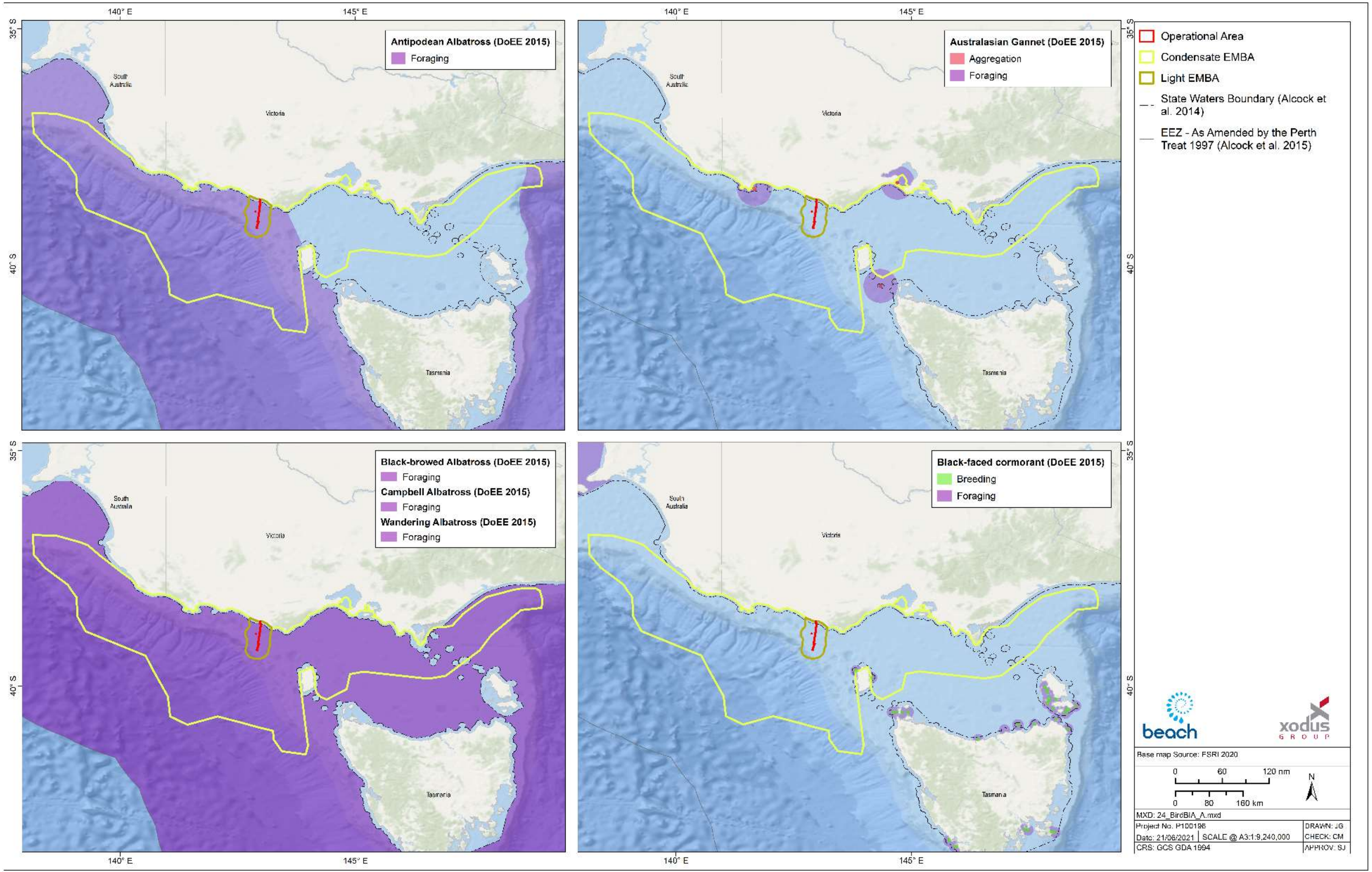

Figure 7-1: Light EMBA and BIAs for antipodean, black-browed, Campbell, wandering albatross, Australasian gannet and black-faced cormorant

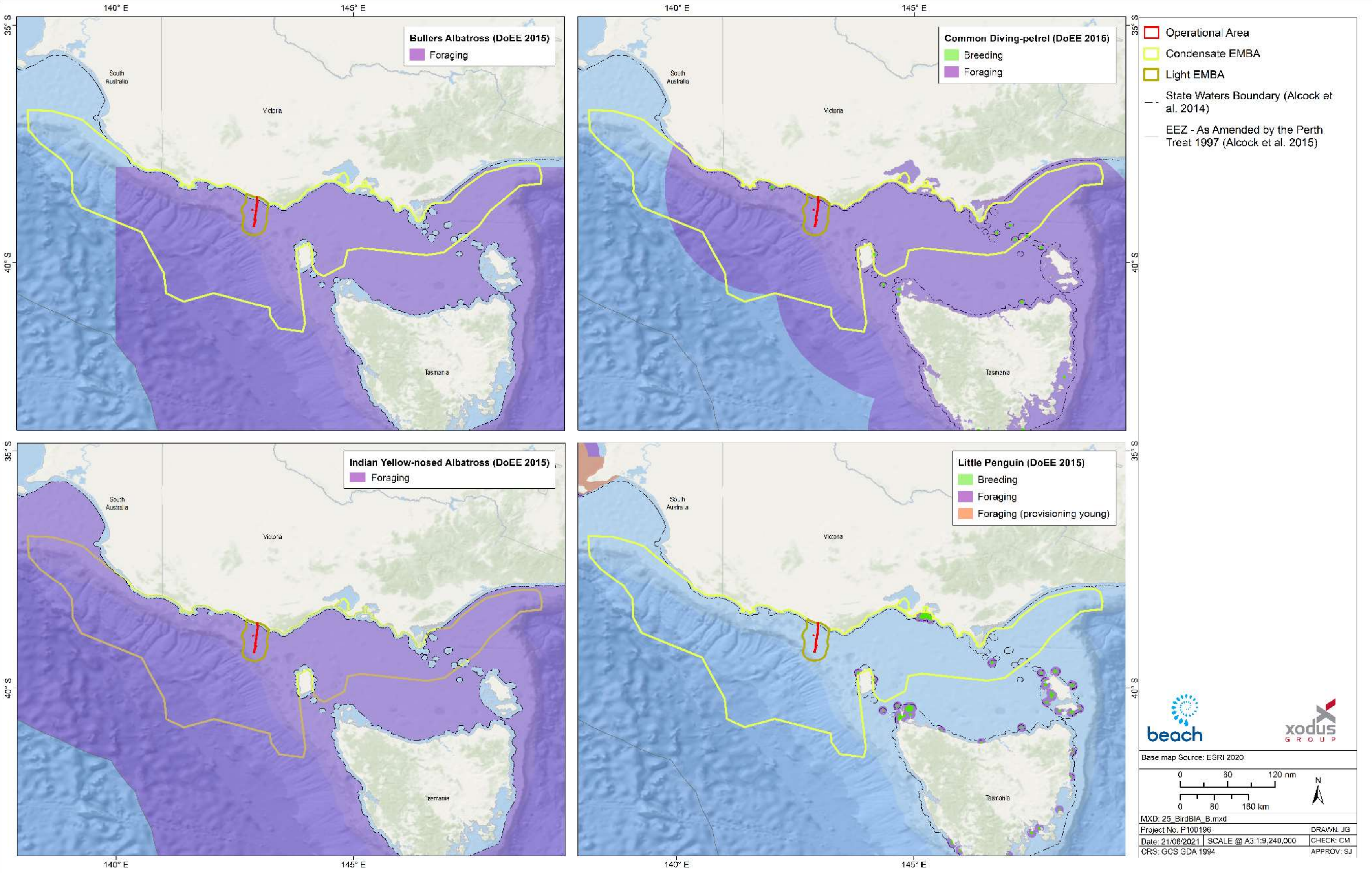

Figure 7-2: Light EMBA and BIAs for Buller's, Indian yellow-nosed albatross, common diving petrel and little penguin

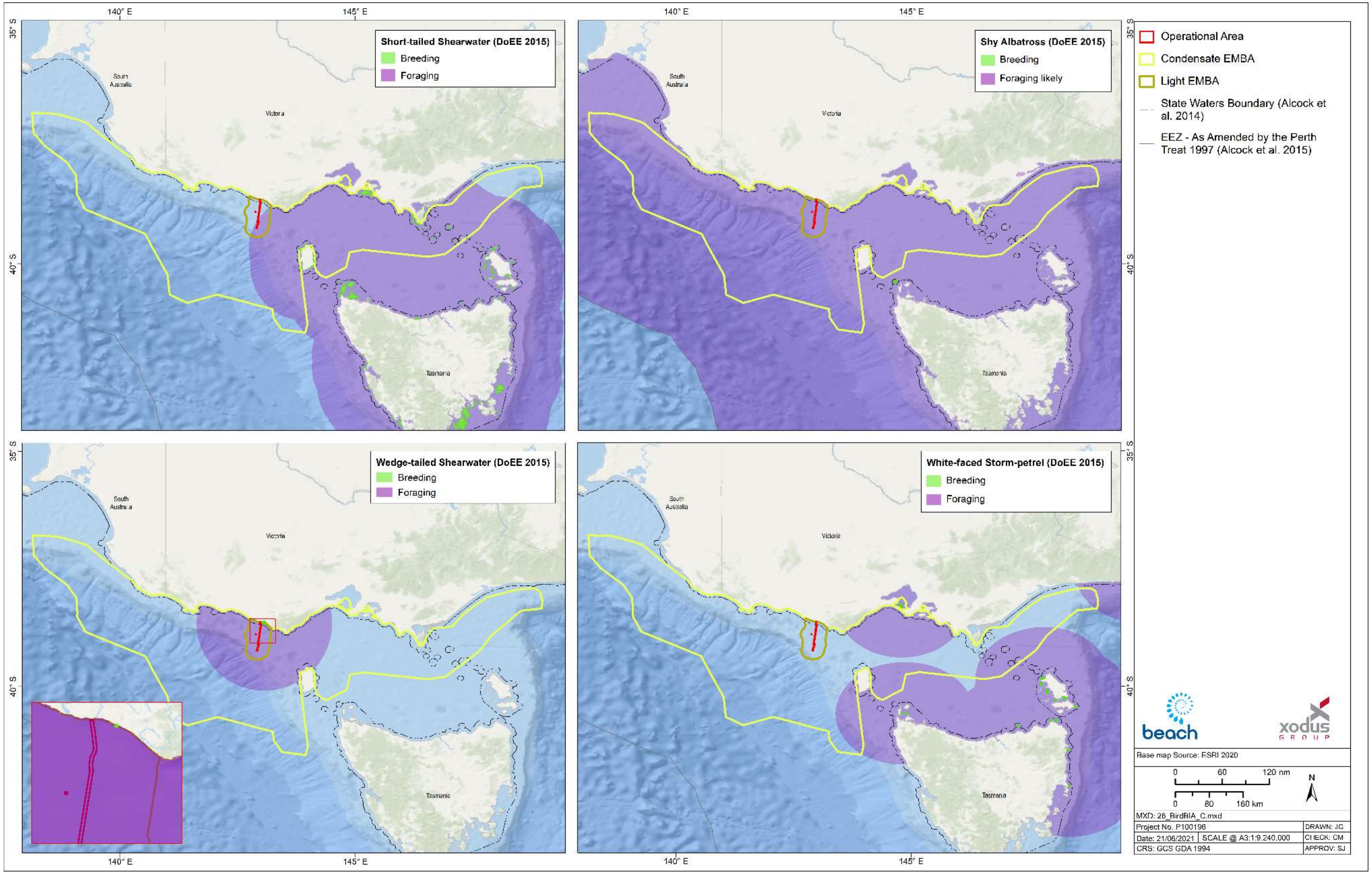

Figure 7-3: Light EMBA and BIAs for short-tailed, wedge-tailed shearwater, shy albatross and white-faced storm-petrel

7.2.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Light emissions	
ALARP decision context and justification	ALARP Decision Context: Type A Impacts from light emissions are relatively well understood though there is the potential for uncertainty in relation to the level of impact. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. Additional controls may be required to ensure impacts can be managed to an acceptable level.
Adopted Control Measures	**Source of good practice control measures**
CM#1: Light Management Procedure	The National Light Pollution Guidelines provide management options for mitigating the effect of light to seabirds. A review of the management options relevant to the activity is provided in the additional controls section with the following to be adopted: Vessels will have and implement a Light Management Procedure as per the National Light Pollution Guidelines (Commonwealth of Australia, 2020). The Light Management Procedure will detail mitigations to manage light based on the information in the Seabird Light Mitigation Toolbox and at a minimum will implement: • screens, blinds or window tinting on windows to contain light inside the vessels. • outdoor/deck lights when not necessary for human safety or navigation will be turned off. • lights will be directed onto work areas. • program for handling grounded birds. • reporting requirements.
CM#3: Marking of Man-Made Offshore Structures	Platform navigation lighting 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).

Additional controls assessed

Control	Cost/Benefit Analysis	Control Implemented?
Seasonal timing	Operations are required to occur year round, therefore activities may be undertaken at any time throughout the year. The following seasonal timings were identified for the species that may be active at night within the light EMBA: • orange-bellied parrot: late February to early April (Australian Museum, 2020). • Common diving petrel: year round (NCVA, 2021). Controls have been identified to ensure lighting is reduced to that for safe operations taking into account that vessels may be required to resupply the platform and undertake IMR activities. In 15 years of operating the Thylacine-A platform no orange-bellied parrots have been recorded. Avoiding the orange-bellied parrot migration is not commensurate to the level of impacts predicted. Other species are present all year round or do not forage at night thus restricting the period when activities will occur does not afford any benefit to these species.	No

Implement management actions during the breeding season. Light management should be implemented during the nesting and fledgling periods.	The light EMBA is at the closest distance ~12 km from islands or a coast where nesting and fledglings may be located. As no impact to nesting or fledglings is predicted the control does not have an environmental benefit.	No
Maintain a dark zone between the rookery and the light sources	The light EMBA is at the closest distance ~12 km from islands or a coast where rookeries may occur, therefore a dark zone between the and potential rookeries and the light sources will be maintained.	Yes
Turn off lights during fledgling season.	The light EMBA is at the closest distance ~12 km from islands or a coast where rookeries may be located. As no impact to fledglings is predicted the control does not have an environmental benefit.	No
Use curfews to manage lighting such as extinguish lights around the rookery during the fledgling period by 7 pm as fledglings leave their nest early in the evening.		
Aim lights downwards and direct them away from nesting areas.	The light EMBA is at the closest distance ~12 km from islands or a coast where nesting may occur. As no impact to nesting areas is predicted the control does not have an environmental benefit.	No
CM#1: Light Management Procedure Prevent indoor lighting reaching outdoor environment.	Use of fixed window screens, blinds or window tinting on vessel windows to contain light inside has the environmental benefit of reducing light emissions from the activity.	Yes
CM#1: Light Management Procedure Reduce unnecessary outdoor, deck lighting on all vessels and permanent and floating oil and gas installations in known seabird foraging areas at sea.	Extinguishing vessel outdoor/deck lights when not necessary for human safety and restrict lighting at night to navigation lights has the environmental benefit of reducing light emissions from activity. Thylacine-A Platform Safety Case requires platform lighting to remain on when platform unmanned as a navigation requirement.	Yes
CM#1: Light Management Procedure Vessels working in seabird foraging areas during breeding season should implement a seabird management plan to prevent seabird landings on the ship, manage birds appropriately and report the interaction.	As the vessel activities may occur year round, a vessel Light Management Procedure will be developed and implemented as per the National Light Pollution Guidelines (Commonwealth of Australia, 2020) which will detail mitigations to manage light based on the information in the Seabird Light Mitigation Toolbox.	Yes
CM#1: Light Management Procedure	Mitigations to manage light, including appropriate use and types of lights, will be reviewed as part of the Light Management Procedure (detailed above). Where the Light Management	Yes – where appropriate

Use flashing/intermittent lights instead of fixed beam. Use motion sensors to turn lights on only when needed. Avoid lights containing short wavelength violet/blue light. Avoid white LEDs. Avoid high intensity light of any colour.	Procedure identifies changes to vessel lighting that has a cost/benefit these mitigations will be implemented.	
CM#1: Light Management Procedure Design and implement a rescue program for grounded birds.	A rescue program will not prevent birds grounding, but as it has proven useful to reducing mortality of seabirds it has an environmental benefit. The program will be developed as part of the Light Management Procedure (CM#1) and will include advice detailed in the International Association Antarctic Tour Operators Seabirds Landing on Ships documents and cover: • handling of birds. • releasing of birds • reporting to DCCEEW in the case of protected species. Note: a recovery program can only occur on the Thylacine-A Platform when it is manned.	Yes – where appropriate

Consequence rating	Moderate (2) with no controls but this would be reduced to Minor (1) with identified controls implemented.
Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Light emissions were assessed as having a minor consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 8).
External context	There have been no stakeholder objections or claims regarding light emissions.
Other requirements	Thylacine-A Platform Safety Case requires platform lighting to remain on when platform unmanned as a navigation requirement. Light emissions will be managed in accordance with the National Light Pollution Guidelines (Commonwealth of Australia, 2020). Light emissions are not identified as a threat in National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). There are no recovery plans, conservation advice or listing advice for the common diving-petrel, short-tailed shearwater or wedge-tailed shearwater. Light emissions will be managed in a manner to not impact on the recovery orange-bellied parrot as per the orange-bellied parrot recovery plan (DELWP, 2016a).

Monitoring and reporting	Impacts associated with light emissions are for a short duration (i.e. during an IMR campaign), over a small area and not predicted to have long term impacts to fauna in the area. Therefore, the monitoring of light emissions is not proposed. Reporting of injury to or death of EPBC Act-listed species will be undertaken as detailed in Table 8-6.
Acceptability outcome	**Acceptable**

7.3 Atmospheric emissions

7.3.1 Hazards

Atmospheric emissions are generally considered to be any emission or entrainment process from a point, non-point or mobile sources that results in air pollution. This includes pollutants associated with greenhouse gas (GHG) emissions). With regards to Otway Operations these emission sources include:

- Combustion engines used on the Thylacine-A Wellhead Platform, vessels used to resupply the offshore platform, helicopters used to transfer personnel and equipment to the platform and vessels used for IMR campaigns.
- Thylacine-A Wellhead Platform continuous vent purge.
- Fugitive emissions.

As per the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard (2004), GHG emissions are categorised as:

- Scope 1: GHG emissions that a company makes directly.
- Scope 2: GHG emissions a company makes indirectly such as through the purchase of electricity.
- Scope 3: GHG emissions associated, not with the company itself, but that the organisation is indirectly responsible for, up and down its value chain. For example, from buying products from its suppliers and the emissions associated with making the products, and from its own products when customers use them.

For the scope of this EP the following applies:

- Scope 1: GHG emissions associated with the Otway Offshore Operations i.e., Thylacine-A Wellhead Platform, vessels, and helicopters.
- Scope 2: are not relevant for the Otway Offshore Operations as no electricity is purchased.
- Scope 3: GHG emissions associated with the production, transport and use of Otway Offshore Operations hydrocarbon products.

The Thylacine-A Wellhead Platform generators typically use gas, although diesel can be used during non-routine activities. Vessels will be powered by diesel (marine diesel oil (MDO)).

Atmospheric emissions will also be generated by the vent system. The Thylacine-A Wellhead Platform has a continuous vent purge (approximately 0.003 MMscfd) of fuel gas to prevent air ingress to the vent and drain system. Some venting of non-combusted hydrocarbon gas also occurs during routine maintenance and intermittently during wireline activities. This is usually in the order of 100 standard cubic metres per routine.

The Thylacine-A Wellhead Platform is equipped with a relief and blowdown system which vents to the vents and drain system. This system will assist in preventing over pressurisation of the process system due to process upset conditions or jet fire impingement. A period of venting may also be required for warming up the wells prior to repressurising the production pipeline, following certain maintenance activities. The volume of gas to be vented may be between 21 tonnes (2 hours warm-up) and 52 tonnes (5 hours warm-up).

Atmospheric venting was selected over flaring because of its inherent simplicity and reliability, which is essential for an unmanned operations. There is no flare on the Thylacine-A Wellhead Platform.

7.3.1.1 Estimated Emissions Inventory

Atmospheric and Scope 1 GHG Emissions

Scope 1 GHG emissions associated with the Otway Offshore Operations are reported to the Clean Energy Regulator as part of the statutory annual *National Greenhouse and Energy Reporting Act* 2007 (NGER Act). NGER reporting includes direct emissions from fuel use, venting and fugitive emissions associated with the Thylacine and Geographe facilities. NGER reporting does not include indirect emissions associated with helicopters transfers to the Thylacine-A Wellhead Platform and vessels used for resupply or IMR activities.

NGER reporting from financial year 2021 (FY21) detailed that the direct emissions from the Thylacine and Geographe facilities as 1,213 and 115 tCO_2e respectively. Indirect emissions of helicopter, vessel platform resupply and vessel IMR fuel use were calculated based on 2021 data using the NGER emissions calculations and resulted in 16.7, 485 and 347 tCO_2e respectively. Assumptions for fuel use were:

- Helicopter: 12 round trips a year from Warrnambool to the Thylacine-A Wellhead Platform.
- Platform resupply: 4 round trips per year from Portland to Thylacine-A Wellhead Platform.
- IMR: one campaign per year with vessel from Portland spending 30 days in the field with a combination of moving to do inspection and stationary on DP to do maintenance work. This scenario is the estimated longest campaign so will overestimate typical IMR campaigns.

This direct and indirect data was used to quantify Scope 1 GHG emissions annually, over the life of the EP and the life of the activity with the results shown in Figure 7-4. This results in a Scope 1 GHG emission of approximately 31,260 tCO_2e over the remaining Geographe and Thylacine field life.

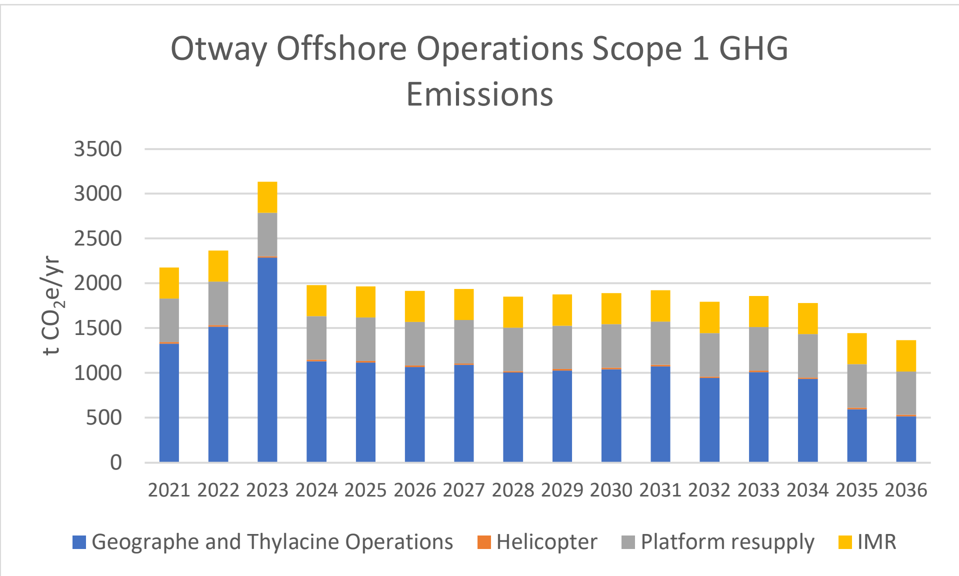

Figure 7-4: Otway Offshore Operations Scope 1 GHG Emission Estimate 2121 - 2036

Scope 1 GHG emissions peak in 2023 when the Thylacine subsea wells are bought onto production and then emissions decrease over the remaining years of production from these fields.

Other products of hydrocarbon combustion emitted to the atmosphere based on National Pollution Inventory data from Thylacine-A Wellhead Platform for 2020-21 were:

- Total Volatile Organic Compounds – 5,650 kg
- BTEX – 38.93 kg

Scope 3 GHG Emissions

Scope 3 or indirect GHG emissions are a result of the product from the activity being combusted or used elsewhere. Scope 3 GHG emissions can be considered indirect consequences of the activity and therefore have impacts (EPBC Act 1999 in Section 527E).

Scope 3 GHG emissions are generated by the production, transport and use of the hydrocarbon products from the Otway Offshore Operations. Scope 3 GHG emissions are not reported under the NGER Scheme but have been estimated using Australia's National Greenhouse Accounts.

Beach commissioned an independent review of its Scope 3 GHG emissions. This was undertaken by Xodus Group with the findings summarised in this section.

The calculations utilised methods defined in the National Greenhouse and Energy Reporting (Measurement) Determination 2008. Assumptions and inclusions for Scope 3 GHG emissions calculations are:

- Otway Gas Plant Scope 1 emissions associated with production, treatment, and export of Otway Offshore Operations hydrocarbon fluids from the Geographe and Thylacine fields:
    - Fuel (gas and diesel engines and heaters)
    - Flare and vent emissions
    - Fugitive emissions
- Otway Gas Plant Scope 3 emissions associated with production, treatment, and export of Otway Offshore Operations hydrocarbon fluids:
    - Electricity supplied by the Victorian electricity grid
    - Otway Offshore Operations product transport and use

Assumptions:

- Proportion of Otway Gas Plant emissions allocated to Otway Offshore Operations based on Otway Offshore Operations proportion of energy content of total feed gas to the facility.
- 100% of gas transmission pipeline fugitive leaks allocated to Otway Offshore Operations delivered gas (conservative assumption with relatively immaterial emissions.

- Final Otway Offshore Operations gas customer location: 40% used in Sydney, 40% used in Melbourne and 20% used in Adelaide.
- Gas use assumes large industrial users e.g., a gas fired power station.
- Gas delivery is via transmission line to city gate (no further intracity gas distribution included).

As noted above, GHG emissions are reported annually under NGER. Reported GHG emissions data were available for 2020/21 for these facilities and were utilised to determine a GHG intensity per unit of production and were coupled with 50th percentile production forecasts to determine an estimate of future GHG emissions, this represents the most likely outcome in terms of production and emissions. Given the nature of reservoir uncertainty over total recoverable volume of hydrocarbon higher or lower total emissions may be realised.

Scope 3 GHG emissions in FY 2020/21 were approximately 3 $MTCO_2e$. This is predicted to increase to 5 $MTCO_2e$ in 2023, before plateauing at 2 $MTCO_2e$ until 2033 and end of production in approximately 2036 (Figure 7-5).

Scope 3 GHG emissions comprise 99.9% of emissions occurring associated with the Otway Offshore Operations, the remaining 0.1% is from Scope 1 GHG emissions. Of the Scope 3 GHG emissions, over 96% result from the final use of the hydrocarbon product for power generation by the end customer. 90% of these emissions are from gas use, 3% are from both condensate use and 3% are from LPG use (Figure 7-5).

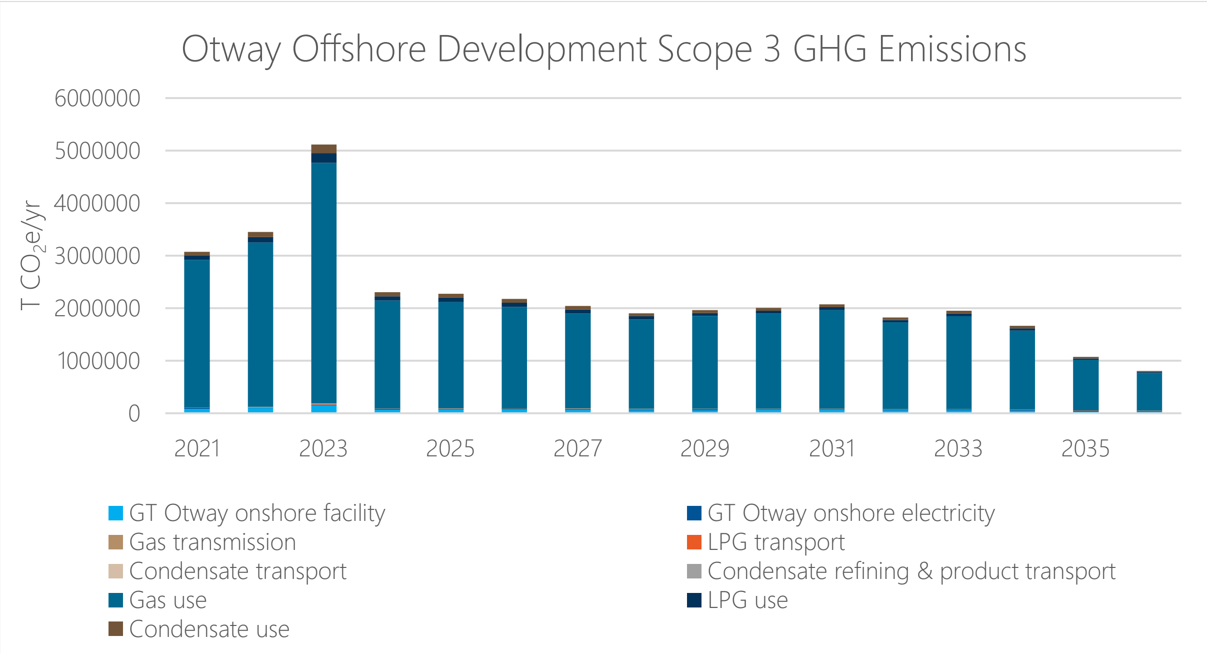

Figure 7-5: Otway Offshore Operations Scope 3 GHG Emission Estimate 2121 - 2036

7.3.2 Predicted environmental impacts

The predicted environmental impacts from atmospheric emissions are:

- Atmospheric emissions leading to a change in air quality and an increase in greenhouse gas emission.

7.3.3 EMBA

Predicted impacts from atmospheric emissions associated with the Offshore Otway Operations will be limited to the operational area. Receptors which may be affected by atmospheric emissions within the operational area include:

- air quality
- coastal settlements
- seabirds

GHG emissions generated during the Otway Offshore Operations and from Scope 3 GHG emissions can contribute to the overall concentration of GHG emissions in the Earth's atmosphere.

7.3.4 Consequence evaluation

Air Quality

As the operational area is away from coastal settlements and given the limited extent of reduced air quality, adverse impact on local or regional biodiversity, ecological integrity, social amenity, or human health is not predicted.

The operational area overlaps foraging BIAs for several albatrosses, the wedge-tailed shearwater, common diving-petrel and short-tailed shearwater. No habitat critical to the survival of birds occur within the operational area. As it is unlikely that seabirds would remain close to the emission source for an extended period impacts are not predicted.

Natural gas and diesel combustion, along with venting, will result in gaseous emissions of GHG such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). While these emissions add to the atmospheric GHG load, which adds to global warming potential, they are relatively small on a global scale, representing an insignificant contribution to overall GHG emissions. These emissions are not considered to have a determinable local-scale impact and therefore impacts are considered to be low.

The extent of the area of potential impact is predicted to be close to the emission source for the duration of the emission (continuously for venting on the Thylacine-A Wellhead Platform and during vessel activities) with a consequence level of Minor (1) based on:

- The low level of emissions.
- The open ocean environment and prevailing winds of the Otway Basin atmospheric emissions will rapidly disperse to background levels close to the emission source.
- Impacts to seabirds and coastal communities are not predicted.

Greenhouse Gas Emissions

GHG emissions generated during the Otway Offshore Operations 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 Otway Offshore Operations 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 Otway Offshore Operations and climate change impacts to specific ecological receptors.

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 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 7-3 and the impacts to ecosystems in Table 7-4.

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 (Table 7-3).

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 7-4, Dunlop et al. 2012). Increases in fire regimes will impact Australian ecosystems altering composition structure, habitat heterogeneity and ecosystem processes. 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 1ºC 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). Once warming reaches 1.5ºC, 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).

Terrestrial ecosystems

All terrestrial ecosystems are likely to be impacted by a changing climate (Table 7-4, 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 7-4.

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).

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. 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).

Marine ecosystems

Sea surface temperatures have increased across the globe over recent decades which poses a significant threat to marine ecosystems including changes to species abundance, community structure and increased frequency and intensity of thermally induced coral bleaching events (CSIRO 2017a).

Between 1920 and 2000, sea level is estimated to have risen on average by 1.2 mm per year due to climate change (Church et al. 2006). In addition to changes in sea level, 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 twenty percent since 1978 (Cai and Cowan 2006). 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). Sea levels will increase by 18 to 59 cm by 2100 in response to both thermal expansion and melting of ice-sheets (Solomon et al. 2007). This will lead to some coastal inundation affecting mangroves, salt marshes and coastal freshwater wetlands. Furthermore, as $CO2$ 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 7-4.

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).

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, 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).

Socio-economic

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.

Table 7-3: Overview of impacts of climate change to the future vulnerability of particular taxa (modified after Steffen et al 2009)

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.
Invertebrates	Expected to be more responsive than vertebrates due to short generation times, high reproduction rates and sensitivity to climatic variables.
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 7-4: Projected impacts of CO_2 rise and climate change on Australian ecosystems (modified after Steffen et al 2009)

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.

Key component of environmental change	Projected impacts on ecosystems
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 northwest 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.
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

Key component of environmental change	Projected impacts on ecosystems
	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.

7.3.5 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.

7.3.5.1 Paris Agreement

The United Nations Framework Convention on Climate Change came into force in 1994 and has been ratified by 197 countries. The convention established a goal of preventing dangerous anthropogenic interference with the climate system. Subordinate treaties and agreements have been ratified by parties to the convention, including the Paris Agreement, which was agreed under the convention at the 21st Conference of the Parties in 2015.

The primary purpose of the Paris Agreement is to strengthen the global response toward climate change. Specifically, the Agreement seeks to substantially reduce GHG emissions to limit the global temperature increase in this century to 2oC, while pursuing efforts to limit the increase even further to 1.5°C (UNFCCC 2020). The Paris Agreement is legally binding, and signatories are reviewed every five years with the submission of an updated national climate action plan, known as Nationally Determined Contribution (NDC).

The Paris Agreement is set up through articles (UNFCCC 2020), with each article focusing on a certain commitment. Some key articles that are committed in the Paris Agreement are:

- Article 2 – Long-term temperature goals
    - Limiting the global temperature increase to well below 2°C, with preference and most efforts toward keeping it below 1.5°C.
- Article 4 – Mitigation
    - The agreement establishes binding commitments by all parties to prepare, communicate and maintain a NDC and to pursue domestic measures to achieve said NDC.
- Article 9, 10, 11 – Finance, technology, and capacity-building support
    - Obligations of developed nations to support the efforts of developing nations to build clean and climate-resilient futures.

- In addition to reporting on finance already provided, developed nations commit to submit indicative information on support every two years.
- Technology framework established under the agreement, and capacity-building activities will be strengthened through inter alia, enhanced support for capacity building actions in developing nations and appropriate institutional arrangements.
- Climate change education, training, public awareness, participation, and access to information.

Australia has ratified the Paris Agreement and has adopted NDCs that can be monitored and reported on as part of the 5-year stocktake. At the Paris conference in 2016, Australia announced its first NDC to reduce GHG emissions by 26-28% below 2005 levels by 2030. This commitment was reaffirmed in 2020 after the 5-year review and further commitments were made in 2021 to reach net-zero emissions by 2050 and inscribe low emissions technology stretch goals.

In May 2022, the elected Labor government made a goal of reducing Australia's GHG emissions by 43% below 2005 levels by 2030 and reaffirmed Australia's commitment to net zero emissions by 2050. This was lodged with the UNFCCC as an updated NDC as part of Australia's obligations under the Paris Agreement. NDCs under the Paris Agreement are legally binding, and Australia mainly focuses on Article 10 with a low-emissions technology led approach. Australia's NDCs are implemented through schemes such as the Safeguard Mechanism and the Emissions Reduction Fund and the soon to be introduced Climate Change Bill 2022, in addition to continuous monitoring and focusing on alternatives to lower overall emissions.

As gas from the Beach Otway Gas Plant is provided to customers within Australia that has ratified the Paris Agreement and set NDCs, GHG emissions arising from third party consumption are managed and mitigated through Australia's GHG legislative frameworks and commitments to achieve Net Zero Emissions by 2050. In addition, Beach has set their own internal targets to achieve net zero Scope 1 and Scope 2 GHG emissions by 2050 (EPO6) with an interim target to reduce Beach GHG emissions by 25 per cent by FY25 against FY18 levels (EPO5).

7.3.5.2 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', including the Otway Gas Plant.

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 Otway Gas Plant emissions are regulated under the Safeguard Mechanism through establishment of a cap (baseline) on emissions. Under this policy, annual emissions are reported under the National Greenhouse & Energy Reporting Scheme and compared against the facility baseline, and Beach is required to generate or procure and surrender Australian Carbon Credit Units for any emissions above the baseline for the compliance period, to ensure that net emissions for the facility remain under the prescribed baseline.

7.3.5.3 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 direct emissions associated with the Otway Offshore Operations and Otway Gas Plant under the NGER Act.

7.3.5.4 Intergovernmental Panel on Climate Change (IPCC) 6th Report

The Intergovernmental Panel on Climate Change (IPCC) released its sixth assessment consisting of three reports, with the most recent release being in April 2022. The three 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. 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.

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 internal target to achieve net zero Scope 1 and Scope 2 GHG emissions by 2050 (EPO6) with an interim target to reduce Beach GHG emissions by 25 per cent by FY25 against FY18 levels (EPO5).

7.3.5.5 International Energy Agency World Energy Outlook

The International Energy Agency annually publishes a range of climate-related scenarios in its "World Energy Outlook" report (IEA 2021). In the most ambitious scenario, Net Zero Emissions by 2050, it projects approximately $365bn of investment in oil and gas supply is needed every year to 2030. In the

Paris Agreement aligned Sustainable Development Scenario, natural gas consumption in Asia is projected to grow by over 36% between 2020 through to 2030 and remains above 2020 levels through to 2050 (IEA 2021).

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 gas from the Beach Otway Gas Plant is provided to customers within Australia that has ratified the Paris Agreement and set NDCs, GHG emissions arising from third party consumption are managed and mitigated through Australia's GHG legislative frameworks and commitments to achieve Net Zero Emissions by 2050. In addition, Beach has set their own internal targets to achieve net zero Scope 1 and Scope 2 GHG emissions by 2050 (EPO6) with an interim target to reduce Beach GHG emissions by 25 per cent by FY25 against FY18 levels (EPO5).

7.3.6 Beach Environmental Management System Relevant to GHG Emissions

Section 8 Implementation Strategy details the components of the Beach Operations Excellence Management System (OEMS) relevant to the management of the petroleum activity covered by this EP. Beach's climate change framework sits within their OEMS. Table 7-5 provides a summary of the Beach OEMS components relevant to the management of GHG emissions.

Table 7-5: 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: • Identifying, managing and mitigating material climate risks to business. • Measuring and reporting carbon emissions as required by the regulatory requirements of the regions we operate in. • Ensuring that our practices and procedures align and integrate climate risks into project decision-making. • Where economically practicable, integrate low emissions technologies in our operations, and identify opportunities for carbon emission reduction. • Evaluating the resilience of our portfolio and investment decisions to potential changes in global climate policy and changes in climate. • Setting targets to encourage innovation and drive reductions in our carbon emissions as well as modelling an internal carbon price to help guide our business decisions.	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. All Beach policies are approved by the Board.

<table>
<tr><th>Beach OEMS Component</th><th>Description</th><th>Contribution to Managing Climate Change</th></tr>
<tr><td>Environmental Policy</td><td>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.</td><td>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.</td></tr>
<tr><td>Sustainability Policy</td><td>The relevant commitments/aspects within Beach's Sustainability Policy are:
• Ensuring an appropriate governance system is in place to provide oversight and accountability for strategy development and performance that relates to maintaining a sustainable business.
• Identifying and managing risks affecting the interests of Beach through its risk management framework.
• Proactively assessing and addressing material social, environmental and economic risks and the impact of our operations, and integrating these considerations into business planning, decision making and implementation processes that ensure sustainable outcomes.
• Continuing to develop and foster a strong culture of safety, environmental sustainability, and social responsibility.
• Exploring ways to improve efficiency in all operations.
• 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.
• Sourcing products and services from local suppliers, where appropriate and possible.
• Liaising with governments, industry associations, joint venture partners and other stakeholders to develop and implement sustainable industry practices.</td><td>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.</td></tr>
</table>

Beach OEMS Component	Description	Contribution to Managing Climate Change
	• Empowering employees by providing information and training, as required, and encouraging the adoption of sustainable principles and practices.	
OEMS – Key Relevant Standards		
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 EP.
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	The purpose of this standard is to operationalise the requirements established by the Company's Sustainability Policy and other associated Beach policies. It sits within OEM Element 11 Assurance and Reporting.	
	11.1.1: The Risk, Corporate Governance and Sustainability Committee (RCGSC) of the Board is	Specifies that Beach's top management is expected to

Beach OEMS Component	Description	Contribution to Managing Climate Change
	responsible for steering the Company position on sustainability and implements this via the Company's Sustainability Policy and preparation of a yearly Sustainability Report.	demonstrate leadership, commitment to, and accountability for climate change adaptation; and formally expresses specific commitments related to climate change mitigation and adaptation.
	11.1.2: The Company's Sustainability Report will be produced in alignment with the Global Reporting Initiative (GRI Standards) and incorporates the recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD). Third party verification of the sustainability report is to be conducted prior to report publication.	Commitment to using internationally recognised standards for the development of the publicly available annual Sustainability Report. Allows Beach to publicly report the impacts of their activities in a structured way that is transparent to stakeholders and other interested parties. The TCFD has developed a framework to help public companies and other organizations more effectively disclose climate-related risks and opportunities through their existing reporting processes.
	11.1.13: Identify emerging trends and reporting requirements under the ESG criteria including but not limited to human rights (including annual modern slavery reporting requirements), people, diversity, health and safety, cultural heritage, human capital development, cyber security, social impact, ethics and corruption, and other identified non-financial material issues.	Commitment to using internationally recognised ESG criteria for the development of the publicly available annual Sustainability Report. Beach participates in the annual Dow Jones Sustainability Index's Corporate Sustainability Assessment which enables us to benchmark our sustainability performance against industry peers as well as manage our sustainability performance. Beach also participates in and tracks its performance against several external benchmarks such as the Dow Jones Sustainability Index (DJSI), and the CDP (formerly, Carbon Disclosure Project). Beach endeavours to improve or maintain ratings provided by these agencies as well as those provided by other independent industry analysts.
	11.1.5: In alignment with BTSD 8.1 (Risk Management Standard), Company Management and Project Leadership will incorporate material social, environmental, governance and economic risks into their operational and project level risk assessments to ensure the Company continues to pursue sustainable activities and projects.	Commitment to identify risks and opportunities relating to climate change. Sources could include environmental aspects, applicable legal and other requirements, and stakeholder expectations. Five material sustainability issues were identified which have remain unchanged for the FY21 reporting period – of which the first was Climate

Beach OEMS Component	Description	Contribution to Managing Climate Change
		change and Greenhouse *(Managing emissions from operations and maintaining transparency*').
	11.1.6: The Company Head of Corporate Risk and General Manager of Corporate Affairs and Sustainability is responsible for monitoring the external political, community and business environment to ensure the Company maintains awareness of external trends, current and emerging risks. Where threshold risks or opportunities are identified, these shall be included in the Corporate Risk process for assessment by Executive Management.	Commitment to identification of risks and opportunities relating to climate change. Identification of the needs and expectations of interested parties that are relevant to the organization's EMS and determination of those it will comply with, including legal requirements and climate adaptation actions taken by third parties. Interfaces with 11.1.5 risk management.
	11.1.8: Operations General Management will formally assess and maintain a register of opportunities to reduce: • emissions, • production of produced water or identify alternate uses, • waste, • energy consumption, • environmental impacts and, • venting and flaring. These opportunities will be included in the yearly budget cycle for review, assessment and approval where appropriate.	Commitment to take action to address opportunities for continual improvement identified in performance evaluation, and to achieve EMS intended outcomes.
	11.1.9: The Executive Management will develop appropriate yearly sustainability targets and initiatives aligned with the Company's Sustainability Policy.	Setting of GHG emission targets and reporting GHG emissions publicly.
	11.1.10: During the Phase Gate approval process (BSTD 2.2) for major capital projects and acquisitions, the business case will include an assessment of: • The potential impact of a Carbon price or other similar financial mechanisms or schemes, • Opportunities for energy optimisation such as integration of renewable technologies, reduction or elimination of flaring, venting and selection of appropriate technology and, • Appropriate provision for decommissioning of the facilities in accordance with applicable legislation.	Specifies that Beach's will assess major capital projects and acquisitions energy optimisation and potential impact of carbon pricing.
	11.1.11: The Company will support transparent reporting of emissions and greenhouse gases	Requires Beach to public report GHG emissions.

Beach OEMS Component	Description	Contribution to Managing Climate Change
	through relevant mechanism such as the National Greenhouse and Energy Reporting Act (2007), the National Pollutant Inventory (NPI), and the New Zealand Emissions Trading Scheme (ETS).	
Leadership and Accountability		
Risk, Corporate Governance and Sustainability Committee Sustainability Steering Committee	The Beach Energy Board has established three committees to oversee management of key business risks – one of which is the Risk, Corporate Governance and Sustainability Committee. This Committee 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 Managing Director; 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, the committee'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 by 2050	Beach have aspirations 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 are working towards these aspirations via the processes described in this assessment of the OEMS. Estimated FY21 emissions are 12% lower than FY18 . Initiatives include: • LDAR surveys completed at all assets remedial actions being taken through the maintenance management system
25 by 25 Initiative	Beach has a stated objective to reduce company emissions by 25 per cent by FY25 against FY18 levels/ targets 25% Beach net operated	

Beach OEMS Component	Description	Contribution to Managing Climate Change
	emissions reduction by 2025 (known as the 25 by 25 Initiative).	• Four emission reduction projects completed at Otway, Middleton and Lang Lang facilities Flaring elimination at BassGas on start-up.

7.3.7 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Atmospheric emissions	
ALARP decision context and justification	Atmospheric emissions: ALARP Decision Context: Type A Impacts from atmospheric emissions are well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation to air emissions. As the impact consequence is rated as Minor (1) applying good industry practice (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP. GHG emissions: ALARP Decision Context: Type B Impacts from GHG emissions are relatively well understood though there is the potential for uncertainty in relation to the level of impact. Activities are well practised, and there are no conflicts with company values, but there is significant partner and media interest in GHG emissions form oil and gas activities including Beach's activities. Additional controls may be required to ensure impacts can be managed to an acceptable level.
Adopted Control Measures	**Source of good industry practice control measures**
CM#4: MO 97: Marine Pollution Prevention – Air Pollution	Vessels will comply with Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution (appropriate to vessel class) for emissions from combustion of fuel including: • hold a 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. • sulphur content of diesel/fuel oil complies with Marine Order Part 97 and Regulation 14 of MARPOL 73/78 Annex VI.
CM#5: Maintenance Management System	Combustion equipment shall be maintained in accordance with in accordance with the maintenance management system to ensure efficient operation.
CM#6: Venting Procedures	Venting is undertaken as described in the Thylacine-A Platform Safety Case, including: • Venting is conducted as per operational and maintenance isolation procedures. • Emergency blow down system designed to blow down topside only. • Fuel gas purge flow forms part of the arrival and departure checks.

	• Drain vents purge set points set to meet the minimum operational requirements.
CM#37 Contractor Supplier HSE Prequalification and Capability Assessment	The tender evaluation for the IMR and support vessels contract will include an evaluation of air and GHG emissions management.
CM#38: Beach Sustainability Standard	General Requirement 11.1.1.8 details that the Beach Operations General Management will formally assess and maintain a register of opportunities to reduce: • emissions • energy consumption • venting and flaring These opportunities will be included in the yearly budget cycle for review, assessment, and approval where appropriate.
CM#39: Beach GHG Management Plan	Beach via its Sustainability Reporting has committed to: • reduce company emissions by 25 per cent by FY25 against FY18 levels. • net zero Scope 1 and 2 emissions by 2050. To achieve these commitments Beach will develop and implement a GHG Management Plan which will formalise the framework and specific techniques used to ensure that GHG emission related EPOs will be met over the life of the facility. The GHG Management Plan will also detail how monitoring of scope 3 GHG emissions attributed to the Otway Operations activity will be undertaken for the life of the activity.
CM#40: Fugitive Leak Detection and Repair Program	Beach undertake periodic leak detection and repair (LDAR) fugitive emissions surveys. The latest survey for the Otway Gas Project was performed in 2021. During these surveys minor valve and flange leaks are repaired on the spot with more significant leak repairs requiring equipment intervention are managed through the equipment maintenance program. For offshore infrastructure such as subsea wells, the IMR program detailed in Section 4.5.4 identifies and repairs any fugitive leaks. IMR programs are undertaken on the platform identify and rectify any leaks/fugitive emissions. However, the offshore facilities are not currently part of the LDAR fugitive emissions surveys. Thus, Beach will implement an offshore LDAR fugitive emissions survey to align with the onshore program with the scope, methodology, frequency, and repair guidance detailed in the GHG Management Plan (CM#39).
CM#41: NGERS Reporting	Beach are required to annually report their direct GHG emissions (Scope 1 and 2) as per the NGERS regulatory requirements. Beach will use this annual reporting process to internally compare both Scope 1 and Scope 3 GHG emissions generated by the Otway Offshore Operations to EP estimates in Section 7.3.1.1 and the Estimate Emissions Inventory Figures 7-4 and 7-5 respectively. This data will feed into the review of the effectiveness of the GHG Management Plan requirements to ensure Beach will meet their GHG targets as detailed in EPO5 and EPO6.

Additional controls assessed		
Control	**Cost/Benefit Analysis**	**Control Implemented?**
Use of low GHG fuels at the Thylacine-A Platform	The Otway Gas Project design includes best practice GHG design. The original Otway Gas Project EES/EIS and Works Approval covered best practice design elements in the facility design which considered the hierarchy of control (Eliminate, reduce, offset). Options considered and not implemented due to high cost and/or feasibility are supply of power from shore (low GHG source), renewable energy generation (offshore wind or solar) and alternative fuels (LNG, Ammonia). Gas engines were selected as the primary power source, these reduce emissions and reduce cost of operations compared to diesel. Diesel maintained as a backup.	No
Use of low GHG fuels for support and IMR vessels	Vessel that use low GHG fuels are relatively now and are not common in Australian waters. To bring vessels into Australia to support operations is an increased cost. Beach via its Contractor Supplier HSE Prequalification and Capability Assessment (CM#37) assesses suppliers emissions management and via this process would support low emission vessels if available.	Yes – as per CM#37 Contractor Supplier HSE Prequalification and Capability Assessment
Eliminate platform venting	A means to dispose of gas is required on the Thylacine-A Platform for operability and safety requirements. Process vent was selected due to low rate of fugitive emissions per calendar year, simplicity and reliability given the unmanned platform philosophy. No reasonably practicable alternative methods for reduction or mitigation of vented or fugitive emissions have been identified (vapour recovery system and flare system have been assessed) that would further reduce the impacts. Other measures have grossly disproportionate cost to benefit.	No

Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Air emissions were assessed as having a minor consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Giving consideration to economic development that safeguards the welfare of future generations, Otway Offshore Operations is considered to align with the following core objectives of ESD by: • Responding to the global energy transition, providing a clean and reliable energy source as gas is expected to play a key role in the future energy mix (e.g., partner with renewables). In addition, gas has the potential to contribute to an incremental reduction in global GHG emissions by displacing more carbon intensive power generation (e.g., coal), firming up renewables, or in hard-to-abate sectors. • Committing to controls for GHG emissions within operational control of Beach, given the uncertainty about future climate change trajectories.

	• Committing to controls for indirect GHG emissions that are controlled or influenced by Operator and connected to the operations of the Otway Offshore Operations. • Contributing to the UN Sustainable Development Goals of achieving universal access to energy. • Providing gas to customers within Australia that has ratified the Paris Agreement, and our responsible for accounting, reporting and reducing emissions that occur in its jurisdiction.
Internal context	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 7.3.6. Activities will be undertaken in accordance with the Implementation Strategy (Section 8).
External context	There have been no stakeholder objections or claims regarding atmospheric emissions or GHG emissions associated with the Otway Offshore Operations.

Other requirements	Atmospheric emissions are not identified as a threat in National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a).
	As 'Loss of habitat caused by anthropogenic emissions of greenhouse gases' has been declared a Key Threatening Process under the EPBC Act. Such changes have the potential to affect listed and migratory species covered by conservation advice and management plans.
	To ensure that Beach's activities are not inconsistent with these conservation advice and management plans and to support Australia's NDC commitments air emissions and GHG emissions will be managed in accordance with applicable legislative and other requirements including:
	• The adopted controls and acceptability assessment has considered regulatory and other guidance as detailed in Section 3 and Section 7.3.5, in particular requirements of:
	  o Paris Agreement
	  o National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015 and Scheme
	  o Victorian Climate Change Act 2017
	  o IPCC Sixth Assessment Report International Energy Agency World Energy Outlook
	• Providing gas to customers within Australia that has ratified the Paris Agreement.

Monitoring and reporting	Atmospheric and GHG emissions shall be recorded and reported in alignment with the *National Greenhouse and Energy Reporting Act* 2007 (NGER Act) and National Pollution Inventory as detailed within Section 8.12.8. Scope 1 and Scope 3 GHG emissions, generated by the Otway Offshore Operations, will be compared annually to the EP estimates detailed in EP Section 7.3.1.1, Estimate Emissions Inventory Figures 7-4 and 7-5, respectively, as per CM#41.
Acceptability outcome	**Acceptable**

7.4 Underwater sound emissions – impulsive

7.4.1 Hazards

Impulsive underwater sound emissions will be generated by:

- Geophysical surveys

7.4.2 Predicted environmental impacts

Potential impacts of underwater sound emissions from geophysical activities to receptors are:

- behavioural changes; and
- auditory impairment, permanent threshold shift (PTS) and temporary threshold shift (TTS).

Underwater impulsive sound emissions may impact the following biological receptors:

- marine invertebrates including commercial species such as squid, rock lobster and giant crab.
- fish (with and without swim bladders) including commercial species such as sharks and scalefish.
- marine reptiles.
- marine mammals.

7.4.3 Consequence evaluation

Single-beam echo sounder

A single-beam echo sounder (SBES) typically has a frequency range between 120 and 710 kHz and a maximum sounding rate of 20 Hz. The beam width varies between 10 (120 kHz) and 2.8 (710 kHz). The single beam bathymetry received sound exposure level typically does not exceed 160 dB.

Multi-beam echo sounder

The frequency range of the multi-beam echo sounder (MBES) is typically 200–500 kHz (classified as high frequency) with a maximum angular coverage of 160°. The maximum source levels are about 236–242 dB re 1 µPa @ 1 m for the 1° and 2° beams (DoC, 2016).

Side scan sonar

Side scan sonar (SSS) typically operates in the 100–500 kHz frequency range (classified as high frequency). The maximum source levels are about 210-220 dB re 1µPa @ 1 m (DoC, 2016). The SSS towfish is typically towed 10–15 m above the seabed (depending on water depth and the exact frequency) at a distance of about 150- 200 m behind the vessel.

Sub-bottom profiler

Acoustic emissions from sub-bottom profiler (SBP) are typically in the frequency range of 0.05 to 12 kHz, with peak sound pressure level (SPL) of up to 220 dB re 1µPa @ 1 m. There are three different types of SBP, which exhibit a trade-off of in resolution versus depth of penetration based on the frequency of the acoustic signal:

1. CHIRP – uses an FM signal across a full range of frequencies, typically either 2-16 kHz or 4-24 kHz (low to high frequency). The maximum source levels of a CHIRP are about 200– 205 dB re 1 µPa @ 1 m (DoC, 2016).

2. High-frequency boomers – the typical frequency spectrum of boomer systems ranges between 0.2 and 10 kHz, with an effective bandwidth of 1 to 10 kHz (low to high frequency). The sound source level can vary from 100 to 220 dB re 1 µPa @ 1 m.

3. Medium-frequency sparkers – the generated frequencies are generally between 50 Hz (0.05 kHz) and 4 kHz (low to high frequency). The sound source level is typically between 215 and 225 dB re 1 µPa @ 1 m.

Based on a review of the geophysical equipment to be used 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. Modelling results for the Otway geophysical survey (McPherson and Wood 2017) have been used as the modelled locations are within the Otway Operation Area and the equipment will be similar.

The modelling study assessed six locations as detailed in Table 7-6 and Figure 7-6. Table 7-6 details those locations relevant to the Otway Operations infrastructure areas.

Table 7-6: Acoustic modelling locations applicable to the seabed assessment locations

Modelled Location	Water Depth (m)	Otway Operations Area
Site 1: THY MID PT	100.5	Thylacine
Site 2: MURCH DDIP	129.5	NA
Site 3: G3	85	Geographe
Site 4: ARTISAN	71.6	Artisan
Site 5: VICP69 NTH	72.8	N/A
Site 6: VICP69 MEEKI	79.1	N/A

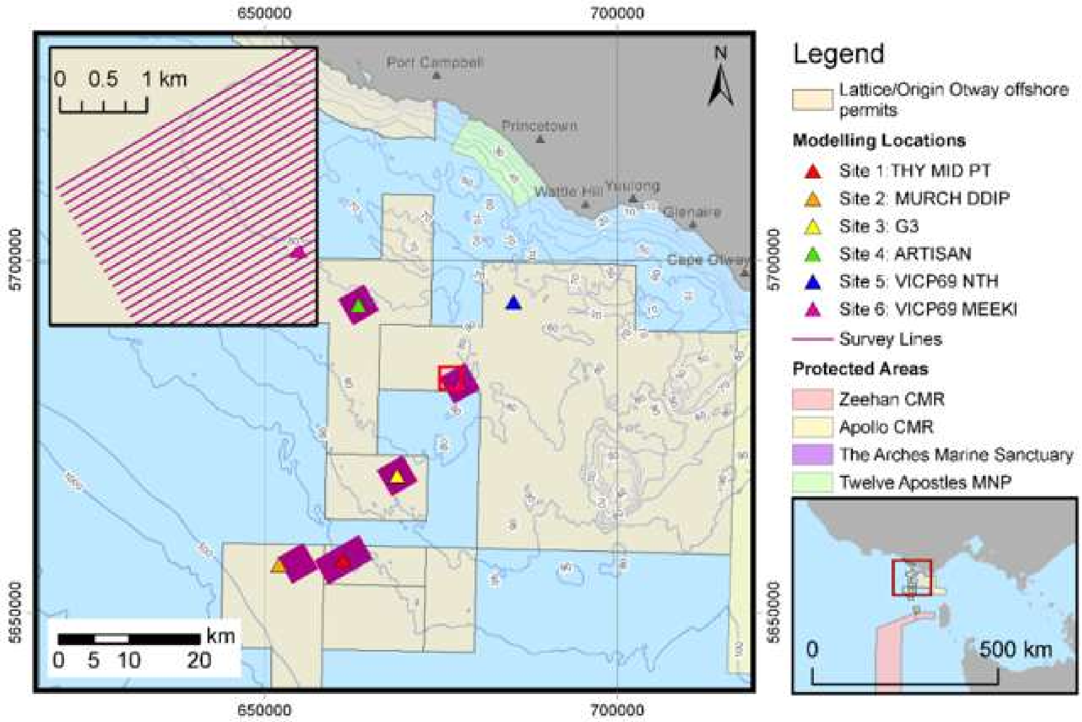

Figure 7-6: Noise modelling locations

To assess whether an impact may occur modelled received sound levels were compared to receptor noise effect criteria (Table 7-7). These criteria are based on published scientific research and papers as detailed in and within the relevant receptor section. In lieu of any noise criteria specific to geophysical surveys, criteria that is applied to seismic surveys have been used.

Table 7-7: Effect criteria used and the applicable results for representative single pulse sites and for accumulated SEL scenarios

Receptor	Noise Effect Criteria	Boomer Maximum R_{max} Distance (m)	SBP Maximum R_{max} Distance (m)	Noise Effect Criteria Reference
Invertebrates: effect at the seafloor	186–190 dB SEL 192–199 dB SEL_{24h} 209–212 dB PK-PK	Not reached Not reached Not reached	Not reached Not reached Not reached	Day et al. 2016
Invertebrates: no effect at the seafloor	202 dB PK-PK	Not reached	Not reached	Payne et al. 2008
Lobster: no effect at the seafloor	183 dB SEL	Not reached	Not reached	McCauley and Duncan 2016
Squid: behavioural	166 dB SPL	36	Not reached	McCauley et al. 2000
Fish (swim bladder): mortality/potential mortal injury	>207 dB PK or 207 dB SELcum[1]	1.6 Not reached	0.3 Not reached	Popper et al. 2014
Fish (swim bladder): recoverable injury	>213 dB PK or >216 dB SELcum[1]	0.6 Not reached	0.1 Not reached	Popper et al. 2014
Fish (no swim bladder): mortality/ potential mortal injury	>213 dB PK or >219 dB SELcum[1]	0.6 Not reached	0.1 Not reached	Popper et al. 2014

Receptor	Noise Effect Criteria	Boomer Maximum R_{max} Distance (m)	SBP Maximum R_{max} Distance (m)	Noise Effect Criteria Reference
Fish (no swim bladder): recoverable injury	>213 dB PK or >216 dB SELcum[1]	0.6 Not reached	0.1 Not reached	Popper et al. 2014
Fish (swim bladder or no swim bladder): TTS	>186 dB SELcum[1]	Not reached	Not reached	Popper et al. 2014
Turtle: behavioural	166 dB SPL	36	Not reached	NSF 2011
Turtle: mortality/potential mortal injury	>207 dB PK or 210 dB SELcum[1]	1.6 Not reached	0.3 Not reached	Popper et al. 2014
Marine mammals: behavioural	160 dB SPL	145	2	NMFS 2013 NOAA 2019
Low-frequency cetaceans: PTS (humpback and pygmy blue whales)	219 dB PK 183 dB SEL_{24h}	Not reached Not reached	Not reached Not reached	NMFS 2018
Low-frequency cetaceans: TTS (humpback and pygmy blue whales)	213 dB PK 168 dB SEL_{24h}	Not reached 10	Not reached 10	NMFS 2018
Mid-frequency cetaceans: PTS (dolphins, beaked whales, sperm whales)	230 dB PK 185 dB SEL_{24h}	Not reached Not reached	Not reached Not reached	NMFS 2018
Mid-frequency cetaceans: TTS (dolphins, beaked whales, sperm whales)	224 dB PK 170 dB SEL_{24h}	Not reached Not reached	Not reached Not reached	NMFS 2018
High-frequency cetaceans: PTS (pygmy and dwarf sperm whales)	202 dB PK 155 dB SEL_{24h}	4.5 Not reached	0.6 Not reached	NMFS 2018
High-frequency cetaceans: TTS (pygmy and dwarf sperm whales)	196 dB PK 140 dB SEL_{24h}	8.9 Not reached	1.2 Not reached	NMFS 2018
Phocid pinnipeds: PTS (seals)	218 dB PK 185 dB SEL_{24h}	Not reached Not reached	Not reached Not reached	NMFS 2018
Phocid pinnipeds: TTS (seal)	212 dB PK 170 dB SEL_{24h}	Not reached Not reached	Not reached Not reached	NMFS 2018

Note 1: Popper et al. 2014 do not defined an accumulation period. For this assessment 24 hrs was used based on the independent, expert peer review by Popper (Santos, 2018) that concluded that a 24-hour period to assess SELcum and any associated effects is likely to be conservative for assessing the potential effects to fish.

7.4.3.1 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 µPa^2.s

- accumulated SEL: 192–199 dB re 1 µPa^2.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 µPa^2.s.

Table 7-7 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.

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 7-7 details that the noise effect criteria at which an alteration of swimming patterns may occur is predicted within 36 m of the boomer and not reached for the SBP.

Based on the modelling no mortality or injury effects to invertebrates including commercial squid, octopus, rock lobster and giant crab species are predicted.

7.4.3.2 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 7-7 details the noise effect criteria from Popper et al., 2014 and the distances at which modelling estimated they could be reaced for fish with and without a swim bladder. In summary:

- The noise effect criteria for mortality/potential mortal injury is predicted for fish with a swim bladder at a maximum distance of 1.6 m and for fish without a swim bladder at 0.6 m.

- 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 0.6 m.
- The noise effect criteria for TTS for fish with and without a swim bladder was not reached.

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 that the geophysical surveys will not result in prolonged or extreme exposure to fish it is unlikely that injury impacts to fish would occur.

The Operational Area does not overlap any areas where site-attached fish species are likely to be present, thus it would be expected that any impacts to fish, including sharks, would be limited to behavioural impacts such as startle response or avoidance behaviour as the vessel moves through an area. Thus, behavioural impacts to fish would be temporary and unlikely to have a significant impact on individuals or at a population level.

7.4.3.3 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 7-7 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 were not reached for the SBP.
- The noise effect criteria for injury to turtles for the boomer is predicted at a maximum distance of 1.6 m for the peak sound pressure level (PK) while the noise effect criteria based on the sound exposure level (SEL) is not reached.

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). For the boomer this noise effect criteria is predicted at a maximum distance of 36 m but was not reached for the SBP.

Three marine turtle species may occur within the operational area. No BIAs or habitat critical to the survival of the species occur within the operational area. Impacts to turtles within the area where the survey is occurring are likely to be restricted to avoidance behaviour as the vessel moves through an area and unlikely to result in any injury due to the very small distance (1.6 m) within which noise levels reach the noise effect criteria for injury. Thus, behavioural impacts to turtles would be temporary and unlikely to have a significant impact on individuals or at a population level.

7.4.3.4 Marine mammals

Noise effect criteria used in this assessment for impacts to marine mammals are from:

- The United States National Marine Fisheries Service (NMFS, 2013; NOAA 2019) acoustic threshold for behavioural effects in marine mammals of 160 dB re 1 µPa (SPL).

- National Marine Fisheries Service (NMFS, 2018) thresholds for the onset of PTS and TTS. These criteria as details in Table 7-7 are based on dual acoustic injury 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. The peak sound pressure level (PK) criterion is not frequency weighted whereas the SEL_{24h} is frequency weighted according to the marine mammal species hearing group.

Two species of pinniped may occur within the operational area: the New Zealand fur-seal and the Australian fur-seal. No BIAs or habitat critical to the survival of the species were identified for pinnipeds.

Twenty one whale species (or species habitat) may occur within the operational area. Foraging behaviours were identified for some species (sei, blue, fin and pygmy right whales); no other important behaviours were identified. The operational area intersects the known core coastal range and the migration and resting on migration BIA for the southern right whale and a foraging BIA for the pygmy blue whale.

Table 7-7 details the noise effect criteria and the distances at which modelling estimated they could be reached. In summary:

- The acoustic threshold for behavioural effects in marine mammals is predicted at a maximum of 2 m for the SBP and 145 m for the boomer.

- For low-frequency cetaceans the noise effect criteria for PTS is not reached. The noise effect criteria for TTS is predicted at a maximum of 10 m for the SBP and boomer for the 24-hour cumulative SEL. The noise effect criteria for TTS for the single pulse was not reached.

- For mid-frequency cetaceans the noise effect criteria for PTS and TTS is not reached.

- For high-frequency cetaceans the noise effect criteria for PTS is predicted for the single pulse at a maximum of 0.6 m for the SBP and 2.8 m for the boomer. The noise effect criteria for PTS for the 24-hour cumulative SEL was not reached. The noise effect criteria for TTS is predicted for the single pulse at a maximum of 1.2 m for the SBP and 5.5 m for the boomer. The 24-hour cumulative SEL noise effect criteria for TTS was not reached.

- For Otariid pinnipeds, such as fur-seals, the noise effect criteria for TTS and PTS where not reached.

Low frequency cetaceans

As detailed in Section 5.6.7.6 several low frequency cetacean may occur within the operational area. Foraging behaviours were identified for some species (sei, blue, fin and pygmy right whales); no other important behaviours were identified. The operational area intersects the known core coastal range and the migration and resting on migration BIA for the southern right whale and a foraging BIA for the pygmy blue whale.

For low-frequency cetaceans the noise effect criteria for PTS is not reached and for TTS is only reached at 10 m for the 24-hour cumulative SEL. Thus, it is not feasible that a low-frequency cetacean, even if foraging, resting, or migrating would be within 10 m of a moving vessel for 24 hours. Predicted impacts would, therefore, be limited to behavioural response such as avoidance of the area while the geophysical survey is undertaken.

The severity of impact to low frequency cetaceans is assessed as moderate based on:

- Geophysical surveys can be managed to ensure that they will not be inconsistent with the Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015b) that details 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 as:
    - the noise effect criteria for PTS is not reached and for TTS is only reached at 10 m for the 24-hour cumulative SEL. Thus, it is not feasible that a low-frequency cetacean, even if foraging, resting, or migrating would be within 10 m of a moving vessel for 24 hours.
    - the distance to the noise effect criteria for behavioural response is 145 m and as this distance is small the control measures detailed in Section 7.4.4 can be implemented to reduce the risk of displacement occurring as per the Guidance on Key Terms within the Conservation Management Plan for the Blue Whale (DAWE 2021a) that details 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 fin and sei whale's conservation advice (TSSC, 2015f; TSSC, 2015g) 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 Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a) identifies acute industrial noise, of which geophysical surveys would be classed, as a threat that is classified as a minor consequence which is defined as individuals are affected but no affect at a population level. PTS and TTS impacts and not predicted to southern right whales based on the distance to TTS effect criteria is 10 m. The distance to the noise effect criteria for behavioural response is 145 m and as this distance is small the control measures detailed in Section 7.4.4 can be implemented to reduce the risk of disturbance to southern right whale migrating or resting on migration.

Mid frequency cetaceans

Mid frequency cetaceans such as dolphins, sperm whales and beaked whales may occur in the operational area, but no BIAs of biologically important behaviours were identified. The noise effect criteria for TTS and PTS for these species was not reached, thus predicted impacts would be limited to behavioural response such as avoidance of the area while the geophysical survey is undertaken.

The extent of the area of where mid frequency cetaceans may be impacted by noise is predicted to be 145 m from the vessel when undertaking the geophysical survey which has a maximum duration of up to 10 days per year. The severity of impact to mid frequency cetaceans is assessed as Minor (1) based on:

- Impacts to mid 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.
- The area of impact is small, as the distance to the noise effect criteria at which impacts could occur is 145 m.
- The area of impact is not within a BIA or habitat critical to the survival of a mid frequency cetacean species and thus impacts are unlikely to have a significant impact on individuals or at a population level.

High frequency cetaceans

High frequency cetaceans such as pygmy and dwarf sperm whales may occur in the operational area, but no BIAs of biologically important behaviours were identified. The maximum distance for the PTS noise effect criteria is 2.8 m and for TTS is 5.5 m, thus predicted impacts would be limited to behavioural response such as avoidance of the area while the geophysical survey is undertaken.

The extent of the area of where seals may be impacted by noise is predicted to be 145 m from the vessel when undertaking the geophysical survey which has a maximum duration of up to 10 days per year. The severity of impact to seals is assessed as Minor (1) based on:

- 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.
- The area of impact is small, as the distance to the noise effect criteria at which impacts could occur is 145 m.
- The area of impact is not within a BIA or habitat critical to the survival of a high frequency cetaceans species and thus impacts are unlikely to have a significant impact on individuals or at a population level.

Pinnipeds

The Australian and New Zealand fur-seals may occur in the operational area but no BIAs or haul out areas were identified. The noise effect criteria for TTS and PTS for these species was not reached, thus predicted impacts would be limited to behavioural response such as avoidance of area while the geophysical survey is undertaken.

The extent of the area of where seals may be impacted by noise is predicted to be 145 m from the vessel when undertaking the geophysical survey which has a maximum duration of up to 10 days per year. The severity of impact to seals is assessed as Minor (1) based on:

- Impacts to seals are likely to be limited to avoidance behavioural where they may move away from the vessel as it is undertaking the geophysical survey.
- The area of impact is small, as the distance to the noise effect criteria at which impacts could occur is 145 m.

The area of impact is not within a BIA or habitat critical to the survival of a seal species and thus impacts are unlikely to have a significant impact on individuals or at a population level.

7.4.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Underwater sound emissions	
ALARP decision context and justification	ALARP Decision Context: Type B Impacts from geophysical impulsive sound emissions are well understood though there is the potential for uncertainty in relation to the level of impact. Geophysical activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests.
Adopted Control Measures	**Source of good practice control measures**
CM#7: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans describes strategies to ensure whales and dolphins are not harmed during offshore interactions with vessels and helicopters. Vessels will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans. These regulations stipulate a safe operating distance of 300 m, however as per Section 7.5.5 this has been increased to 500 m to take into account the distance to the noise effect criteria for vessels. This is greater than the furthest noise effect distance of 145 m for geophysical surveys. As the geophysical survey vessel is manoeuvrable, even when the geophysical equipment is in the water this requirement, the 500 m distance can be applied. Maintaining a 500 m distance to all whales will ensure that impacts will be managed such that they can continue to utilise the area without injury and will not be displaced from biologically important behaviours such as foraging, migrating, or resting.
CM#2a Geophysical survey pre-start visual observation	For geophysical surveys using SBP (boomer or sparker) a prestart visual observation period of 30 mins will be applied to 500 m prior to the start of the SBP (boomer or sparker) this is to ensure that no whales are within 500 m prior to starting the equipment. A 500 m distance is conservative as the furthest distance for noise effect criteria for the geophysical survey equipment was estimated at 145 m for behavioural effects. If during the prestart visual observation period, a whale is sighted within 500 m of the vessel the SBP equipment activation will be delayed until the whale has moved outside of the 500 m zone or 30 minutes has lapsed since the last whale sighting within 500 m. 30 minutes is sufficient time for the vessel and/or whale to have moved 500 m away and to account for blue whales that are capable of diving for periods upwards of 20 minutes. Once the survey has commenced CM#7 applies where the vessel is required to maintain a 500 m distance to all whales. 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. Applying a 500 m distance will ensure that impacts to whales will be managed such that they can continue to utilise the area without injury and are not displaced from biologically important behaviours such as foraging, migrating, or resting. These controls will be applied to all seasons as a conservative measure to cover not only the peak foraging periods in the area (January to April) but the broader period when pygmy blue whales, and other whales such as the fin, pygmy right and sei may be in the area and when southern right whales are within nearshore BIAs or moving through the area in May/June and Oct/Nov.

CM#2b Geophysical survey Marine Mammal Observer	For geophysical surveys a dedicated MMO will be present on the vessel to undertake prestart visual observations and implement the 500 m distance to any whales during: • 1 November to 30 June within the operational area • 1 May to 30 November within the Victorian coastal migration and resting on migration BIA and emerging aggregation area. These timings are based on: • Foraging whales including blue whales may be present in the region from November (though less likely prior to this time) through to May. • Southern right whales are within nearshore BIAs or moving through the area in May/June and Oct/Nov. The MMO will have proven experience in whale observation, distance estimation and reporting. At other times at least one crew member onboard the vessel will have proven experience in whale observation, distance estimation and reporting to ensure the safe operating distances are implemented.	
CM#2c Geophysical survey adaptive management	If whale numbers are greater than expected such that pre-start observations are delayed three times in a 24-hour period or the vessel must move away from a whale or a pod of whales three times in a 24-hour period, a review of the controls in place will be undertaken by the Activity Offshore Representative, Activity Project Manager and Environment Advisor. The review will be documented and will be undertaken against the Implementation of the EPBC Act Policy 2.1 Part A requirements to identify if further controls need to be applied to ensure that impacts and risks are ALARP and within the defined acceptable level. The implementation of an adaptive management process will ensure that if numbers are greater than expected due to favourable conditions, impacts and risks can continue to be managed to ALARP and within the defined acceptable level.	
Additional controls assessed		
Control	**Cost/Benefit Analysis**	**Control Implemented?**
Seasonal timing	Blue whales are potentially in the foraging BIA within the Otway shelf waters from November through to June. Southern right whales may travel through the operational area to and from coastal aggregation and migration areas during May-June and September-November and be present in the coastal aggregation and migration areas, which the operational area overlaps, between June to October. Thus, there is no period when there is not a whale undertaking a biologically important behaviour within the Otway region. The implementation of additional controls above the legislative requirements of the EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans will be implemented to manage potential impacts to whales undertaking biologically important behaviour.	No
Implementation of the EPBC Act Policy 2.1 Shutdown Zones	Geophysical equipment operates at significantly lower source levels than a commercial seismic array, and thus the resulting sound levels are proportionally lower at comparable distances. EPBC Act Policy 2.1 was developed for seismic surveys with the aim of the policy to provide: • practical standards to minimise the risk of acoustic injury to whales in the vicinity of seismic survey operations.	No

	- a framework that minimises the risk of biological consequences from acoustic disturbance from seismic survey sources to whales in biologically important habitat areas or during critical behaviours. - provide guidance to both proponents of seismic surveys and operators conducting seismic surveys about their legal responsibilities under the EPBC Act. Modelling has shown that received noise levels and distances to noise effect criteria for the geophysical survey are significantly lower than those for seismic surveys with the largest distance predicted to be 145 m for the behavioural noise effect criteria for marine mammals. The distances proposed in the policy to minimise the risk of acoustic injury to whales and risk of biological consequences from acoustic disturbance from seismic survey sources to whales in biologically important habitat areas or during critical behaviours of 1 km, for the low power zone, and 500 m, for the shut-down zone, are significantly larger than the predicted distance of 145 m for the noise effect criteria for behavioural disturbance and 10 m for the noise effect criteria for TTS. As the vessel is continuously moving, the distance from the vessel to any marine mammal will exceed the small distances within which noise levels reach the noise effect criteria within seconds. Displacement due to behavioural impacts could occur up to 145 m from the source, and with a moving vessel the distances to the threshold criteria will occur quickly (within 3 minutes for a vessel travelling at approx. 8 km/hr). By the time a whale is sighted, and equipment shut down, it is likely the distance would have been covered and the whale has passed, therefore affording no benefit. As such, based on the small distances within which the noise effect criteria for marine mammals are met, that impacts are not predicted to injure individuals or displace pygmy blue whales from the foraging BIA, the implementation of shut-down zones does not afford any further benefit.	
Implementation of the EPBC Act Policy 2.1 Soft start	Soft starts are applied to seismic surveys to slowly ramp up the seismic source allowing fauna to move away from the source. No seismic source will be used for the activity and the geophysical equipment being used for the survey cannot be slowly ramped up.	No
Passive acoustic monitoring (PAM)	PAM is most useful in the detection of odontocetes such as sperm whales, dolphins and porpoise known to emit regular distinctive clicks and high frequency calls during long dives. PAM has limited utility in detecting lower frequency calls of baleen whales (such as blue whales, southern right whales) especially when in the presence of constant background low frequency sound such as that generated by the vessel towing the PAM system. Given the very low utility and associated unreliability of using PAM to inform mitigation decision making, any additional cost is considered disproportionate to the benefit gained.	No
Dedicated monitoring vessel	An additional dedicated vessel is not required as monitoring activities can be effectively conducted from the geophysical vessel. Cost is disproportionate to marginal environmental benefit.	No
Aerial surveillance	Aerial surveillance from aircraft or drones is not required as monitoring activities can be effectively conducted from the geophysical vessel.	No

	Cost is disproportionate to marginal environmental benefit.
Consequence rating	Moderate (2)
Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Sound emissions were assessed as having a moderate consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 8).
External context	There have been no stakeholder objections or claims regarding impulsive sound emissions.
Other requirements	Sound emissions will be managed in accordance with legislative requirements. Sound emissions will: • not impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). • be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area (Commonwealth of Australia, 2015b; DAWE 2021a). • not impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). • not impact southern right whale established or emerging aggregation BIAs or the migration and resting on migration BIA (DSEWPaC, 2012a). • not impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • not impact the recovery of the white shark as per the Recovery Plan for the White Shark (DSEWPaC, 2013a). Actions from the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b; DAWE 2021a) applicable to the activity in relation to assessing and addressing anthropogenic noise have been addressed as per: • assessing the effect of anthropogenic noise on blue whale behaviour. Section 0 assesses the effects of anthropogenic noise from the activity on blue whale behaviour. • 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. Section 0 demonstrates that the activity can be conducted in a manner that is consistent with the conservation management plan and will not result in injury or displacement of pygmy blue whales from a foraging BIA.
Monitoring and reporting	Cetacean sightings will be recorded using the DCCEEW sighting sheets as detailed in Section 8.12.9 .
Acceptability outcome	**Acceptable**

7.5 Underwater sound emissions - continuous

7.5.1 Hazards

Continuous underwater sound emissions will be generated by:

- Platform operations (venting, power, HVAC, crane usage etc.)
- Helicopter operations
- Subsea infrastructure
- Maintenance and repair activities
- Vessel operations

Vessels generate continuous sound from propeller cavitation, thrusters, hydrodynamic flow around the hull, and operation of machinery and equipment.

Sound will be generated by helicopters during take-off and landing on the Thylacine-A Wellhead Platform.

Underwater sound emissions are generated by liquid or gas flow though pipelines and valves, specifically wellheads and choke valve operations such as those found at the Geographe subsea facilities. The Thylacine-A Wellhead Platform is a fixed platform, with topside choke valves only, therefore does not generate underwater sound emissions.

Installation of rock bolts by divers and subsea tree top plate trimming with a disk cutter for any choke valve replacement work will also create sound while these activities are being undertaken.

7.5.2 Predicted environmental impacts

Potential impacts of underwater sound emissions from the Otway Offshore Operations are:

- behavioural changes; and
- auditory impairment, permanent threshold shift (PTS) and temporary threshold shift (TTS).

7.5.3 EMBA

The sound EMBA is the area where sound levels are predicted to be above sound exposure criteria. Acoustic modelling undertaken to determine the sound EMBA is described below.

Underwater sound emissions may impact biological receptors within the sound EMBA such as:

- fish (with and without swim bladders) including commercial species such as sharks and scalefish;
- marine reptiles; and
- marine mammals.

As different sound exposure criteria apply to these receptors, sound EMBAs for each receptor is defined in the receptor consequence sections to identify potential receptors that may be affected.

7.5.4 Consequence evaluation

Helicopters

Helicopters are used to transport personnel to and from the platform. The presence of the helicopter and its associated sound field will be highly transient. On approach to the platform the helicopter will descend to the helideck where there is greatest potential to ensonify the water column. 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 500 Hz (Richardson et al. 1995). Richardson et al. (1995) reported helicopter sound (for Bell 214 type) being audible in air for four minutes before it passed over receivers, but only detectable underwater for 38 seconds at 3 m depth and for 11 seconds at 18 m depth for the same flight path. Thus, the predicted extent of impact is between 3 to 18 m for a period of 11 – 38 seconds twice a day (landing and take-off). Based on such short-term, intermittent sounds the consequence to whales (including pygmy blue whales within the foraging BIA, southern right whales within the current core coastal range and fin or sei whales which may also be foraging) and other marine fauna is assessed as Minor (1).

Subsea infrastructure

Measurements of operational wellheads (McCauley, 2002) showed sound levels of 113 dB re 1 µPa; with broadband sound level only marginally above rough sea condition ambient levels. Based on the measurements of wellhead sound discussed in McCauley (2002), which included flow in flowlines, sound produced along a flowline or pipeline may be expected to be similar to that described for wellheads, with the radiated sound field falling to ambient levels within a hundred metres of the flowline.

Woodside undertook acoustic measurements of underwater sound emissions generated by the operation of choke valves associated with the Angel facility (JASCO 2015; in Woodside, 2020). These measurements indicated choke valve sound is continuous, and the frequency and intensity of sound emitted is dependent on the rate of production from the well. Sound intensity at low production rates (16% and 30% choke positions) were approximately 154–155 dB re 1 µPa, with higher production rates (85% and 74% choke positions) resulting in lower sound levels (141–144 dB re 1 µPa). Sound emissions from choke valve operation was broadband in nature, with the majority of sound energy concentrated above 1 kHz. sound from choke valve operation was considered minor compared to sound generated by vessels using thrusters in the area.

Based on spherical spreading of underwater sound it is estimated that at the highest levels recorded of 155 dB re 1 µPa this would attenuate to below the cetacean behavioural sound criteria of 120 dB re 1 µPa within ~ 60 m. Based on this small distance the consequence to whales (including pygmy blue whales within the foraging BIA, southern right whales within the current core coastal range and fin or sei whales which may also be foraging) and other marine fauna is assessed as Minor (1).

Rock bolt installation and subsea cutting

Subsea tree top plate trimming with a disk cutter may be required for any choke valve replacement work and would take ~1- 2 hours. 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. Acoustic modelling undertaken by JASCO (Koessler and McPherson

2021 Appendix F) 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. The furthest distance to either criteria is 2.98 km. As detailed in Figure 16, Figure 17, Figure 54 and Figure 55 in Koessler and McPherson (2021) (Appendix F) show that the ranges to the behaviour and TTS 24hr exposure criteria at Geographe for the vessel with the cutting tool are not influenced by the vessel at Thylacine North-1.

Information on sound levels from rock bolt installation was not available. Rock bolts are installed by hand equipment used by divers and could be presumed to be of a similar noise level to an ROV undertaking cutting as discussed above.

Vessels

Underwater sound emissions will be generated by vessel dynamic position (DP), and to a lesser extent machinery, pumps and generators on vessels (Erbe et al. 2013).

7.5.4.1 Underwater sound level modelling

JASCO Applied Sciences (JASCO) performed a modelling study of underwater sound levels associated with the Beach Energy Otway Development (Koessler and McPherson 2021 Appendix F), to supplement drilling and construction results previously presented in Koessler et al. (2020), Matthews et al. (2020) and Matthews et al. (2021). The results from these previous modelling studies have been revised due to a better understanding of the propagation loss in the region gained through the validation monitoring of drilling operations at Artisan-1 (McPherson et al. 2021).

The considered locations: Artisan and Thylacine were selected to estimate sound levels that would be representative of all locations within the Otway operations (at wells and along pipeline and umbilical routes) based on water depth, proximity to the continental slope, and the seabed type. Distances to sound level thresholds for vessel activities occurring close to shore, where the water depth is significantly less and decreases rapidly, are expected to be shorter than those modelled at Artisan. This is in part because of the increased losses due to the increased number of surface and seafloor interactions the sound field experiences in shallow water, but also due to the lower frequencies where the sources are louder being less supported in significantly shallow water.

The modelling study 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. 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).

Where several modelled scenarios are representative of vessel activities, such as where location or season has been varied in the modelling parameters, the furthest distance to the exposure criteria has been selected for evaluation of potential impacts.

Table 7-8 summarised the modelling scenarios applicable to Otway Offshore Operations. As the sound pressure level (SPL) metric does not depend on the duration of the operation, these estimates are valid for both, stationary (maintenance and repair) and moving (inspection) vessel activities. Note the modelling study by Koessler and McPherson (2021) (Appendix F) details results for other scenarios such as drilling and installation that are not relevant to this EP.

Table 7-8 Modelled underwater sound scenarios

#	Activity	Modelled Scenario
A4	Platform	Platform operations
A3	OSV standby transit	Offshore support vessel on standby using minimal DP
1, 2 ,3, 4	Platform and OSV resupply	Resupply of the platform can take between 2 to 8 hr depending on the activity being undertaken. Modelling based on the Siem Offshore VS491 vessel which are currently being used for supply vessel for the Otway Offshore Operations.
5, 6	Platform and OSV standby	Standoff from platform during higher risk activities such as work over, heavy lifts and well intervention. OSV standing by within 1–3 km of the platform for up to 8 hr while work on the platform is undertaken. The vessel is required to be ready to respond as required. During this time, the vessel is assumed to be operating under a mix of slow transit, minimal power DP and drifting. This modelling was based on the Siem Offshore VS491 which are currently being used for supply vessel for the Otway Offshore Operations.
7, 8	Maintenance and Repair - Thylacine	Stationary vessel on DP undertaking repair / maintenance. Pipelay Vessel (PLV) stationary on location, operating at 20% MCR (i.e. DP) This modelling was based on Skandi Singapore and would be the maximum sized vessel to undertake maintenance and repair activities.
11, 12	Maintenance and Repair stationary - Artisan	
9, 10	Inspection vessel moving-Thylacine	Slowly moving vessel undertaking inspection of subsea infrastructure. Pipelay Vessel (PLV) moving slowly, operating at 20% MCR This modelling was based on Skandi Singapore and would be the maximum sized vessel to undertake inspection activities.
13, 14	Inspection vessel moving - Artisan	
15,16	Maintenance and Repair stationary at Thylacine with Maintenance and Repair stationary at Geographe with ROV cutting tool	Stationary vessel on DP undertaking repair / maintenance. Pipelay Vessel (PLV) stationary on location, operating at 20% MCR (i.e. DP) with ROV cutting tool. This modelling was based on Skandi Singapore and would be the maximum sized vessel to undertake maintenance and repair activities.

7.5.4.2 Marine Mammals

Exposure Criteria - PTS and TTS

The US National Marine Fisheries Service (NMFS 2018) reviewed available literature to determine 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 NFMS (2018) exposure criteria are based on a cumulative SELs over a period of 24 h. Table 7-9 details the criteria and furthest modelled distances to them for each scenario.

The PTS and TTS 24 h criteria are only relevant to those receptors that are likely to be present in the area of ensonification for a period of 24 h. For this assessment the PTS and TTS 24 h criteria was applied to marine mammals that may be undertaking biologically important behaviours, such as calving, foraging, resting or migration (as defined by Commonwealth of Australia, 2015c), that could result in them being within the ensonification area above the PTS and TTS criteria for a period of 24 h or greater.

Exposure Criteria - Behaviour

Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate metric for assessing behavioural reactions. The current interim NFMS (NOAA 2019) criterion of 120 dB re 1 µPa for non-impulsive sound sources such as vessels is used as the marine mammal behavioural criteria for this assessment as it represents a conservative criterion as Southall et al. (2007) reviewed extensive literature and studies in relation to marine mammal behavioural response to impulsive (seismic, pile driving) and non-impulsive (drilling, vessels) and found that most marine mammals exhibited varying responses between 140 and 180 dB re 1 µPa.

Table 7-9 details the furthest modelled distance to the NOAA (2019) exposure criteria for each scenario.

Phocid seals

For Phocid seals the furthest distance to the PTS criteria is reached at 80 m and the furthest distance to the TTS criteria is 430 m during resupply at the platform. From the PMST Reports Phocid seals were not identified within the operational area (500 m around the operations infrastructure) and thus PTS and TTS are not assessed further.

The distances to the behavioural threshold ranged from 200 m at the platform to 7.31 km during resupply at the platform. No Phocid seals were identified within the Sound Behaviour EMBA (7.5 km) PMST report (Appendix A.5) thus behaviour impacts are not assessed further.

Otariid seals

For Otariid seal the PTS criteria is only reached at 10 m for the maintenance and repair activities while cutting and the furthest distance to the TTS criteria is 80 m during resupply at the platform. The Australian and New Zealand fur seal may occur within the operational area (500 m around the operations infrastructure) but no biologically important behaviours or biologically important areas were identified within the operational area thus PTS and TTS are not assessed further.

The distances to the behavioural threshold ranged from 200 m at the platform to 7.31 km during resupply at the platform. The PMST Report (Appendix A.5 Sound Behaviour EMBA 7.5 km) identified that the Australian and New Zealand fur seal may occur within the Sound Behaviour EMBA (7.5 km). Impacts are predicted to be temporary avoidance for resupply (7.31 km), standby (450 m) and IMR activities (2.71 km) and potentially permanent avoidance of an area of 200 m around the Thylacine-A platform. The consequence is assessed as Minor (1) as there are no biologically important behaviours, biologically important areas, aggregation areas or haul-out area identified within the predicted ensonified area.

High-frequency cetaceans

The furthest distance to the high-frequency cetacean PTS criteria is 110 m and the TTS criteria is 1.46 km. The PMST Report (Appendix A.4 Sound 24 hr EMBA 1.5 km) identified that high-frequency cetaceans such as pygmy and dwarf sperm whales may occur within the Sound 24 hr EMBA (1.5 km), however, no biologically important areas or behaviours were identified within the area of ensonification and therefore they are not assessed further.

The distances to the behavioural threshold ranged from 200 m at the platform to 7.31 km during resupply at the platform. The PMST Report (Appendix A.5 Sound Behaviour EMBA 7.5 km) identified that that high-frequency cetaceans such as pygmy and dwarf sperm whales may occur within the Sound Behaviour EMBA (7.5 km). Impacts are predicted to be temporary avoidance for resupply (7.31 km), standby (450 m) and IMR activities (2.71 km) and potentially permanent avoidance of an area of 200 m around the Thylacine-A platform. The consequence is assessed as Minor (1) as there are no biologically important behaviours or biologically important areas identified within the predicted ensonified area.

Mid-frequency cetaceans

The furthest distance to the mid-frequency cetacean PTS criteria is 50 m and the TTS criteria is 100 m. The PMST Report (Appendix A.4 Sound 24 hr EMBA 1.5 km) identified several dolphin species, beaked and toothed whales, however, no biologically important areas or behaviours were identified within the area of ensonification and therefore they are not assessed further.

The distances to the behavioural threshold ranged from 200 m at the platform to 7.31 km during resupply at the platform. The PMST Report (Appendix A.5 Sound Behaviour EMBA 7.5 km) identified several dolphin species, beaked and toothed whales that may occur within the Sound Behaviour EMBA (7.5 km). Impacts are predicted to be temporary avoidance for resupply (7.31 km), standby (450 m) and IMR activities (2.71 km) and potentially permanent avoidance of an area of 200 m around the Thylacine-A platform. The consequence is assessed as Minor (1) as there are no biologically important behaviours or biologically important areas identified within the predicted ensonified area.

Table 7-9: Cetacean PTS, TTS and behaviour sound criteria and predicted furthest distances and areas

Hearing group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)	OSV standby transit		Platform		Platform and OSV resupply		Platform and OSV standby		Inspection vessel moving		Maintenance and repair vessel stationary		Maintenance and repair vessel stationary with ROV cutting tool	
		R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)
PTS															
LF cetaceans	199	–	–	0.02	0.001	0.18	0.07	0.02	0.001	0.02	0.21	0.06	0.01	0.06	0.01
MF cetaceans	198	–	–	0.02	0.001	0.05	0.002	0.02	0.001	0.01	0.02	0.02	0.001	0.02	0.001
HF cetaceans	173	–	–	0.03	0.004	0.11	0.02	0.03	0.004	0.03	0.37	0.09	0.03	0.12	0.04
Phocid seals	201	–	–	0.02	0.001	0.08	0.01	0.02	0.001	0.01	0.14	0.02	0.001	0.02	0.001
Otariid seals	219	–	–	–	–	–	–	–	–	–	–	–	–	0.01	0.001
TTS															
LF cetaceans	179	–	–	0.04	0.004	1.25	4.01	0.04	0.004	1.18	13.62	0.60	1.04	0.66	1.35
MF cetaceans	178	–	–	0.03	0.003	0.10	0.02	0.03	0.003	0.02	0.22	0.07	0.02	0.09	0.03
HF cetaceans	153	–	–	0.30	0.28	0.63	1.17	0.30	0.28	1.46	16.02	0.84	2.02	0.87	2.37
Phocid seals	181	–	–	0.03	0.00	0.43	0.46	0.03	0.00	0.13	1.54	0.19	0.02	0.19	0.12
Otariid seals	199	–	–	0.02	0.001	0.08	0.01	0.02	0.001	0.01	0.15	0.02	0.001	0.02	0.001
Behaviour	**SPL threshold** (Lp; dB re 1 µPa)														
Marine mammals	120	0.38		0.20		7.31		0.45		2.71		2.71		2.98	

Note: a dash indicates the level was not reached within the limits of the modelling resolution (20 m).

Low-frequency cetaceans

The furthest distance to the low-frequency cetacean PTS criteria is 180 m and the TTS criteria is 1.25 km. Table 7-10 details the low-frequency cetaceans that have biologically important areas and/or biologically important behaviours within the Sound 24 hr EMBA (1.5 km) as identified from the Sound 24 hr EMBA PMST Report (Appendix A.4) and Table 5-9.

The distances to the behavioural threshold ranged from 200 m at the platform to 7.31 km during resupply at the platform. Table 7-10 details the low-frequency cetaceans that have biologically important areas or biologically important behaviour within the Sound Behaviour EMBA (7.5 km) as identified from the Sound Behaviour EMBA PMST Report (Appendix A.5) and Table 5-9.

The distance, area of impact and predicted duration for each activity is shown in Table 7-11.

Table 7-10: Low-frequency cetaceans with biologically important behaviours within the PTS and TTS ensonification area

Species	Biologically Important Behaviour
Blue whale	Foraging, feeding or related behaviour known to occur within area.
	High density foraging BIA
Fin whale	Foraging, feeding or related behaviour likely to occur within area.
	No BIAs
Pygmy right whale	Foraging, feeding or related behaviour may to occur within area.
	No BIAs
Sei whale	Foraging, feeding or related behaviour likely to occur within area.
	No BIAs
Southern right whale	Cow and calf pairs may move through the current core coastal range.
	Migration and resting on migration BIA

Table 7-11: Distance to sound criteria, area of impact and predicted duration for each activity

Activity	Furthest distance to sound criteria	Area of ensonification	Duration
Thylacine-A Platform	40 m	0.004 km^2	Continuous
Thylacine-A Platform resupply	7.31 km	167.87 km^2	Up to 6 hours for 2 days four times a year
Thylacine-A Platform and vessel on standby	450 m	0.64 km^2	Up to 6 hours once or twice a year
Inspection vessel moving	2.71 km	23.07 km^2	Once a year for up to 30 days
Maintenance and repair vessel	2.71 km	23.07 km^2	Once every 2 years up to 30 days
Maintenance and repair vessel with ROV cutting tool or rock bolt installation	2.98 km	27.9 km^2	One off activities. Cutting ~ 1- 2 hrs Rock bolt up to 4 hrs

Blue whales

Foraging behaviour for blue whales has been identified in the area where the PTS, TTS and behavioural criteria is reached. As detailed in Section 5.6.7.6 cetacean foraging within the Otway shelf, and hence the area where the PTS, TTS and behavioural criteria is reached, is typically from January to April though whales maybe present from November to June which overlaps the period when Otway Offshore Operations activities may occur (activities occur year round).

The Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015b) details 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.

DAWE (2021a) defines 'displaced as a foraging area' as:

> The recovery plan requirement, Action A.2.3, applies in relation to BIAs. A whale could be displaced from a Foraging Area if impact mitigation is not implemented. This means that underwater anthropogenic noise should not:
>
> - Stop or prevent any blue whale from foraging
> - Cause any blue whale to move on when foraging
> - Stop or prevent any blue whale from entering a Foraging Area
>
> It is considered that a whale is displaced from a Foraging Area if foraging behaviour is disrupted, regardless of whether the whale can continue to forage elsewhere within that Foraging Area. 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.

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.

As detailed in Table 7-11 the extent and duration of impact differs based on the activity being undertaken, however, the severity is assessed as moderate and is of an acceptable level based on:

- A conservative approach has been taken in applying the sound modelling and results such as the furthest distance to the PTS and TTS criteria for the scenarios modelled to assess potential impacts.

- The Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015b) details that shipping and industrial noise are classed as a minor consequence for which the definition is: individuals are affected but no affect at a population level.

- The Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015b) details that "It is the high intensity signals with high peak pressures received at very short range that can cause acute impacts such as injury and death." As vessel noise is continuous noise sources and do not have high intensity signals it is unlikely that they would cause injury to foraging pygmy blue whales.

- Though activities may occur during the period when pygmy blue whales are likely to be foraging within the BIA, the largest area of potential impact within the pygmy blue whale high density foraging BIA (35,627 km^2) is very small, at any one time being:
  - ~0.00001% for the Thylacine-A Platform continuous operations.
  - ~0.47% for up to 8 hours for resupply of the Thylacine-A Platform.
  - ~0.002% for up to 8 hours for vessel standby at the Thylacine-A Platform.
  - ~0.065% for up to 30 days for inspection, maintenance and repair activities.
- PTS and TTS impacts are not predicted from the Thylacine-A Platform and or the Thylacine-A Platform and vessel on standby based on predicted distance to the 24 hr exposure criteria are 20 m and 40 m respectively. It would be highly unlikely for a pygmy blue whale to remain within those distances for 24 hours.
- Displacement of foraging blue whales at the Thylacine-A Platform are not predicted as the platform has been operating since 2006.
- For platform resupply, vessel on standby and inspection, maintenance and repair activities adopted controls as detailed in Section 7.5.5 will prevent possible PTS, TTS and displacement impacts to pygmy blue whale that may be foraging.

Southern right whales

For southern right whales the following areas are within the predicted ensonified area as shown in Figure 7-7:

- Current core coastal range is within the area where the PTS, TTS and behavioural criteria is reached for all activities.
- Victorian coastal migration and resting on migration BIA and emerging aggregation area off Port Campbell is within the area where the PTS, TTS and behavioural criteria is reached for inspection, maintenance and repair activities.

As detailed in Section 5.6.7.6, there is the potential for southern right whales to be within the Victorian coastal migration and resting on migration BIA and emerging aggregation area from late May/early June till October and transiting through the area during May-June and September-November as they move to and from coastal aggregation areas.

As detailed in Table 7-11 the extent and duration of impact differs based on the activity being undertaken, however, the severity is assessed as moderate and is of an acceptable level based on:

- A conservative approach has been taken in applying the sound modelling and results such as the furthest distance to the PTS and TTS criteria for the scenarios modelled to assess potential impacts.

- The Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a) identifies shipping and industrial noise as a threat that is classed as a minor consequence which is defined as individuals are affected but no affect at a population level.
- Though activities may occur during the period when southern right whales are within the core coastal area, the largest area of potential impact within the core coastal area (217,825 km^2) is very small, at any one time being:
  - ~0.000002% for the Thylacine-A Platform continuous operations.
  - ~0.08% for up to 8 hours for resupply of the Thylacine-A Platform.
  - ~0.0003% for up to 8 hours for vessel standby at the Thylacine-A Platform.
  - ~0.011% for up to 30 days for inspection, maintenance and repair activities.
- PTS and TTS impacts are not predicted from any of the activities to southern right whales, by themselves or with calf, that may be moving through the core coastal area to and from coastal aggregation and migration areas based on mean recorded swims speeds for southern right whales are between 3 – 3.3 km/hr (Mate et al. 2011; Mackay et al. 2015 cited in Charlton 2017). As the furthest distance to the PTS or TTS criteria is 1.25 km over 8 hr and 750 m over 2 hr southern right whales, by themselves or with calf, would move out of the ensonified area before PTS or TTS could occur.
- Avoidance behaviour may be exhibited if southern right whales are within the area where the behavioural criteria is reached. Disturbance on the behaviour of the mothers that could increase their energy expenditure will result in a reduction of energy available for their calf and for their return migration (Christiansen et al. 2014b). Based on an average swim speed of 3 km/hr (Charlton 2021 per com) energetic costs would be extremely low if avoidance behaviour occurred for the platform (200 m), the only continuous activity, and vessel standby (450 m), and low for platform resupply (7.31 km) and inspection, maintenance and repair activities (2.27 – 2.98 km) and thus not predicted to impact the fitness of mothers or calves moving between calving and feeding areas.
- Southern right whales may avoid the area where the behavioural criteria is reached but there is no impediment to them continuing to and from coastal aggregation and migration areas. Southern right whales are a highly mobile migratory species that travel thousands of kilometres between habitats used for essential life functions (DSEWPaC, 2012a). Along the Australian coast, individual southern right whales 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 (DSEWPaC, 2012a). As such, avoidance of the ensonified area is unlikely to prevent or hinder them from undertaking their seasonal migrations.
- PTS, TTS or behavioural criteria from activities at the platform, including vessel standby and resupply, are not reached at the Victorian coastal migration and resting on migration BIA or southern right whale emerging aggregation area.

- For inspection, maintenance and repair activities adopted controls as detailed in Section 7.5.5 will prevent possible PTS, TTS and displacement impacts to southern right whales that maybe present in the migration and resting on migration BIA and emerging aggregation area at Port Campbell. This includes CM#36b - SRW Exclusion Zone where no IMR activities will be planned within 3 km of a SRW BIA or emerging aggregation area during May to end of October when SRW are potentially present in the BIAs or emerging aggregation area. This will ensure that SRWs will not be prevented from calving in the Port Campbell emerging aggregation area or affect the survival of the SRW while leaving the aggregation area.

- Cumulative impacts from the activities proposed within this EP at the Thylacine-A Platform, including vessel standby and resupply, and from IMR activities are not predicted at the SRW BIAs and emerging aggregation area at Port Campbell based on:

  - IMR activities will not be undertaken within 3 km (furthest distance to noise criteria for IMR activities) of a SRW BIA or emerging aggregation area when SRW are potentially present in the BIAs or emerging aggregation area and noise criteria (PTS, TTS or behavioural) from activities at the platform, including vessel standby and resupply, are not reached at the SRW BIAs or emerging aggregation area at Port Campbell.

  - The Thylacine-A Platform is ~65 km from the emerging aggregation area at Port Campbell and ~ 70 km to the closest SRW BIA. Acoustic modelling (Koessler and McPherson 2021 Appendix F) for concurrent activities at the platform such as platform operations and resupply shows the furthest distance to the noise criteria (behaviour) is 7.31 km and for IMR activities is 2.98 km, thus if an IMR activity was to occur within 3 km of the platform the overlapping noise footprint would not be reached at a SRW BIA or the emerging aggregation area at Port Campbell due to the distance from the overlapping noise footprint being ~ 60 and 55 km, respectively from these areas.

  - Concurrent IMR campaigns are not planned.

- Cumulative impacts from activities within the surrounding area on SRWs calving in the Port Campbell emerging aggregation area and their survival while leaving the aggregation area are not predicted based on:

  - Beach Otway Development Drilling will be completed in June 2022 and is currently being undertaken at Thylacine. Acoustic modelling (Koessler and McPherson 2021 Appendix F) for concurrent activities at Thylacine of MODU drilling, platform and resupply shows the furthest distance to the noise criteria (behaviour) is 7.90 km. As the Thylacine wells and platform are > 50 km from a SRW BIA and the emerging aggregation area at Port Campbell the overlapping noise footprint would not be reached at these areas. As the MODU and platform are using the same supply vessel concurrent resupply activities will not occur.

  - A Beach IMR activity may be undertaken while drilling is occurring at Thylacine. Acoustic modelling (Koessler and McPherson 2021 Appendix F) for concurrent activities at Thylacine of MODU drilling, platform and IMR vessel shows the furthest distance to the noise criteria (behaviour) is 6.08 km. As the Thylacine wells and platform are > 50 km from a SRW BIA and the emerging aggregation area at Port Campbell the overlapping noise footprint would not be reached at these areas. Acoustic modelling was also undertaken for the Geographe subsea installation and commissioning activities to access cumulative impacts from concurrent subsea installation and commissioning activities at Geographe and the MODU and support vessel undertaking resupply at the Thylacine wells. The installation vessel used for the modelling was the Skandi Singapore which is also the vessel used for acoustic modelling for IMR activities. Thus, the scenario for the Geographe subsea installation and commissioning activities would be representative of concurrent activities of MODU drilling at Thylacine with support vessel undertaking resupply and an IMR activity at Geographe. The modelling results indicate that the modelled sound pressure levels received at the emerging aggregation area at Port Campbell were a maximum of 97.3 dB SPL which is ~22 dB less than the marine mammal behavioural noise criteria or 120 dB SPL. The modelled SPL shows that if SRW are present in the emerging aggregation area at Port Campbell at the time of the combined activities, their behaviour (e.g., calving, resting) will not be affected.

- Beach Geographe Subsea Installation and Commissioning is complete.

- Beach Otway Phase 5 Early Dive Installation Campaign is scheduled for Q2, or Q3 2022 after the Otway drilling campaign has been completed. This activity is planned to be undertaken within 30 m of the Thylacine-A Wellhead Platform. Concurrent activities could consist of the platform and resupply, and an installation vessel. This scenario has not been modelled but based on the acoustic modelling (Koessler and McPherson 2021 Appendix F) the furthest distance to the noise criteria (behaviour) for the platform and resupply is 7.31 km and for drilling, platform and installation is 6.08 km. Even, if these overlapping noise footprints resulted in a doubling of the greatest distance (i.e. 7.31 km x 2 = 14.62 km), which is an overestimation, noise levels above the behavioural criteria would not be reached at the SRW BIA and the emerging aggregation area at Port Campbell as the Thylacine platform where the installation campaign will be undertaken is > 50 km from the SRW areas.

- TGS Otway Deep Marine Seismic Survey proposed dates of October 2021 to February 2022 has passed.

- Cooper Energy CHN Operations will also undertake IMR activities on their offshore infrastructure which is to the west of the Beach Otway Operations infrastructure. Beach will not be undertaking IMR activities within 3 km of a SRW BIA or emerging aggregation area when SRW are potentially present in the BIAs or emerging aggregation area, thus the closest distance to Cooper Energy's infrastructure and to Beach's infrastructure outside this 3 km area is 3 km. As Cooper Energy CHN Operations EP does not include acoustic modelling and the IMR activities are within the same area and likely to use similar vessels it can be presumed the furthest distance to the noise criteria (behaviour) of 2.98 km would also apply to Cooper Energy's IMR activities. Thus, if IMR activities where being undertaken by Beach and Cooper Energy at the same time impacts from these concurrent activities are not predicted to the SRW BIAs or emerging aggregation area when SRWs are present in these areas.

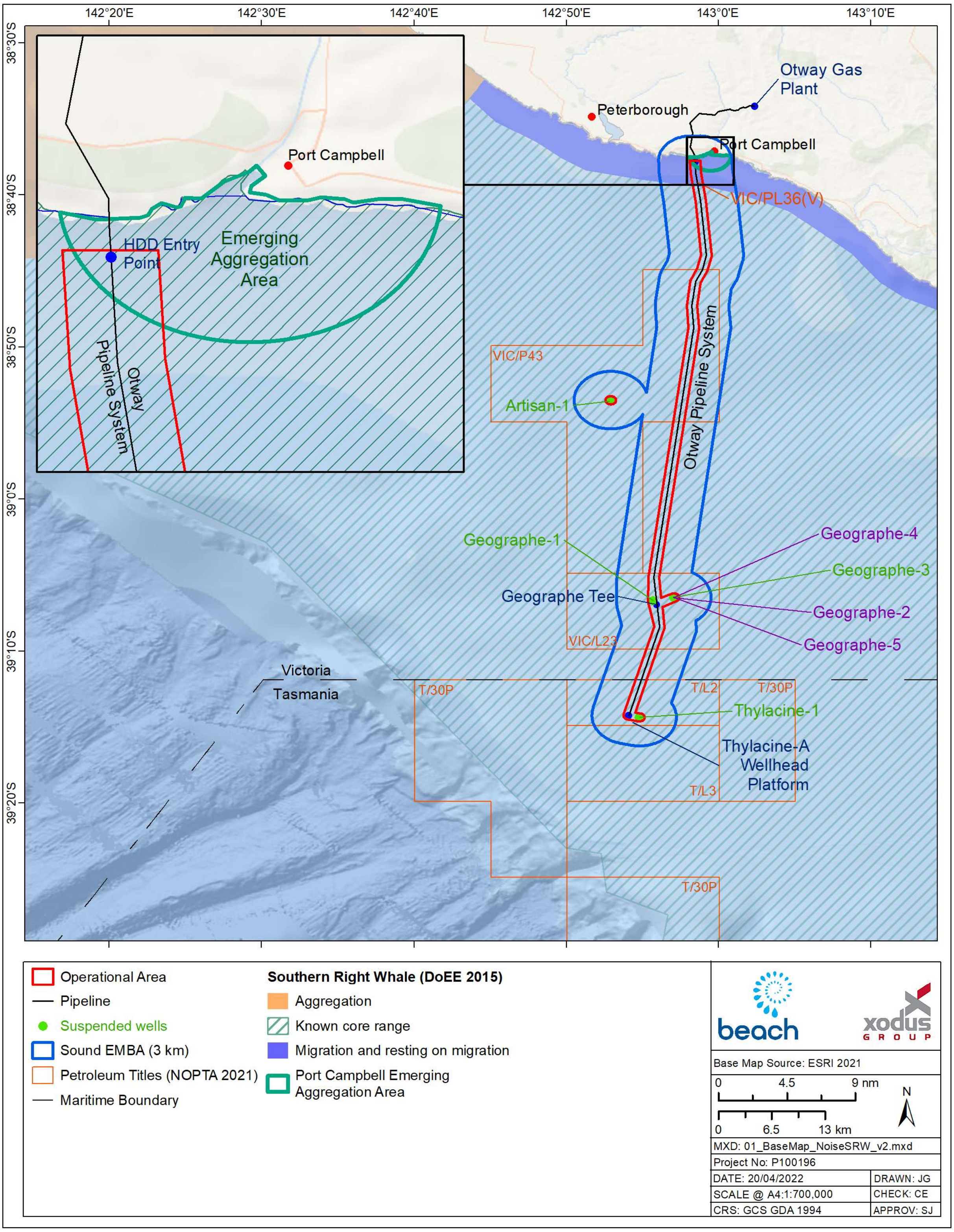

Figure 7-7: Southern right whale BIAs, current core coastal range, emerging aggregation area and sound EMBA

Other whales

Foraging behaviour for fin, pygmy right and sei whales has been identified in the area where the PTS, TTS and behavioural criteria is reached. As detailed in Section 5.6.7.6 cetacean foraging within the Otway shelf, and hence the area where the PTS, TTS and behavioural criteria is reached, is typically from January to April though whales maybe present from November to June which overlaps the period when Otway Offshore Operations activities may occur (activities occur year round).

The fin, pygmy right and sei whales do not have conservation management plans. The fin and sei whales have conservation advice (TSSC, 2015f; TSSC, 2016g) which both identify anthropogenic noise as a threat with the conservation and management actions of:

- Once the spatial and temporal distribution (including biologically important areas) of sei whales is further defined an assessment of the impacts of increasing anthropogenic noise (including from seismic surveys, port expansion, and coastal development) should be undertaken on this species.
- If required, additional management measures should be developed and implemented to ensure the ongoing recovery of sei whales.

As detailed in Table 7-11 the extent and duration of impact differs based on the activity being undertaken, however, the severity is assessed as moderate and is of an acceptable level based on:

- The fin and sei whale's conservation advice (TSSC, 2015f; TSSC, 2016g) has a consequence rating for anthropogenic noise and acoustic disturbance as minor with the extent over which the threat may operate as moderate-large.
- There is no conservation advice for the pygmy right whale and the Species Profile and Threats Database (DotEE, 2020a) does not identify anthropogenic noise and acoustic disturbance as a threat.
- Low numbers of fin, sei and pygmy right whales are predicted within the PTS, TTS and behaviour ensonification area based on the following:
  - the PTS and TTS ensonification area is ~75 km from the Bonney coast upwelling KEF which is known as feeding aggregation area (Gill et al. 2011; McCauley et al. 2018).
  - the PTS and TTS ensonification area is within an area with a historical frequency <10% of an upwelling occurring (Huang and Wang 2019).
  - no biologically important areas were identified for these species.
  - aerial surveys in the Otway region (2002 – 2013) recorded seven fin whale sightings consisting of 8 individuals, 12 sei whale sightings consisting of 14 individuals and one pygmy right whale sighting consisting of 100 individuals (Gill et al. 2015). Gill et al. (2015) did observer feeding behaviour for sei and fin whales but noted that it is at least an opportunistic feeding area for these species.

7.5.4.3 Marine Turtles

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 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.

In 2006, the Working Group on the Effects of Sound on Fish and Turtles was formed to develop sound exposure criteria for fish and turtles. The Working Group developed guidelines with specific thresholds for different levels of effects for several species groups including turtles (Popper et al. 2014).

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. Based on this information avoidance behaviour may occur within the operational area.

Finneran et al. (2017) presented revised thresholds for turtle PTS and TTS for continuous sound. Table 7-12 details the criteria and modelled distances to them (Koessler and McPherson 2021. Appendix F). The 24 hr PTS criteria was reached within 40 m when undertaking resupply at the Thylacine-A Wellhead Platform and 20 m when the undertaking maintenance and repair activities. The 24 hr TTS criteria was reached within:

- 20 m of the Thylacine-A Wellhead Platform with and without the support vessel on standby.
- 170 m when undertaking resupply at the Thylacine-A Wellhead Platform.
- 30 m when undertaking inspection activities.
- 80 m when undertaking maintenance and repair activities.

Three marine turtle species may occur within the operational area (500 m) though no BIAs or habitat critical to the survival of the species were identified.

The extent of the area of impact is predicted to be within the operational area. The severity is assessed as Minor (1) based on:

- the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 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.
- thresholds for turtle PTS and TTS over 24 hrs were predicted to occur with a maximum distance of 170 m within the operational area where no marine turtle important habits are located.

- avoidance behaviour may occur within the operational area where no marine turtle important habits are located.
- low numbers of marine turtles are predicted in the operational area and therefore impacts would be limited to a small number of individuals.

7.5.4.4 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 7-13 details the criteria and modelled distances to them (Koessler and McPherson 2021. Appendix F).

No cumulative impacts are expected as there are no habitats likely to support site-attached fish in the operational area.

The recoverable injury threshold was not reached for any scenario. The 12 hr TTS criteria was reached within 140 m when undertaking resupply at the Thylacine-A Wellhead Platform and 30 m when the undertaking IMR activities and 40 m when undertaking maintenance and repair activities with cutting or rock bolting. As there are no habitats likely to support site-attached fish in the operational area it is also unlikely that fish species would be present for a period of 12 hours. Thus, TTS impacts are not predicted.

Behavioural impacts are more likely such as moving away from the vessel. There are no habitats or features within the operational area that would restrict fish and sharks from moving away from the vessel.

The operational area is within a distribution BIA for the white shark though no habitat critical to the survival of the species or behaviours were identified. The Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a) does not identify sound as a threat.

Low levels of commercial fishing for fish species were identified within the operational area within shark fishing occurring nearshore and snapper and wrasse fishing within grids covering Artisan and the Otway Pipeline System. Thus, temporary avoidance may occur during inspection, maintenance and repair activities.

The extent of the area of impact is predicted to be within the operational area for the duration of vessel activities. The severity is assessed as Minor (1) based on:

- The Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a) does not identify sound impacts as a threat.
- Avoidance behaviour may occur within the operational area, however, no habitats likely to support site-attached fish have been identified within the operational area.

- Temporary avoidance behaviour may occur within the operational area (500 m) for commercial fish during inspection, maintenance and repair activities, however recovery would occur once the activity had finished. Based on the small area of impact, low fishing activity and that displaced fish would still being available to be caught outside of the operational area, impacts to commercial fishing are not predicted.

Table 7-12: Finneran turtle SEL_{24h} thresholds and modelled distances

Marine Turtles	SEL_{24h} threshold	Platform (Scenario A4)	OSV standby (Scenario A3)	Platform and OSV standby (Scenario 5 & 6)	Platform resupply (Scenario 1, 2,3 ,4)	Vessel based inspection (DP) (Scenario 9, 10, 13, 14)	Vessel based maintenance / repair with and without cutting (Scenario 7, 8, 11, 12, 15, 16)
		R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)
PTS	220 dB re 1 µPa²·s	Not reached	Not reached	Not reached	40 m	Not reached	20 m
TTS	200 dB re 1 µPa²·s	20 m	Not reached	20 m	170 m	30 m	80 m

Table 7-13: SPL criteria for fish with a swim bladder involved in hearing and modelled distances

Fish: Swim bladder involved in hearing	SPL (Lp; dB re 1 µPa)	Platform (Scenario A4)	OSV standby (Scenario A3)	Platform and OSV standby (Scenario 5)	Platform resupply (Scenario 1)	Vessel based Inspection/ maintenance / repair (Scenario 7, 8, 9,10)	Vessel based maintenance / repair with cutting (Scenario 15, 16)
		R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)	R_{max} (km)
Recoverable injury	170 dB SPL for 48 h	Not reached	Not reached	Not reached	Not reached	Not reached	Not reached
TTS	158 dB SPL for 12 h	Not reached	Not reached	Not reached	140 m	30 m	40 m

7.5.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Underwater sound emissions	
ALARP decision context and justification	**ALARP Decision Context: Type B** Impacts from sound emissions are relatively well understood though there is the potential for uncertainty in relation to the level of impact. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. Additional controls may be required to ensure impacts can be managed to an acceptable level.
Adopted Control Measures	**Source of good practice control measures**
CM#7: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans Wildlife (Marine Mammal) Regulations 2009	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans and the Vic Wildlife (Marine Mammal) Regulations 2009 describes strategies to ensure whales and dolphins are not harmed during offshore interactions with vessels and helicopters. Support vessels will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 and Vic Wildlife (Marine Mammal) Regulations 2009 in relation to distances to cetaceans. These regulations stipulate a safe operating distance of 300 m. This will be increased to 500 m to take into account the furthest distance to the sound criteria (450 m) when the support vessel is on standby. Helicopters will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans. The Wildlife (Marine Mammal) Regulations 2009 only provides separation distances to seals on land and at protected or significant seal breeding colonies, none of these are within the area of predicted impact for seals.
CM#36 Otway Operations Vessel Whale Management Procedure	The Vessel Whale Management Procedure details the controls to prevent possible PTS, TTS and displacement impacts to foraging blue whale and southern right whales that maybe present in the core coastal area and migration and resting on migration BIA. The procedure assumes that once an activity is underway foraging whales that enter the pre-activity survey zone are not displaced as foraging behaviour has not been disrupted as the whale has commenced or continued foraging and thus aligns with the Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015b) and DAWE (2021) definitions. In this situation only PTS and TTS need to be managed to ensure the activity is not inconsistent with the Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015b). Prior to an activity commencing a pre-activity survey will be undertaken of the activity survey zone for the activity: • Resupply – 7.5 km • Inspection – 3 km • Maintenance and repair – 3 km

The activity survey zones are based on the distance to the furthest modelled PTS, TTS or behaviour criteria, as detailed in Table 7-9, and have been rounded up to take into account accuracy of estimation of distance at sea.

On advice from the Blue Whale Study, a conservative approach will be adopted whereby it is assumed that all whales present on the Otway shelf are conducting biologically important behaviours (e.g., foraging blue whales). All whales will also include southern right whales with or without a calf.

Surveys will be undertaken for 30 min prior to the activity commencing. If a whale is sighted within the pre-activity survey zone the activity will not commence until:

- No whales are observed for 30 min within the pre-activity survey zone; or
- Whales are observed leaving the pre-activity survey zone.

MMOs currently contracted to the Otway drilling campaign have stated that from a vessel bridge height of ~20 m, observations are possible up to 7 km. Given that the vessels used for the drilling campaign are the same vessels that will be used to support operations and undertake resupply, the pre-activity survey zone distance of 7.5 km can be met as the vessel will be able to move around within the pre-activity survey zone providing full observation coverage prior to resupply commencing.

The period of 30 min is deemed as sufficient time to observed deep diving whales such as blue whales based on blue whale foraging behaviour and dive duration detailed in the blue whale section in Section 5.6.7.6.

Once the activity has commenced observations will be undertaken within the activity survey zone distances detailed above.

If a whale is sighted within the activity survey zone the following will occur:

- If the vessel can do so it will move away from the whale and maintain a minimum separation distance equal to the activity survey zone.
- If the vessel cannot move away from the whale, the vessel will reduce thrusters if safe to do so. The activity will cease as soon as it is safe, and the vessel will move out of the activity survey zone.

The activity can recommence once:

- No whales are observed for 30 min within the activity survey zone; or
- Whales are observed leaving the activity survey zone.

As detailed platform resupply is undertaken using the drilling support vessels from which MMOs can observe up to 7 km. Thus, once resupply commences, they may not be able to see as far as the 7.5 km activity survey zone. As resupply activities at the Thylacine-A Platform may take up to 8 hrs and are undertaken ~5 times a year the cost, both monetary and increased sound emissions, associated with having another vessel present to be able to see the full activity survey zone is disproportionate to the benefit as the presurvey of the activity zone will be undertaken to identify if any whales are within the activity zone or likely to enter the activity zone. The probability that pygmy blue whales would enter the activity zone to forage within the period that resupply would be undertaken would be extremely low considering the short resupply time.

Activities can commence at night or in low visibility conditions (i.e., when observations cannot be undertaken) if no more than three whales have been seen in the activity survey zone in the preceding daylight hours. The no more than three whales criterion is acceptable for blue whales because it indicates the krill stock at

	the location has been diminished. More than three whales within the previous daylight hours may indicate a large krill supply and more whales could be expected. The daylight hours is justified because it is the longest possible continuous observation period (i.e., one full day of observations). Three southern right whales would be an indication that there is an increased likelihood of a southern right whale within the activity survey zone during the period that observations cannot be undertaken. During the period that drilling is occurring for the Otway Development the following will be undertaken to inform operations activities in relation to the presence of whales within the Otway Development and Operations areas: • One week prior to an activity being undertaken a review of whale data to determine if blue and/or southern right whales have been observed in the area. • When undertaking an activity presence of whales observed from drilling or operations activities will be communicated via radio.
CM#36a Marine mammal observer	A trained and experienced MMO will undertake activity survey zone observations for activities that will be undertaken over a period greater than 24 hours, this will typically be for IMR activities. For IMR activities greater than 5 consecutive days at sea an additional trained MMO will be onboard the vessel to support the trained and experienced MMO. Five consecutive days at sea was deemed appropriate to managed fatigue during periods when there are longer daylight hours in southern Australia during the summer months (up to 15 hours) which are greater than a 12-hr work shift. For a period of up to 5 consecutive days fatigue can be appropriately managed by the MMO being supported by the Officer of the Watch as per below. In addition, vessel crew who act as Officer of the Watch will receive training from the MMO in whale observation and distance estimation to assist the MMO during daylight hours. Resupply activities at the Thylacine-A Platform may take up to 8 hrs and are undertaken ~5 times a year. For resupply the vessel Officer of the Watch will undertake the activity survey zone observations. They will be trained in the Vessel Whale Management Procedure, whale observation and distance estimation. This is deemed acceptable based on: • Mitigation actions are based on sighting a whale within the activity survey zone, so identification of species and/or activity is not required and thus experience in whale identification is not required. • The vessel Officer of the Watch will be experience at distance estimation at sea as their role is to monitor for hazards at sea in all conditions. • The cost is disproportionate as there is no increase in environmental benefit as the Officer of the Watch is capable of undertaking the observations required for an activity that will take at most 8 hours.
CM#36b SRW Exclusion Zone	No IMR activities will be planned within 3 km of a SRW BIA or emerging aggregation area during May to end of October when SRW are potentially present in the BIAs or emerging aggregation area. The Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a) includes objectives relevant for evaluation of environmental impacts of underwater noise on SRWs and requires that 'aggregations categorised as

	emerging areas in 2011 meet criteria for an established area by 2021; OR are occupied in a greater number of years from 2011–2021 compared with 2005–2010'. The implementation of an exclusion zone for these areas, including the Port Campbell emerging aggregation area, will ensure that the activity is not inconsistent with the Conservation Management Plan for the Southern Right Whale as it will not impede the recovery objective for this emerging aggregation area.	
CM#5: Preventative Maintenance System	Power generation and propulsion systems on the vessels will be operated in accordance with manufacturer's instructions and ongoing maintenance to ensure efficient operation.	
Additional controls assessed		
Control	**Cost/Benefit Analysis**	**Control Implemented?**
Seasonal timing	Pygmy blue whales are potentially in the foraging BIA within the Otway shelf waters from November through to June. Southern right whales may travel through the operational area to and from coastal aggregation and migration areas during May-June and September-November and be present in the coastal aggregation and migration areas, which the operational area overlaps, between June to October. Thus, there is no period when there is not a whale undertaking a biologically important behaviour within the Otway region. The implementation of additional controls above the legislative requirements of the EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans will be implemented to manage potential impacts to whales undertaking biologically important behaviour.	No
Anchoring of the vessels	This control is not feasible for the vessels to support operations and for IMR activities based on: • Inspection activities require the vessel to be continuously moving while undertaking the inspection. • Maintenance and repair activities require minor adjustments to the vessel position while undertaking the activity and anchoring may damage existing subsea infrastructure. • Resupply operations require the vessel to use DP to maintain position adjacent to the platform to counter wind and current conditions. • Vessel standby activities require the vessel to be able to react immediately in the event of an issue on the platform.	No
Shut down zones	Implemented with safety controls. Shutting down the CSV DP system during installation activities could lead to the vessel drifting and colliding with another vessel, potentially resulting in a safety risk to personnel or an MDO spill. It may lead to damage to subsea equipment if the equipment is	No

	suspended by a crane in the air or in the water at the time of shutdown or, as a worst case, result in damage to existing subsea equipment. It could also result in a vessel strike to the whales that shutting down the propulsion system is meant to protect.	
Passive acoustic monitoring (PAM)	PAM is most useful in the detection of odontocetes such as sperm whales, dolphins and porpoise known to emit regular distinctive clicks and high frequency calls during long dives. PAM has limited utility in detecting lower frequency calls of baleen whales (such as blue whales, southern right whales) especially when in the presence of constant background low frequency sound such as that generated by the vessel towing the PAM system. Given the very low utility and associated unreliability of using PAM to inform mitigation decision making, any additional cost is considered disproportionate to the benefit gained.	No
Dedicated monitoring vessel	An additional dedicated vessel is not required as monitoring activities can be effectively conducted from the Thylacine-A Platform and/or operations or IMR vessels. Cost is disproportionate to marginal environmental benefit.	No
Aerial surveillance	Aerial surveillance from aircraft or drones is not required as monitoring activities can be effectively conducted from the Thylacine-A Platform and/or operations or IMR vessels. Cost is disproportionate to marginal environmental benefit.	No
Consequence rating	Moderate (2)	
Likelihood of occurrence	NA	
Residual risk	Low	
Acceptability assessment		
To meet the principles of ESD	Sound emissions were assessed as having a moderate consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.	
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 8).	
External context	There have been no stakeholder objections or claims regarding sound emissions.	
Other requirements	Sound emissions will be managed in accordance with legislative requirements. Sound emissions will: • not impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b).	

	• be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area (Commonwealth of Australia, 2015b). • not impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). • not impact southern right whale established or emerging aggregation BIAs or the migration and resting on migration BIA (Commonwealth of Australia 2015b). • not impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • not impact the recovery of the white shark as per the Recovery Plan for the White Shark (DSEWPaC, 2013a). Actions from the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) applicable to the activity in relation to assessing and addressing anthropogenic noise have been addressed as per: • assessing the effect of anthropogenic noise on blue whale behaviour. Section 0 assesses the effects of anthropogenic noise from the activity on blue whale behaviour. • 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. Section 0 demonstrates that the activity can be conducted in a manner that is consistent with the conservation management plan and will not result in injury or displacement of pygmy blue whales from a foraging BIA.
Monitoring and reporting	Cetacean sightings records.
Acceptability outcome	**Acceptable**

7.6 Physical presence

7.6.1 Hazards

Physical presence of the Otway Offshore Operations includes:

- Thylacine A-Platform, T-1 suspended well and associated PSZ (gazetted 2005)
- Geographe subsea wells and infrastructure and associated PSZ (gazetted 2013)
- Artisan-1 suspended well and associated PSZ (gazetted 2020)
- Otway Pipeline system
- 500 m safety zone around vessels when undertaking IMR activities and geophysical surveys.

7.6.2 Predicted environmental impacts

The physical presence of offshore infrastructure, PSZs and vessels operating within the operational area can result in the displacement of other marine users.

The physical presence of subsea infrastructure on the seabed can result in snagging of fishing equipment

7.6.3 EMBA

Predicted impacts from the physical presence of offshore infrastructure, PSZs and vessels will be limited to the operational area.

Other marine user identified to occur within the operational area are:

- recreation and tourism
- commercial shipping
- petroleum activities
- commercial fishing

7.6.4 Consequence evaluation

Recreation and tourism

Recreation and tourism could be affected by restricted access to an area (i.e. due to the presence of a PSZ), particularly if the area is of interest due to fishing opportunities or presence of marine fauna. Impacts to recreational fishing and tourism are not predicted due to the distance that the PSZs are offshore (32 km - 70 km) and the absence of emergent features within the operational area. Vessel activities and the Otway Pipeline System which may intersect areas nearshore where recreational fishing occurs ongoing for over 10 years and to date there has been no interactions or incidents with recreation and tourism activities.

Commercial shipping

The operational area includes major shipping routes (Section 5.7.4) however, the gazetted PSZs and vessel activities associated with the Otway Gas Development have been ongoing for over 10 years and to date there has been no interactions or incidents.

Commercial vessels are required to avoid the gazetted PSZs. PSZs are marked on navigation charts and communicated to marine users, allowing commercial vessels to plan their journey to ensure they are not inconvenienced by the 500 m exclusion area.

Vessels undertaking activities within the operational area will not be anchored, and any disturbance to commercial vessels will be minor disturbance only.

The extent of the area of impact is predicted to be the area of the gazetted PSZs. The severity is assessed as Minor (1) based on the area of impact is small and the exclusion is required for safe operations of the platform and commercial vessels.

Petroleum activities

Beach-managed petroleum activity may be undertaken within the operational area as part of the Otway Offshore Development, however there are no other petroleum activities managed by other titleholders planned within the operational area.

Petroleum activities managed by other titleholders will be required to avoid the permanent PSZs gazetted around the Thylacine-A Wellhead Platform, Geographe subsea infrastructure and Artisan-1 well. Displacement of other petroleum activities is therefore not predicted.

Commercial fishing

The Commonwealth SESSF and Southern Squid Jig Fishery have catch effort within the operational area based on ABARES reports 2014 – 2020 (Patterson et al. 2018, 2017, 2016, 2015 and Georgeson et al. 2014). The Skipjack Fishery is not currently active and management arrangements for the fishery are under review.

Based on Victorian Fishing Association data from 2016 to 2020 the catch effort in the fishing grids surrounding the operational area is low, with a vast majority of the fishing effort congregated around the shoreline as described in Section 5.7.9.

During stakeholder consultation for previous Beach activities up to six fishers have identified they may fish in the broader Otway Offshore Development area which includes the operational areas of the development wells (Section 8.12.9).

A report commissioned by Beach and developed by South East Trawl Fishing Industry Association (SETFIA) on Trawl and Gillnet fishing activity (October 2019) found:

- Trawl fishing in the Southern and Eastern Scalefish and Shark Fishery Commonwealth Trawl Sector board trawl sub-sector does not occur in the Otway Offshore Project area as the grounds appear too rough for trawl fishing in its current form.

- Gillnet fishing in the Southern and Eastern Scalefish and Shark Fishery Gillnet Hook and Trap Sector does not seem to occur within the Otway Offshore Project area.
- There is no Southern and Eastern Scalefish and Shark Fishery Commonwealth Trawl Sector Danish seine sub-sector fishing in the Otway Offshore Project area.

There is a clear separation of these commercial fishers and the Offshore Project area. Therefore, no interaction is anticipated between trawl or gill net fishers and the Otway Offshore Operations.

During stakeholder consultation for previous Beach activities stakeholders have raised concerns in relation to displacement of their fishing activities in relation to new PSZs. No comments were received in relation to displacement of fishers during stakeholder consultation undertaken for the revision of this EP. The gazetted PSZs and vessel activities associated with the Otway Gas Development have been ongoing for over 10 years and to date there has been no interactions or incidents. The most recent PSZ at the Artisan-1 well was communicated to commercial fishers with no concerns raised.

The extent of displacement is the gazetted PSZs. The severity is assessed as Minor (1) based on:

- small area of displacement (0.79 km^2) within each petroleum safety zone which have been in place since 2005 for the Thylacine-A Wellhead Platform, 2013 for the Geographe wells and subsea infrastructure and 2020 for the Artisan-1 well.
- no trawl or gill net fishing occurs in the operational area.
- limited fishing has been identified within the operational area other than the nearshore area of the Otway Pipeline System and HDD Entry Point.

7.6.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Physical Presence	
ALARP decision context and justification	ALARP Decision Context: Type A Impacts from physical displacement are well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. Though objections and claims have been raised by stakeholders, via consultation in relation to development activities in the Otway Development Area, in relation to trawl and gillnet snagging risks on subsea wells subsequent data identified that there is no trawl or gillnet fishing in the operational areas. Objections and claims have also been raised by stakeholders, via consultation in relation to development activities in the Otway Development Area, in relation to displacement of their fishing areas, however, these have been adequately assessed and controls adopted to manage impacts to ALARP. No objections or claims were raised from fishers from consultation undertaken for the development of this EP. As the impact consequence is rated as Minor (1) applying good industry practice (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.

Adopted Control Measures	Source of good industry practice control measures
CM#8: Ongoing consultation	Consultation will continue with relevant stakeholders as detailed in Section 9.8
CM#9: Permanent Petroleum Safety Zone (PSZ)	PSZs, administrated by NOPSEMA under the OPGGS Act, are specified areas surrounding petroleum wells, structures or equipment which vessels or classes of vessel are prohibited from entering or being present in. Otway Pipeline System and Thylacine-A Wellhead Platform and Geographe subsea infrastructure PSZs are clearly marked on navigational charts
CM#10: Beach Fair Ocean Access Procedure	Beach's Fair Ocean Access Procedure (Appendix D) is being developed with input from commercial fishing industry organisations (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. An information sheet on the procedure is available in Appendix D.
CM#11: Navigation and communication aids	The Thylacine-A Wellhead Platform is provided with navigational lights, RACON and foghorn in accordance with International Association of Lighthouse Authorities (IALA) requirements.
CM#27: MO 30: Prevention of collisions	AMSA MO 30: Prevention of collisions requires that onboard navigation, radar equipment, and lighting meets the International Rules for Preventing Collisions at Sea (COLREGs) and industry standards.
CM#29: MO 27: Safety of navigation and radio equipment	AMSA MO 27: Safety of navigation and radio equipment gives effect to SOLAS regulations regarding radiocommunication and safety of navigation, and provides for navigation safety measures and equipment and radio equipment requirements.
CM#3: Marking of Man-Made Offshore Structures	Thylacine-A Wellhead Platform: Sections 2.1 and 2.2 of the Recommendation O-139 on The Marking of Man-Made Offshore Structures (IALA, Ed 2, 2013).
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Physical displacement was assessed as having a minor consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 8).
External context	The merits of claims or objections raised by a relevant stakeholder have been adequately assessed and additional controls adopted where appropriate.
Other requirements	Physical displacement will be managed in accordance with the applicable legislative requirements.

Monitoring and reporting	Monitoring of potential impacts is undertaken via stakeholder engagement.
Acceptability outcome	**Acceptable**

7.7 Benthic disturbance

7.7.1 Hazards

Benthic disturbance can occur as a result of activities which interact with the seabed, for example IMR activities such as use and parking of ROV on the seabed, excavation, pipeline repair, replacement of subsea infrastructure and infrastructure, including pipeline, stabilisation. The footprint of all IMR activities will be within the operational area, and where replacement occurs the footprint will not change from the original infrastructure footprint.

During the Geographe well installation and commissioning campaign there may be a situation where redundant infrastructure cannot be to be recovered to the vessel due to it being under existing infrastructure, for example electrical and hydraulic flying leads. Electrical and hydraulic flying leads left insitu may require stabilisation on the seabed to ensure they do not move around.

Vessel anchoring will not occur during the activity.

7.7.2 Predicted environmental impacts

Benthic disturbance can impact on benthic habitats and fauna through smothering and alteration of habitat and localised and temporary increases in suspended sediments near the seabed.

7.7.3 EMBA

Predicted impacts from benthic disturbance will be limited to the operational area. Receptors which may be affected by benthic disturbance within the operational area include:

- Benthic habitats and species assemblages.

7.7.4 Consequence evaluation

As detailed in Section 5.5.2 and 5.5.3 a seabed site assessment was undertaken over the Otway Development gas fields and proposed infrastructure corridors. This included Geographe and Thylacine fields, and the Artisan-1 wellhead location. In relation to benthic habitat within the Artisan, Geographe and Thylacine fields and broader area the following was identified:

- the seabed topography is dominated by exposed rock on the seabed.
- small patches of very thin transgressive coarse sand are present across the survey area.
- the seabed showed a scattered sessile biota on a sandy seafloor.
- no rocky reefs or outcrops were identified.
- the sandy substrates described for Thylacine and Artisan gas fields are consistent with the reported description for the broader Otway Development area of unconsolidated seabed sediments made up of carbonate sands.
- 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.

- 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.
- 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 species or ecological communities listed as threatened under the EPBC Act were observed.

The operational areas overlap the Shelf Rocky Reefs and Hard Substrates KEF. No threatened ecological communities or habitats critical to the survival of the species were identified within the operational areas. The Shelf Rocky Reefs and Hard Substrates KEF is in all areas of the South-east Marine Region continental shelf including Bass Strait, from the sub-tidal zone shore to the continental shelf break.

The seabed site assessment identified that the substrate was hard substrate within the operational areas but did not identify rocky reefs (Ramboll, 2020. Appendix E). The seafloor supported a patchy complex of branching epibiota (i.e., bryozoans, gorgonian cnidarians and sponges) which is characteristic of the hard grounds associated with the hard substrates' component of the Shelf Rocky Reefs and Hard Substrates KEF (Section 5.4.13). However, the hard substrate and associated biota characteristic of the hard substrate component of the Shelf Rocky Reefs and Hard Substrates KEF is not unique to the operational areas based on Commonwealth of Australia (2015c) stating that the hard grounds associated with the Shelf Rocky Reefs and Hard Substrates KEF are located in all areas of the South-east Marine Region continental shelf including Bass Strait. This is support by the recent seabed site assessment (Ramboll, 2020. Appendix E), that identified that the 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, and also previous surveys within the Otway Basin, as detailed below, that identified hard substrate with similar biota to that in the operational areas.

A comprehensive assessment of the Otway Basin coast to continental shelf margin collecting bathymetric data and video footage for the pipeline right-of-way options was undertaken for the Otway Gas Project EIS (Woodside, 2003) (Section 5.5.2) identified:

- 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).
- benthic assemblages (CEE Consultants Pty Ltd, 2003) ranged from very low density sessile; large sponge to diverse, high density sessile: sponge, coral dominated crinoids common and mobile species.
- BBG (2003) found that the substrate in water depths that predominate in the Otway Gas Project operational area (between 82 and 66 m) area was 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.

There is limited information on the recovery of benthic habitats after the removal of equipment. As the affected areas are expected to be like the surrounding seabed it would be expected that following removal of the equipment, sand and other material would begin to fill the area of disturbance and that recolonization would occur. This could take months to a year or more but is unlikely to have lasting effects.

The extent of the area of impact is predicted to be small / within the existing infrastructure footprint for a duration of up to months to years while the disturbed area recolonises. The severity is assessed as Minor (1) based on:

- no threatened ecological communities, critical habitats, sensitive or protected benthic habitat or species, including commercial invertebrate species, have been identified in the area of impact (operational areas).
- though the operational areas overlap hard substrate similar to that described for the Shelf Rocky Reefs and Hard Substrates KEF this feature, and associated biota are not unique to the operational area based on Commonwealth of Australia (2015c) stating that the hard grounds associated with the Shelf Rocky Reefs and Hard Substrates KEF are located in all areas of the South-east Marine Region continental shelf including Bass Strait, and on surveys within the Otway Basin that identified hard substrate with similar biota to that in the operational areas.
- due to the small area of disturbance and that the hard substrate habitat and associated biota is not unique to the operational areas the benthic disturbance will not modify, destroy, fragment, isolate or disturb a substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results.
- there is no impediment to the disturbed areas recolonising as the benthic habitat and associated biota is not unique within the operating areas.
- grout bags and cement from the installation of rock bolts are low toxicity.

7.7.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Benthic disturbance	
ALARP decision context and justification	ALARP Decision Context: Type A Impacts from benthic disturbance are well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation to benthic disturbance. As the impact consequence is rated as Minor (1) applying good industry practice (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#12: IMR Scope of Work	Benthic disturbance is limited to during IMR campaigns. The IMR scope of work will detail activities that may disturb the seabed and how these activities will limit the area of disturbance.

CM#34: Beach OEMS Element 6 Asset Management	The standard defines the minimum requirement for the monitoring and assurance processes that support the ongoing safe and reliable management of an asset throughout its lifecycle. All equipment associated with the Otway Gas Development is inspected, monitored and maintained in accordance with the CMMS to ensure that it is in good condition and can be safely decommissioned when required. If during the Geographe well installation and commissioning campaign equipment cannot be recovered it will be: • Left insitu i.e. not moved and placed on the seabed. • Will be stabilised to ensure it does not move. For electrical and hydraulic flying leads this may require stabilisation on the seabed. • If not recovered will be inspected as part of the well inspections program as the accepted WOMP.
CM#14: Beach Chemical Management Plan	All chemicals, including grout or cement used for stabilisation methods, will be assessed prior to use to ensure the lowest toxicity, most biodegradable and least accumulative chemicals are selected which meet the technical requirements of the application.
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Benthic disturbance was assessed as having a minor consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 8).
External context	There have been no stakeholder objections or claims regarding benthic disturbance.
Other requirements	No other requirements were identified in relation to benthic disturbance.
Monitoring and reporting	Impacts associated with benthic disturbance are over a small area and not predicted to have long term impacts to protected or commercially important receptors. Therefore, the monitoring is not proposed.
Acceptability outcome	**Acceptable**

7.8 Planned marine discharges – vessels

7.8.1 Hazards

Vessels will have planned marine discharges within the operational area such as cooling water, brine, bilge water, deck drainage, putrescible waste, sewage and grey water.

Wastewater and putrescible waste discharges from the Thylacine-A Wellhead Platform are not expected as:

- The wellhead platform is normally unmanned;
- During manned periods, all wastewater and putrescible waste will be contained and transported back to shore;
- The platform is mainly grated to allow rainwater and seawater from the bird deterrent system to easily fall through without resulting in contaminated runoff;
- Liquid collected in the closed drain system is pumped to the production pipeline by the two drain pumps operating in lead/lag mode, before the drain system is vented; and
- Chemical storage areas are bunded.

7.8.2 Predicted environmental impacts

Planned marine discharges can result in changes in water quality such as increased temperature, salinity, nutrients, chemicals and hydrocarbons which can lead to toxic effects to marine fauna.

Putrescible waste discharges can result in changes in fauna behaviour if result in fauna habituate to this food source.

7.8.3 EMBA

Predicted impacts from planned marine discharges from vessels will be limited to the operational area. Receptors potentially affected include water quality and marine fauna.

7.8.4 Consequence evaluation

7.8.4.1 Planned marine discharges

The consequence evaluation considers the potential cumulative impacts from:

- planned marine discharges of waste waters and putrescible wastes from vessels when undertaking petroleum activities within the operational area.

These discharges will result in:

- nutrients levels may be intermittently elevated within 500 m of a vessel when sewage, greywater and putrescible waste discharged.
- water temperature may be elevated within 100 m of the of a vessel from the constant discharge of cooling water.

- hydrocarbon levels may be intermittently elevated within 100 m of a vessel when bilge waster is discharged.

Cumulative impacts may occur from the vessel discharges if work scopes overlap. This may only occur if re-supply operations at the Thylacine-A Wellhead Platform are undertaken during an IMR campaign. However, vessels undertaking activities under this EP will mostly be moving, increasing the dispersion of wastewater and reducing the area of potential impacts. The small additional volumes that an additional vessel will discharge and intermittent nature of the discharges, except for cooling water which has a predicted area of impact of 100 m, would be unlikely to significantly increase the impact extent beyond 500 m or the impacts to water quality and marine receptors while concurrent activities are occurring.

For the consequence evaluation, it is assumed that vessels would be operating adjacent to existing infrastructure, therefore all wastewater discharges will dissipate within the operational area (500 m).

Though plankton may be sensitive to some aspects of marine discharges such as increased temperatures (Huertas et al. 2011) this is typically for prolonged exposure. In view of the high level of natural mortality and the rapid replacement rate of many plankton species (Richardson et al, 2017) impacts from short term exposure to marine discharges of low toxicity that will rapidly dilute is unlikely to have lethal effects to plankton that area ecologically significant.

Fish species, including commercial species maybe present within the operational area. There are no BIAs or protected habitats and commercial fishing for fish species has not been identified within the operational area. No features have been identified where site attached species would be present. As fish species would be transient in the operational area, toxicity impacts are not predicted due to the low toxicity of the marine discharges and rapid dilution.

The operational area overlaps the distribution BIA for white shark by although no critical habitats or behaviours are known to occur. The Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a) does not identify vessel discharges or equivalent as a threat. As these species would be transient in the operational area toxicity impacts are not predicted due to the low toxicity of the marine discharges and rapid dilution.

No turtle BIAs are located within the operational area though turtle species may occur. Chemical and terrestrial discharge is identified as a threat to turtles in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b) though not specifically from vessels and is focus on long term exposure. As these species would be transient in the operational area toxicity impacts are not predicted due to the low toxicity of the marine discharges and rapid dilution.

The operational area overlaps the pygmy blue whale high density foraging BIA. The Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) does not identify discharges from vessels as a threat to the recovery of these species. It does identify that marine pollution can have a variety of possible consequences for blue whales at an individual and population level, or indirectly through harming their prey or the ecosystem. The conservation plan identifies acute chemical discharge (oil or condensate spill) as a threat that is classed as a minor consequence which is defined as individuals are affected but no affect at a population level. Given that chemicals associated with a spill is classed as a minor consequence impacts from low toxicity discharges that would rapidly dilute would be expected to be the same or a lower consequence, The operational area overlaps the southern right whale current core coastal range. The Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a) does not identify discharges from vessels as a threat to the recovery of these species but does identify chemical pollution in the form of sewage and industrial discharges as a threat more likely in coastal aggregation areas. The conservation plan identifies acute chemical discharge as a threat that is classed as a minor consequence which is defined as individuals are affected but no affect at a population level. Given that the conservation plan identifies acute chemical discharge as a threat more likely in coastal aggregation areas it would be expected that chemical discharges in an offshore area which would rapidly dilute would be the same or lower consequence.

The South-east Marine Region Profile (Commonwealth of Australia, 2015c) details that the oceanography of the South-east Marine Region contributes to enhanced areas of primary productivity, including:

- spring and autumn phytoplankton blooms in the Subtropical Convergence Zone (south of Tasmania).
- primary productivity associated with the Bass Cascade and upwelling of cool nutrient-rich waters along the mainland coast north-east of Bass Strait.
- localised seasonal upwellings along the Bonney coast.

The closest of these high productivity areas to the Otway Offshore Operations is the Bonney coast upwelling KEF. Figure 5-19 shows that the Bonney coast upwelling KEF is ~83 km from the operational area. The Bonney coast upwelling KEF is an area of high productivity and aggregations of marine life, of importance as feeding grounds to blue, sei and fin whales and higher predatory species, typically in summer and autumn months. However, based on the large distance between the operational area and the Bonney coast upwelling KEF impacts to water quality and therefore productivity are not predicted.

The extent of impact, including any cumulative impacts, is predicted to be 500 m from a vessel. The severity is assessed as Minor (1) based on:

- marine discharges will be of low toxicity with controls such as treatment and chemical assessment in place.
- marine discharges are not predicted to have lasting effects on either the biological or physical environment in the operational area with no specific value when compared with surrounding waters.
- the operational area overlap with the white shark distribution BIA is small; and the Recovery Plan for the White Shark (DSEWPaC, 2013a) does not identify vessel discharges or equivalent as a threat.
- the operational area overlap with the pygmy blue whale foraging BIA is small; and the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) identifies acute chemical discharge (oil or condensate spill) as a threat that is classed as a minor consequence which is defined as individuals are affected but no affect at a population level.

- the operational area overlap with the southern right whale current core coastal range is small; and the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a) identifies acute chemical discharge as a threat that is classed as a minor consequence which is defined as individuals are affected but no affect at a population level.
- marine discharges do not interfere with wind-generated upwelling events, nor are they likely to impact marine fauna attracted to the area by regional upwelling events.
- potential impacts to plankton are not expected to result in impacts to foraging marine species given the overall abundance of food resources within the region.
- as the discharges are discharged into an open oceanic environment they are predicted to mix rapidly with the surrounding waters and impacts to sediments and benthic biota including invertebrates is not predicted.
- given the anticipated rapid dilution of low concentration of hydrocarbons and chemicals within the water column, there is no identified potential for decreases in water quality that may impact on marine fauna attracted to regional upwelling events.

7.8.4.2 Putrescible waste

The operational area where the vessels would discharge putrescible waste overlaps foraging BIAs for several albatross species, common diving-petrel, and short-tailed and wedged-tailed shearwater (Figure 5-26, Figure 5-27 and Figure 5-28). No habitat critical to the survival of seabirds occur within the operational area. Marine pollution is identified as a threat in the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a); however, vessel food waste discharge would be sporadic and for a short duration thus would not result in seabirds habituating to this food source. The common diving-petrel (listed as marine) and wedged-tailed shearwater (listed as marine and migratory) do not have a recovery plan or conservation advice.

Fish may also become attracted to the food waste but as for seabirds the sporadic nature of vessel food waste discharge would not lead to fish habituating to this food source.

Periodic discharge of macerated food waste to the marine environment will result in a temporary increase in nutrients in the water column that is expected to be localised to waters surrounding the discharge with no lasting effects to either the biological or physical environment.

The extent of the impact is predicted to be 500 m from the vessel while undertaking activities in the operational area. The severity is assessed as Minor (1) based on:

- food waste discharges are sporadic and for a short duration thus would not result in fauna habituating to this food source.
- food waste will rapidly disperse in the marine environment.
- The nutrients within putrescible waste are to be discharged within an area of regionally elevated nutrient levels created by seasonal upwelling events, therefore additional nutrients loading is not likely detrimental to marine fauna.

7.8.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Planned marine discharges – vessels	
ALARP decision context and justification	ALARP Decision Context: Type A Impacts from planned marine discharges are well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims were raised by stakeholders in relation to planned marine discharges As the impact consequence is rated as Minor (1) applying good industry practice (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#13: *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and Marine Order 96 (Marine pollution prevention — sewage) 2018 giving effect to MARPOL Annex IV.	This Act regulates 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, putrescible waste, garbage, air pollution etc.
CM#5: Maintenance Management System	Equipment to treat marine discharges such as bilge water, slops from deck drainage, sewage and food waste are operated in accordance with the maintenance management system to ensure efficient operations.
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Planned marine discharges were assessed as having a minor consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 8).
External context	There have been no stakeholder objections or claims regarding planned marine discharges.
Other requirements	Planned marine discharge will be managed in accordance with legislative requirements. Planned marine discharges will not: • impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). • impact the recovery of the white shark as per the Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a). • impact the long-term survival and recovery of albatross and giant petrel populations breeding and foraging as per the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a).

	• impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). • impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • impact sei or fin whales, covered by conservation advice.
Monitoring and reporting	Impacts associated with planned marine discharges are over a small area and not predicted to have long term impacts to protected or commercially important receptors. The control measures adopted ensure water quality remains within internationally recognised and acceptable parameters therefore, monitoring is not proposed.
Acceptability outcome	**Acceptable**

7.9 Planned marine discharges – operations and IMR

7.9.1 Hazards

During operations and IMR activities, planned marine discharges include:

- Hydraulic control fluid discharged during Geographe subsea valve actuation.
- Fugitive discharge of hydraulic fluid through the hydraulic control system.
- Hydraulic control fluid discharge during maintenance and repair of subsea infrastructure (e.g. replacement of hydraulic fluid lead (HFL).
- Dye discharged during IMR activities such as leak testing.
- Chemicals used to remove marine debris.
- MEG discharge during well choke replacement activities.

The Otway Pipeline System is a closed system, with no discharges of MEG or corrosion inhibitor chemicals expected. There are no planned discharges from the Thylacine-A Wellhead Platform, and the closed drain system discharges liquid to the wells with no discharge of treated water. No hydraulic fluid from the Thylacine production wells is released to the marine environment.

Hydraulic fluid is provided to Geographe via the main umbilical from the Thylacine-A Wellhead Platform. It is delivered via the infield umbilical to the SVS. Each time the SVS is actuated a small volume of hydraulic fluid is released. A maximum of 1500 kg per year of hydraulic fluid are released subsea as a result of movements of G-2, G-4 and G-5 tree valves and Geographe SVS valves.

During IMR activities, hydraulic control fluid, MEG and other chemicals (such as dye and sulphuric acid) may be used and / or discharged to the marine environment.

All chemicals that will be or have the potential to be discharged to the marine environment must be assessed prior to use to ensure the lowest toxicity, most biodegradable and least accumulative chemicals are selected which meet the technical requirements of the application.

7.9.2 Predicted environmental impacts

Planned discharges of hydraulic control fluid, MEG and other operational discharges can result in changes in water quality which can lead to toxic effects to marine fauna.

7.9.3 EMBA

Predicted impacts from planned marine discharges from operations and IMR will be limited to the operational area. Receptors potentially affected include water quality and marine fauna.

7.9.4 Consequence evaluation

Hydraulic control fluids are water-based and readily biodegradable. As open marine waters are typically influenced by regional wind and large-scale current patterns resulting in the rapid mixing of surface and near surface waters any discharges of hydraulic control fluids would disperse rapidly within a small area. The extent within which the hydraulic fluids would disperse is estimated to be with 500 m of the release location.

During leak detection, dye is dosed into the system and a visual observation is made (by ROV / diver) to identify if a leak is present. Dyes are typically fluorescent to aid detection, and equipment can be used to detect dye in the water column at very low volumes. As with hydraulic fluid, the open water environment, small volumes and subsea currents means dye is expected to disperse within 500 m from the release location.

Marine debris removal may be aided by the use of chemicals such as Sulfamic Acid (or equivalent such as Citric Acid).

During choke replacement activities a small amount of MEG (up to 75 L) is likely to be release to the marine environment. MEG is a category 'E' OCNS chemical with no substitution warning and is readily biodegradable and has a low potential for bioaccumulation.

Within the extent of potential impact, potential receptors to a change in water quality would be plankton, fish, turtles and marine mammals. As the discharges are discharged into an open oceanic environment they are predicted to mix rapidly with the surrounding waters and impacts to sediments and benthic biota including invertebrates is not predicted.

Though plankton may be sensitive to some aspects of marine discharges such as increased temperatures (Huertas et al. 2011) this is typically for prolonged exposure. In view of the high level of natural mortality and the rapid replacement rate of many plankton species (Richardson et al, 2017) impacts from short term exposure to marine discharges of low toxicity that will rapidly dilute is unlikely to have lethal effects to plankton that area ecologically significant.

Fish species, including commercial species maybe present within the operational areas. There are not BIAs or protected habitats and commercial fishing for fish species has not been identified within the operational areas. No features have been identified where site attached species would be present. As fish species would be transient in the operational area toxicity impacts are not predicted due to the low toxicity of the marine discharges and rapid dilution.

The operational areas are within the distribution BIA for white shark, although no critical habitats or behaviours are known to occur. Sharks will be transient through the area thus impacts are not predicted. The Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a) does not identify chemical discharges or equivalent as a threat. As these species would be transient in the operational area toxicity impacts are not predicted due to the low toxicity of the marine discharges and rapid dilution.

No turtle BIAs are located within the operational areas though turtle species may occur. Chemical and terrestrial discharge is identified as a threat to turtles in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b) though not specifically from hydraulic control fluid or dye used during leak testing. As these species would be transient in the operational area toxicity impacts are not predicted due to the low toxicity of the marine discharges and rapid dilution.

Marine mammals can actively avoid plumes, limiting exposure. The operational area overlaps the pygmy blue whale foraging BIA. The Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) does not identify discharges from operations as a threat to the recovery of these species. Though pygmy blue whales could potentially forage within the operational area toxicity impacts are not predicted due to the low toxicity of the marine discharges and rapid dilution.

The operational areas overlap the southern right whale current core coastal range distribution. The Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a) does not identify chemical discharges as a threat to the recovery of these species. These species are likely to be transient within the operational area thus toxicity impacts are not predicted due to the low toxicity of the marine discharges and rapid dilution.

The extent of the impact is predicted to be 500 m from the discharge point (i.e. within the operational area). The severity is assessed as Minor (1) based on:

- marine discharges will be of low toxicity with controls such as treatment and chemical assessment in place.
- no sensitive resident receptors or particular values were identified within the area that may be affected when compared with surrounding waters.
- marine discharges do not interfere with wind-generated upwelling events, nor are they likely to impact marine fauna attracted to the area by regional upwelling events.
- potential impacts to plankton are not expected to result in impacts to foraging marine species given the overall abundance of food resources within the region.
- discharges will rapidly disperse in the marine environment.

7.9.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Planned marine discharges – operations and IMR	
ALARP decision context and justification	ALARP Decision Context: Type A Impacts from planned marine discharges are well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation to marine discharges of hydraulic control fluids or other operational discharges. As the impact consequence is rated as Minor (1) applying good industry practice (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP. As the risk is rated as low applying good industry practice (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#14: Beach Chemical Management Plan	All chemicals that could be discharged to the marine environment must be assessed prior to use to ensure the lowest toxicity, most biodegradable and least accumulative chemicals are selected which meet the technical requirements of the application.
CM#5: Maintenance Management System	Systems that generate or treat planned discharges will be operated in accordance with the computerised maintenance management system (CMMS) to ensure efficient operation

CM#15: Hydraulic Control System	The hydraulic power unit (HPU) on Thylacine-A wellhead platform provides control of Thylacine and Geographe subsea wells. The HPU monitors system pressure and hydraulic fluid inventory and is inspected and maintained in accordance with the CMMS.
Consequence rating	Minor (1)
Likelihood of occurrence	NA
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	Planned marine discharges were assessed as having a minor consequence which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 8).
External context	There have been no stakeholder objections or claims regarding planned marine discharges.
Other requirements	Planned marine discharge will be managed in accordance with legislative requirements. Planned marine discharges will not: • impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). • impact the recovery of the white shark as per the Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a). • impact the long-term survival and recovery of albatross and giant petrel populations breeding and foraging as per the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). • impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). • impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • impact se or fin whales, covered by conservation advice.
Monitoring and reporting	Impacts associated with planned marine discharges are over a small area and not predicted to have long term impacts to protected or commercially important receptors. The control measures adopted ensure water quality remains within acceptable parameters given the chemicals are assessed to internationally recognised standards, therefore, monitoring is not proposed.
Acceptability outcome	**Acceptable**

7.10 Establishment of invasive marine species

7.10.1 Hazards

The introduction of marine pests could occur during vessel operations as a result of:

- discharge of ballast water containing foreign species.
- translocation of species through biofouling of the vessel hull, anchors and/or niches (e.g. sea chests, bilges and strainers).
- disposal of contaminated waste and materials.

Successful IMS invasion requires the following three steps:

- colonisation and establishment of the marine pest on a vector (e.g., vessel hull) in a donor region (e.g., home port).
- survival of the settled marine species on the vector during the voyage from the donor to the recipient region (e.g., project area).
- colonisation (e.g., dislodgement or reproduction) of the marine species in the recipient region, followed by successful establishment of a viable new local population.

7.10.2 Predicted environmental risks

IMS or pathogens may become established where conditions are suitable, and these species may have impacts on local ecological and economic values. However, establishment of introduced marine species is mostly likely to occur in shallow waters in areas where large numbers of vessels are present and are stationary for an extended period.

If the risk of establishment of IMS is realised, the following known and potential environmental impacts may occur:

- change in ecosystem dynamics.
- changes to the functions, interests or activities of other users.

Change in ecosystem dynamics may include 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 area.

7.10.3 EMBA

Predicted impacts from the risk of establishment of IMS will be limited to the operational area. Receptors potentially affected include marine invertebrates and benthic habitats, and commercial fisheries.

7.10.4 Consequence evaluation

IMS or pathogens may become established where conditions are suitable, and these species may have impacts on local ecological and economic values. Establishment of introduced marine species is most likely to occur in shallow waters in areas where large numbers of vessels are present and are stationary for an extended period.

In the event of an IMS being introduced to the marine environment, successful colonisation is dependent upon suitable substrate availability. The operational area does not present a location conducive to marine pest survival because it is mostly located in deep waters (offshore infrastructure location in water greater than 70 m (83m – 101m)), however the Otway Pipeline System and HDD entry point are located in shallower waters (6 m at the HDD entry point; 66 m – 72 m at the Hot Tap Tee locations).

IMS introduced during the activity has the potential to impact ecosystem dynamics. As a result of a change in ecosystem dynamics, further impacts may occur, which include change in the functions, interests or activities of other users.

Receptors potentially impacted by a change in ecosystem dynamics include:

- marine invertebrates
- benthic habitat (soft sediment, macroalgae, soft corals)
- commercial fisheries.

Given the distance from planned operations (184 km to closest AMP), no impacts to Australian Marine Parks are predicted.

7.10.4.1 Marine invertebrates and benthic habitats

IMS are likely to have little or no natural competition or predators, thus potentially outcompeting native species for food or space, preying on native species, or changing the nature of the environment. It is estimated that Australia has more than 250 established marine pests, and that approximately one in six introduced marine species becomes a pest (Department of the Environment, 2015). Once established, some pests can be difficult to eradicate (Hewitt et al., 2002) and therefore there is the potential for a long-term or persistent change in habitat structure. 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).

The chances of successful colonisation in the Otway region are considered small given:

- The Fugro seabed survey (2019) identified that the seabed is dominated by exposed rock with very thin transgressive coarse sand and no rocky reefs or outcrops. This type of habitat is not conducive to the establishment of IMS and is outside of coastal waters where the risk of IMS establishment is considered greatest (BRS, 2007).
- the offshore operations are geographically isolated from other subsea or surface infrastructure which might be suitable for colonisation.
- the offshore location of the Thylacine-A wellhead platform and Geographe subsea facilities does not present a location conducive to marine pest survival because it is located in deep waters with the operational area in water greater than 70 m (83 m – 101 m).

- Vessel activities at shallower locations (HDD entry point, Hot Tap Tee locations) will be limited to IMR, with no routine activities undertaken in shallower waters.

Areas of higher value or sensitivity are located away from the well sites with Twelve Apostles Marine National Park on the Victorian coast approximately 54 km away from the operational area. While unlikely, if an IMS was introduced, and if it did colonise an area, it is expected that any colony would remain fragmented and isolated, and only within the vicinity of the Thylacine-A Wellhead Platform / subsea infrastructure (i.e. it would not be able to propagate to nearshore environments, and protected marine areas present in the wider region).

Given the impact of a successful IMS colonisation has the ability to significantly impact local species and thus change local epifauna and infauna populations permanently, the consequences have been evaluated as Serious. However, it is considered such an event is Remote due to the unfavourable conditions within the operational area required for colonisation. As outlined in Section 7.10.5 Beach has demonstrated that the acceptability criteria is met and therefore, the residual risk is considered low.

7.10.4.2 Commercial fisheries

The introduction of IMS has the potential to result in changes to the functions, interest or activities of other users, including commercial fisheries. 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. For example, the introduction of the Northern Pacific Seastar (*Asterias amurensis*) in Victorian and Tasmanian waters was linked to a decline in scallop fisheries (DSE, 2004). However, areas suitable for commercial scallop fishing are not expected near the well locations; commercially suitable scallop aggregations occur in the waters of eastern Victoria (Koopman et al. 2018).

AFMA have confirmed there is no fishing effort for Commonwealth fisheries within the operational area. There is some fishing effort from the Rock Lobster Fishery,

Whilst it has been assessed that the introduction of an IMS would have a Serious impact on state and Commonwealth fisheries the likelihood has been assessed as Remote. Beach has demonstrated that the acceptability criteria is met and therefore, the residual risk is considered low.

7.10.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Establishment of invasive marine pests	
ALARP decision context and justification	ALARP Decision Context: Type B On the basis of the impact assessment completed, Beach considers the control measures described are appropriate to manage the impacts associated with the risk of introduction and establishment of IMS. The Victorian DJPR have expressed interest in the management of IMS in Victorian State waters.
Adopted Control Measures	**Source of good practice control measures**
CM#16: Beach Domestic IMS Biofouling Risk Assessment Process	All vessels mobilised from domestic waters to undertake offshore petroleum activities within the operational area must complete the Beach Domestic IMS Biofouling Risk Assessment Process as detailed in the Beach Introduced

	Marine Species Management Plan (S400AH719916) prior to the initial mobilisation into the operational area. The Beach Domestic IMS Biofouling Risk Assessment Process: • validates compliance with regulatory requirements (Commonwealth and State) in relation to biosecurity prior to engaging in petroleum activities within the operational area; • identifies the potential IMS risk profile of vessels and submersible equipment prior to deployment within the operational area; • identifies potentially deficiency of IMS controls prior to entering the operational area; • identifies additional controls to manage IMS risk; and • prevents the translocation and potential establishment of IMS into non-affected environments (either to or from the operational area).		
Additional controls assessed			
Control	**Control Type**	**Cost/Benefit Analysis**	**Control Implemented?**
Only use vessels that are based in Victoria to reduce the potential for introducing IMS.	Equipment	Specialised IMR vessels are likely required to undertake IMR activities. Using vessels that are based in Victoria (if available) may reduce the likelihood of introducing an IMS but this would depend on the IMS risk level of the port where the vessel is based. The control measures that are to be implemented are required to be undertaken for vessels from any port in Victoria or Australia. Thus, there is limited environmental benefit associated with implementing this response.	Not selected
Consequence rating	Serious (3)		
Likelihood of occurrence	Remote (1)		
Residual risk	Low		
Acceptability assessment			
To meet the principles of ESD	The risk of the establishment of IMS was assessed as low and the consequence was assessed as serious which has the potential to result in serious or irreversible environmental damage. However, this is assessed as acceptable based on: • There is little uncertainty associated with this aspect as the activities are well known, the cause pathways are well known, and activities are well regulated and managed. • No impacts to MNES are predicted. • The implementation of controls make it a remote likelihood that IMS will be introduced from the activity resulting in a low residual risk. • It is not considered that there is significant scientific uncertainty associated with this aspect. Therefore, the precautionary principle has not been applied.		
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy.		

	Activities will be undertaken in accordance with the Implementation Strategy (Section 8).
External context	There have been no stakeholder objections or claims regarding the introduction or establishment of invasive marine pests in relation to the activity.
Other requirements	The impact will be managed in accordance with legislation requirements and guidance, including: • Offshore Installations - Biosecurity Guide (DAWR 2019) • National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia 2009) • Australian Ballast Water Management Requirements (Commonwealth of Australia, 2020) and Australia Biofouling Management Requirements (DAWE 2022) gives effect to the Biosecurity Act 2015 and associated regulations; International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Convention) and relevant guidelines or procedures adopted by the Marine Environment Protection Committee of the International Maritime Organization (IMO) • IMO Biofouling Guidelines There are no EPBC management plans (management plans, recovery plans or conservation advice) which relate specifically to IMS introduction and establishment as a threat. The South-east Commonwealth Marine Reserves Network Management Plan 2013-23 (Director of National Parks, 2013) identifies IMS, and diseases translocated by shipping, fishing vessels and other vessels as a threat to the AMP network. The implementation of the controls make it unlikely that IMS will be introduced from the activity and spread to nearby AMPs.
Monitoring and reporting	Impacts as a result of the introduction of marine invasive species will be monitored and reported in accordance with the Section 8.10.
Acceptability outcome	**Acceptable**

7.11 Disturbance to marine fauna

7.11.1 Hazards

Disturbance to marine fauna could occur as a result of activities within the operational area, through:

- Vessel operations resulting in collision with marine fauna
- Bird deterrent system on the Thylacine-A Wellhead Platform disturbing birds

7.11.2 Potential environmental impacts

Disturbance to marine fauna can result in injury or death.

Disturbance to fauna from underwater noise emissions is addressed in Section 0.

7.11.3 EMBA

Predicted impacts resulting from the risk of disturbance to marine fauna will be limited to the operational area. Receptors include marine fauna, specifically slow moving marine fauna and seabirds.

7.11.4 Consequence evaluation

Marine fauna species most susceptible to vessel strike are typically characterised by one or more of the following characteristics:

- commonly dwells at or near surface waters.
- often slow moving or large in size.
- frequents areas with a high levels of vessel traffic.
- fauna population is small, threatened, or geographically concentrated in areas that also correspond with high levels of vessel traffic.

The National Strategy for Mitigating Vessel Strike of Marine Mega-fauna (Commonwealth of Australia, 2017a) identifies cetaceans and marine turtles as being vulnerable to vessel collisions.

Three marine turtle species may occur within the operational area though no BIAs or critical habitat to the survival of the species were identified. The Recovery Plan for Marine Turtles in Australia (DotEE, 2017d) identified vessel strike as a threat.

Two species of pinniped may occur within the operational area: the New Zealand fur-seal and the Australian fur-seal. No BIAs or habitat critical to the survival of the species were identified for pinnipeds.

Twenty one whale species (or species habitat) may occur within the operational area. Foraging behaviours were identified for some species (sei, blue, fin and pygmy right whales); no other important behaviours were identified. The operational area intersects the current core coastal range for the southern right whale and a foraging BIA for the pygmy blue whale. The Conservation Management Plan for the blue whale and the southern right whale, Conservation Advice for the sei whale and fin whale and Conservation Listing for the humpback whale identify vessel strike as a threat.

Protected species vulnerable to vessel strikes are identified as being transient in the area except for pygmy blue whales within the foraging BIA. Pygmy blue whales are likely to be foraging within the BIA (November to June) which overlaps the period of the activity. The Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) detail that collisions will impede the recovery of blue whale populations if a sufficient number of individuals in the population lose reproductive fitness or are killed.

The occurrence of vessel strikes is very low with no incidents occurring to date associated with Beach's activities in the Otway or Bass Strait region.

Birds are often found associated with offshore platforms as they provide a safe and relatively undisturbed site for birds to roost. For the Thylacine platform it was reported that crested terns and gannets roosted on the helideck, support structures, crane boom and lesser extent, flat surface of structures mainly on the upper deck (Avisure 2016). The birds are often found on the helideck and pose a hazard to safe helicopter operations by increasing the risk of bird collision and potential harm to both marine fauna and human life. In addition, defecating on the platform can cover important safety marking on the helideck as well as being a slip hazard.

The crested tern and gannet species (listed species not threatened species) reported to roost on the helideck are not covered by a species specific management plans, however, the crested tern and Australasian gannet are covered by the draft Wildlife Conservation Plan for Seabirds (CoA 2019c) which identifies resource extraction stating 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). The draft Wildlife Conservation Plan for Seabirds (CoA 2019c) details that implementing a comprehensive monitoring program of impacts of these offshore platforms should include nature, timing and extent of bird mortality caused by these structures. This information can then be used to better inform regulators responsible for exploration and extraction proposals. Beach have a bird injury/mortality reporting program that is reviewed to identify improvements to the bird deterrent system. Since Beach has operated the bird deterrent system on Thylacine-A wellhead platform there has been three bird strikes associated with the helicopter rotors. The aim of the bird deterrent system on Thylacine-A wellhead platform is to deter the birds from landing on the platform and disperse any birds on the platform prior to the helicopter arriving and departing to avoid any collisions.

The bird deterrent system on Thylacine-A wellhead platform has been developed by a bird management specialist (Avisure) to ensure that appropriate management actions are implemented to deter birds from the platform. As a result of site visits and a detailed assessment of the platform, a bird deterrent system was developed which aims to minimise the bird attraction to the helideck, reduce perching opportunities, monitor bird activity and optimise flight operations to reduce bird strike risk. The key components of the bird deterrent system are:

- Bird spikes / bird wires: bird spikes / anti-perch wire are installed on various structural members to deter birds and reduce perching opportunities.
- Bird spray: There are several sea water spray nozzles installed around the helideck. These sprinklers aim to irritate birds; pump and nozzle combination do not generate sufficient pressure or flow rate to harm birds.

- Marine horn: An electric marine horn (Kahlenberg KB-20) has been adapted as a form of noise deterrent. KB-20 horns are standard marine horn used on marine vessels, with no known impacts to birds.

Table 7-2 details the shorebirds and seabirds that may be foraging, breeding, roosting, or migrating within the light EMBA and may be attracted to the platform. These were identified from the light EMBA PMST Report (Appendix A.3) and BIAs from the National Conservation Values Atlas. No roosting or breeding behaviours have been identified within the light EMBA.

Although the bird deterrent system has been designed to avoid injury to birds, it is possible that operation of the bird deterrent system may injure or kill birds either through direct contact or stunning them such that they become entangled in plant, equipment and netting below the helideck. The bird deterrents (primary and secondary methods) are designed to scare birds, rather than injure them to ensure safety risks associated with helicopter operations are adequately managed. The water sprinkler is used daily (when birds are present), even when helicopter flights are not scheduled. This prevents birds from habituating to an inactive helideck, reducing the numbers, and hence lowering the risk of being harmed.

The extent of the area where disturbance to marine fauna may occur is within the operational area and the risk could occur while the activity is undertaken. The severity is assessed as moderate and likelihood as highly unlikely based on:

- within the operational area vessels will be slow moving to stationary.
- the occurrence of vessel strikes is very low with no incidents occurring to date associated with Beach’s activities in the Otway or Bass Strait region.
- the bird deterrent system is designed to scare birds, rather than injury them.
- if an incident occurred, it would be restricted to individual fauna.

7.11.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Disturbance to marine fauna	
ALARP decision context and justification	ALARP Decision Context: Type A The risk of disturbance to marine fauna is well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation to air emissions. As the risk is rated as low applying good industry practice (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#7: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans describes strategies to ensure whales and dolphins are not harmed during offshore interactions with vessels.
CM#18: Bird Deterrent system	Operators of the bird deterrent systems are trained and follow standard operating systems.

	The water sprinkler is used daily (when birds are present), even when helicopter flights are not scheduled. This prevents birds from habituating to an inactive helideck, reducing the numbers and hence lowering the risk of being harmed.
Consequence rating	Moderate (2)
Likelihood of occurrence	Highly Unlikely (2)
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	The risk of disturbance to marine fauna was assessed as low and the consequence was assessed as moderate which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the risk is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 8).
External context	There have been no stakeholder objections or claims regarding disturbance to marine fauna.
Other requirements	Disturbance to marine fauna will be managed in accordance with legislative requirements. Disturbance to marine fauna if it occurred will not: • impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). • impact the recovery of the white shark as per the Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a). • impact the long-term survival and recovery of albatross and giant petrel populations breeding and foraging as per the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). • impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). Actions from the recovery plan applicable to vessel collision will be implemented. • impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • impact the recovery of sei or fin whales, covered by conservation advice. The activity is not inconsistent with the draft Wildlife Conservation Plan for Seabirds (CoA 2019c) as the the bird deterrent system is designed to scare birds, rather than injury them. Applicable actions associated with the plan have been addressed as per: • implementing a comprehensive monitoring program of impacts of these offshore platforms should include nature, timing and extent of bird mortality caused by these structures. Beach records any injury/deaths of bird species associated with the platform and these are reported to NOPSEMA as recordable incidents.

	Actions from the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) applicable to the activity to minimise vessel collisions have been addressed as per: • ensure all vessel strike incidents are reported in the National Ship Strike Database. Vessel collision with protected marine fauna are required to be reported as detailed in Section 8.10. • 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. Section 7.11 details the impact assessment and mitigation measures (controls) to be implemented to ensure impacts are of an acceptable level and ALARP.
Monitoring and reporting	Disturbance to protected marine fauna area required to be reported as detailed in Section 8.12
Acceptability outcome	**Acceptable**

7.12 Unplanned marine discharges - solids

7.12.1 Hazards

Solids which may be accidentally discharged include:

- Waste maybe accidently blown overboard off the vessels or Thylacine-A Wellhead Platform.
- Grit may be used to remove paint or debris from the platform topside during maintenance. Containment will be used to recover grit and debris; however unplanned discharges may occur.

7.12.2 Predicated environmental impacts

Solids accidently released to the marine environment may lead to injury or death to individual marine fauna through ingestion or entanglement.

7.12.3 EMBA

Impacts resulting from the risk of unplanned marine discharge (solids) will be limited to the operational area.

7.12.4 Consequence evaluation

The Threat Abatement Plan for the impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Ocean (Commonwealth of Australia, 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.

The operational area overlaps foraging BIAs for several albatross species, the wedge-tailed shearwater, common diving-petrel and short-tailed shearwater. No habitat critical to the survival of birds occur within the operational area. Marine debris is identified as a threat in the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a).

Three marine turtle species (or species habitat) may occur within the operational area though no BIAs or critical habitat to the survival of the species were identified. The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b) identified marine debris as a threat.

Three species of pinniped (or species habitat) may occur within the operational area; the New Zealand fur-seal, the Australian fur-seal and the Australian sea lion. A foraging BIA for the Australian sea lion is present within the EMBA.

Five whale species (or species habitat) may occur within the operational area. Foraging behaviours were identified for some species (sei, blue, fin and pygmy right whales); no other important behaviours were identified. The operational area intersects a foraging BIA for the pygmy blue whale and the current core coastal range for the southern right whale.

The Conservation Management Plan for the blue whale and for the southern right whale and Conservation Advice for the sei whale and fin whale do not identify marine debris as threat. The Conservation Listing for humpback whales identifies marine debris as threat.

The extent of the area of where the risk of unplanned waste being discharged to the marine environment is within the operational area and the risk could occur at any time. The severity is assessed as Minor (1) and remote as unplanned release of waste is uncommon; if waste was lost overboard impacts would be restricted in exposure and quantity and would be limited to individual fauna.

7.12.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Unplanned marine discharges - Solids	
ALARP decision context and justification	ALARP Decision Context: Type A The risk of an unplanned marine discharge of solids impacts to marine fauna is well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation unplanned marine discharge of solids. As the risk is rated as low applying good industry practice (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#19: MO 95: Marine Pollution Prevention – Garbage	Marine Order Part 95 (Marine pollution prevention — garbage gives effect to MARPOL Annex V. MARPOL is the International Convention for the Prevention of Pollution from Ships and is aimed at preventing both accidental pollution, and pollution from routine operations. Specifically, MARPOL Annex V requires that a garbage / waste management plan and garbage record book is in place and implemented.
CM#20: Fabric Maintenance	Grit blasting on the platform jacket and topsides uses containment and recovery to minimise losses to the ocean. Grit blasting material will meet the requirements of the Chemical Management Plan as per Section 8.11.2.
Consequence rating	Minor (1)
Likelihood of occurrence	Remote (1)
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	The risk of a marine fauna injury or death from unplanned discharge of solids was assessed as low and the consequence was assessed as minor which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.

Internal context	The proposed management of the risk is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 8).
External context	There have been no stakeholder objections or claims regarding marine fauna injury or death from unplanned discharge of solids
Other requirements	Waste on board the vessels and Thylacine-A Wellhead Platform will be managed in accordance with legislative requirements. Marine fauna injury or death from unplanned discharge of solids if occurred will not: • impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). • impact the long-term survival and recovery of albatross and giant petrel populations breeding and foraging as per the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). • impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). • impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • impact the recovery of sei or fin whales, covered by conservation advice.
Monitoring and reporting	Unplanned discharge of solids is required to be reported as per Section 8.12.8.
Acceptability outcome	**Acceptable**

7.13 Loss of containment – hazardous substances

7.13.1 Hazards

Several loss of containment scenarios of hazardous substances have been identified as credible during Otway Offshore Operations. These are described in Table 7-14.

There is no refuelling of the platform or vessels within the operational area.

Table 7-14 Credible Loss of Containment (hazardous substances) scenarios

Scenario	Description
Loss of Containment – hazardous substances stored on Thylacine-A Platform and vessels	Routine operation of the Thylacine-A Wellhead Platform 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
Loss of Containment – hose failure	Hose failure during transfer of hazardous substances could occur as a result of equipment damage, resulting in a loss of containment of the hose volume.
Loss of containment – MEG pipeline	The MEG pipeline is a closed system; however, loss of containment could occur as a result of: • equipment damage • loss of pipeline integrity • dropped objects

7.13.2 Predicted environmental impacts

The predicted environmental impacts of a loss of containment (hazardous substances) are:

- 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 functions, interests or activities of other users

7.13.3 EMBA

Impacts resulting from the risk of a loss of containment of hazardous substances will be limited to the operational area.

7.13.4 Consequence evaluation

An evaluation of the types of minor spill events was completed to determined indicative volumes associated with each type of event. Both hydraulic line failure and use of hazardous materials onboard were associated with small volume spill events – with the maximum volume based upon the loss of an intermediate bulk container ~1 m^3.

The estimated fluid inventory of the MEG pipeline is approximately 550 m^3, based on 82 km of DN 100 pipe. Typically, the MEG pipeline is 80-90 wt% MEG: 10-20 wt% water mixture plus a corrosion inhibitor and alkyl hydroxide.

MEG is a category 'E' OCNS chemical with no substitution warning and is readily biodegradable and has a low potential for bioaccumulation.

The potential consequence of a loss of containment of hazardous substances within the operational area would be limited to a localised and temporary change in water quality in the vicinity of the release, and the potential change to fauna behaviour within surface waters affected by the spill, such as avoidance. As such, the consequence of this scenario has been evaluated as Minor (1) given there is unlikely to be a lasting effect to biological and physical environment in an area that is not formally managed.

7.13.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Loss of Containment – hazardous substances	
ALARP decision context and justification	ALARP Decision Context: Type A The risk of a minor spill is well understood and there is nothing new or unusual. Good practice is defined, and uncertainty is minimal. There are no conflicts with company values, no partner interests and no significant media interests. No objections or claims where raised by stakeholders in relation to minor spills during the activity. As the risk is rated as low applying good industry practice (as defined in Section 6.7.2.1) is sufficient to manage the impact to ALARP.
Adopted Control Measures	**Source of good industry practice control measures**
CM#21: Spill containment	Vessel management system includes provision to maintain spill containment aboard the vessel and clean spills aboard the vessel to prevent release to the marine environment. Computerised Maintenance Management Plan (CMMS) on the platform requires that bunded areas are maintained to prevent unplanned spills of chemicals to the marine environment. Spill kits are present on the Thylacine-A Wellhead Platform.
CM#22: SMPEP or SOPEP (appropriate to class)	In accordance with MARPOL Annex I and AMSA MO 91 [Marine Pollution Prevention – oil], a Shipboard Marine Pollution Emergency Plan (SMPEP) or SOPEP (according to class) is required. These will follow the Guidelines for the Development of Shipboard Oil Pollution Emergency Plans, adopted by IMO as Resolution MEPC.54(32) and approved by AMSA. Specifically, the SMPEP/SOPEP contains procedures to stop or reduce the flow of hydrocarbons to be considered in the event of tank rupture.
CM#23 NOPSEMA accepted Safety Case	Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009 set out the requirements for safety cases. The Thylacine-A Platform and Otway Pipeline System Safety Cases demonstrate how the risks to the integrity of the MEG system will be reduced to as low as reasonably practicable (ALARP). The safety cases: • identify the hazards and risks.

	• describe how the hazards and risks are controlled. • describe the management system in place to ensure the controls are effectively and consistently applied. • describe the operation, monitoring, inspection and maintenance of the MEG system. • describe the leak detection, and emergency shutdown and isolations systems to reduce the extent of loss of containment of MEG.
CM#24: Thylacine-A Wellhead Platform Hose Integrity Management Plan	Hoses are managed and maintained as per Thylacine-A Wellhead Platform Hose Integrity Management Plan
Consequence rating	Minor (1)
Likelihood of occurrence	Unlikely (3)
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	The risk of a loss of containment (hazardous substances) was assessed as low and the consequence was assessed as minor which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the risk is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 8).
External context	There have been no stakeholder objections or claims regarding loss of containment (hazardous substances).
Other requirements	Loss of containment (hazardous substances) will be managed in accordance with legislative requirements. Loss of containment (hazardous substances) will not: • impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b). • impact the recovery of the white shark as per the Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a). • impact the long-term survival and recovery of albatross and giant petrel populations breeding and foraging as per the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). • impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). • impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a). • impact the recovery of sei or fin whale, covered by conservation advice.
Monitoring and reporting	Loss of containment (hazardous substances) are required to be reported as per Section 8.10.
Acceptability outcome	**Acceptable**

7.14 Quantitative hydrocarbon spill modelling

Beach commissioned RPS Australia West Pty Ltd (RPS) to conduct quantitative spill modelling (Appendix A) for two credible, yet hypothetical, worst-case hydrocarbon release scenarios:

Scenario 1: a 222,224 bbl (2584 bbl/d) subsea release of condensate over 86 days.

The modelled scenario was based on a loss of well control (LOWC) at the Artisan-1 well location using the condensate composition of the Thylacine field and a flow rate based on unrestricted open-hole release whilst drilling.

Beach modelled the worst-case discharge (WCD) using the Thylacine reservoir characteristics which are similar to the Geographe reservoir. These reservoirs have high permeability and contain a gas with a relatively low condensate – gas ratio of circa 13 bbl/MMscf. The modelling assumes a reservoir pressure on the same pressure – depth trend as Thylacine and that the loss of control happens with no pipe in the hole i.e. the flow rate is only constrained by the hole size and casing already in the hole (nominally 8.5" hole with 7" casing above). The flow rate is therefore controlled by the pressure differential between the reservoir and the seafloor.

This methodology aligns with the Society of Petroleum Engineers (SPE) Technical Report: Calculation of Worst-Case Discharge (WCD) (April 2015).

This modelling yields a gas flow rate commencing at circa 290 MMscf/d with associated condensate at 13 bbl/MMscf yielding a condensate volume of circa 3770 bbl on the first day of the release. The pressure in the reservoir depletes over the period of time taken to control the well (86 days) with an associated decline in gas and condensate rates decline leading to an estimated total released condensate volume of circa 222 thousand barrels. This gives an average release rate for condensate of 2,584 bbl/day over the 86-day period.

The modelling scenario, which is based on a LOWC whilst drilling, is greater than the highest maximum production rates for each field of that could be lost if there was a loss of containment from the production wells:

- TA-1 maximum production rate 60 MMscf/d with an associated condensate rate of 600 bbl/d.
- G-4 maximum production rate 100 MMscf/d with an associated condensate rate of 1,600 bbl/d.

Beach has a high degree of confidence in the estimated release rates as they are based on known reservoir properties in the region from both a flow dynamic viewpoint and the composition of the reservoir fluids. Release rates and volumes are based on a total LOWC which assumes the failure of multiple control systems.

Modelling was undertaken of a subsea loss of containment for the subsea wells and would be a worst case scenario for the Thylacine-A Platform. The Thylacine gas field is equipped with surface well head trees on the Thylacine-A platform. In the case of an uncontrolled release from the platform, safety equipment including the Surface Controlled Subsurface Safety Valve (SCSSV) would isolate the leak within a maximum of 2 minutes unless the SCSSV malfunctioned and did not isolate the reservoir. In the case of a surface release there is a chance of ignition, a resultant high chance of escalation and structural damage, and with possible subsequent failure of the platform. If the product ignited then all would be vented to the atmosphere; additionally if the product did not ignite then the resultant aerial release would vent the gas straight off and the condensate would be exposed to much higher rates of evaporation as it would likely be sprayed into the atmosphere, with less settling on the sea surface.

The modelled duration of 86 days represents the time determined to implement a full dynamic well kill via the drilling of a relief well at any of the well locations.

To develop the loss of containment (LOC) EMBA for the Artisan, Thylacine and Geophage wells the low threshold boundary for the LOWC modelling at the Artisan-1 well location was duplicated and also positioned over the Thylacine-A Wellhead Platform and Geographe wells to form a composite for where a LOC could occur. The offshore extent for the LOC EMBA was revised to account for the additional offshore waters potentially at impacted by a LOC from either the Geographe or Thylacine locations. No change was made to the shoreline extent of the LOC EMBA as it was assumed that a similar area would be impacted based on the Artisan-1 location being closer to shore.

Scenario 2: a 300 m^3 surface release of marine diesel oil (MDO) over 6 hours.

This scenario represents a loss of inventory from the largest fuel tank on a supply or IMR vessel due to a hypothetical vessel collision incident. The calculation of discharge volume and timing aligns with the methodology recommended in the AMSA Technical guidelines for preparing contingency plans for marine and coastal facilities (Commonwealth of Australia, January 2015).

The spill modelling was undertaken at the Artisan-1 well location. To develop the diesel spill EMBA the low threshold boundary for the vessel spill modelling at the Artisan-1 well location was duplicated and also positioned over the Thylacine-A Wellhead Platform, Geographe wells and Geographe Gas Pipeline to form a composite for all locations where a vessel diesel spill could occur.

7.14.1 Hydrocarbon exposure thresholds

In the event of an oil pollution 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 presented in Table 7-15 are considered appropriate to:

- predict potential hydrocarbon contact at conservative (low exposure) concentrations and inform the description of the environment (Section 4.7), inform the EPBC Protected Matters Search (Appendix A.1) and identify AMPs, Marine National Parks (MNPs), Marine Parks (MPs), and Ramsar wetlands that may require monitoring in the event of a worst-case discharge based upon conservative (low exposure) in-water thresholds;
- inform the oil spill impact and risk evaluation; and
- inform oil spill response planning based upon potentially actionable concentrations of hydrocarbons (see OPEP) and potential monitoring requirements (see Section 8.9.4 and OSMP).

Table 7-15: Hydrocarbon exposure thresholds

Exposure type	Exposure threshold		
	Low exposure	**Moderate exposure**	**High exposure**
Surface	0.5 g/m^2	10 g/m^2	25 g/m^2
Shoreline	10 g/m^2	100 g/m^2	1,000 g/m^2

Exposure type	Exposure threshold		
	Low exposure	**Moderate exposure**	**High exposure**
Entrained*	10 ppb	100 ppb	1,000 ppb
Dissolved*	6 ppb	50 ppb	400 ppb

* In-water (entrained & dissolved) hydrocarbon thresholds are based upon an instantaneous (1 hr) hydrocarbon exposure

Beach also applies a time-based exposure (ppb.hrs) for in-water hydrocarbons to evaluate the potential consequences associated with hydrocarbon contact at various concentrations, considering potential exposure pathways for various receptor types. Time-based exposure is not used to inform the outer geographical extent of potential hydrocarbon contact to various receptors.

The quantitative spill modelling assessment was completed for two distinct periods, defined by the unique prevailing wind and general current conditions; summer (November–April) and winter (May–October).

The spill modelling was performed using an advanced three-dimensional trajectory and fates model, Spill Impact Mapping Analysis 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.

The modelling study was carried out in several stages. Firstly, a five-year current dataset (2008–2012) that includes the combined influence of ocean currents from the HYCOM model and tidal currents from the HYDROMAP model was developed. Secondly, high-resolution local winds from the Climate Forecast System Reanalysis model 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 oils.

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 spill simulations per season for each scenario initiated at random start times, using the same release information (spill volume, duration and composition of the oil). This ensured that each simulation was subject to different wind and current conditions and, in turn, movement and weathering of the oil.

7.15 Loss of Containment - diesel

7.15.1 Hazards

MDO is used in offshore vessels. During vessel activities associated with Otway Offshore Operations, an accidental release of fuel may occur. A collision between a Beach contracted vessel and third-party vessel has the potential to result in a spill of fuel. The following events have the potential to result in a spill of fuel:

- a collision between a project vessel and third-party vessel.

No refuelling of vessels will occur during Otway Offshore Operations.

- A vessel collision typically occurs as a result of:
- mechanical failure/loss of DP
- navigational error, or
- foundering due to weather.
- Grounding is not considered credible due to the water depths typically being greater than 10 mand absence of submerged features in the operational area.

7.15.1.1 Characteristics of diesel oils

Diesel oils are generally considered to be low viscosity, non-persistent oils, which are readily degraded by naturally occurring microbes.

Diesel oils are considered to have a higher aquatic toxicity in comparison to many other crude oils due to the types of hydrocarbon present and their bioavailability. They also have a high potential to bio-accumulate in organisms.

Marine diesel is a medium-grade oil (classified as a Group II oil) used in the maritime industry. It has a low density, a low pour point and a low dynamic viscosity (Table 7-16), indicating that this oil will spread quickly when spilled at sea and thin out to low thicknesses, increasing the rate of evaporation.

Due to its chemical composition, approximately 40% will generally evaporate within the first day, with the remaining volatiles evaporating over 3-4 days depending upon the prevailing conditions. Diesel shows a strong tendency to entrain into the upper water column in the presence of moderate winds and breaking waves (>12 knots) but floats to the surface when conditions are calm, which delays the evaporation process. Table 7-17 shows the boiling point ranges for the diesel used in the spill modelling.

Table 7-16: Physical characteristics of marine diesel oil

Parameter	Characteristics
Density (kg/m^3)	829 at 15ºC
API	37.6
Dynamic viscosity (cP)	4.0 at 25ºC
Pour point (°C)	-14
Oil category	Group II
Oil persistence classification	Light-persistent oil

Table 7-17: Boiling point ranges of marine diesel oil

Characteristic	Volatiles (%)	Semi-volatiles (%)	Low volatiles (%)	Residual (%)
Boiling point (°C)	<180	180 – 265	265 – 380	>380
Marine diesel oil	6.0	34.6	54.4	5
	Non-Persistent			Persistent

On release to the marine environment, diesel would evaporate and decay and be distributed over time into various components. Of these components, surface hydrocarbons, entrained hydrocarbons (non-dissolved oil droplets that are physically entrained by wave action) and dissolved aromatics (principally the aromatic hydrocarbons) have the most significant impact on the marine environment. These are discussed in further detail below.

7.15.1.2 Extent of potential hydrocarbon exposure

The extent of possible exposure to hydrocarbons is based upon a hypothetical worst-case 300 m^3 surface release of MDO over 6 hours at the Artisan-1 well location with results derived from the Artisan-1 Exploration Well Oil Spill Modelling, RPS 2019 (Appendix B). The extent of potential hydrocarbon exposure at moderate thresholds (including 48-hour time-based in-water dissolved and entrained) for a marine diesel spill scenario is presented in Figure 7-8.

Potential extent of hydrocarbon exposure to Australian Marine Parks

Whilst Apollo AMP could potentially be exposed to moderate (instantaneous) thresholds of entrained hydrocarbons (up to7% summer and 16% winter), spill modelling indicates there in no potential for Apollo AMP to be impacted by moderate or high time-based in-water exposure thresholds.

No AMPs are predicted to be exposed to high (instantaneous or time-based) thresholds of dissolved or entrained hydrocarbons.

Potential extent of hydrocarbon exposure to surface waters

During summer conditions, moderate (10 g/m^2) exposure to surface hydrocarbons were predicted to travel a maximum distance of 12 km from the release location. During winter, moderate exposure of surface hydrocarbons extended to a maximum distance of 10 km from the release location.

None of the receptors identified within the modelling report were exposed at or above the moderate or high (>25 g/m^2) thresholds. However, spill modelling indicates potential summer and winter exposure to surface waters up to a maximum of 6 km from the release location of 48% and 41% probability respectively.

Potential extent of hydrocarbon exposure to shorelines

No shoreline contact above the minimum threshold (>10 g/m^2) was predicted for any of the seasons modelled.

Potential extent of in-water dissolved hydrocarbon exposure

The averaged dissolved hydrocarbon concentrations over 48 hours was highest within open ocean surrounding the release location registered 8 ppb and 9 ppb during summer and winter conditions, respectively based upon a 1% probability of exposure in open waters surrounding the release location. No identified receptors were exposed at or above the low 48-hour time-based dissolved hydrocarbon exposure threshold.

Based on the 1-hour (instantaneous) exposure window, the greatest predicted dissolved hydrocarbon concentration was 76 ppb during summer and 59 ppb during winter. Open waters surrounding the release location recorded a probability of 2% and 3% during the summer and winter conditions, respectively, based on the moderate instantaneous threshold. There was no predicted exposure to identified receptors at either moderate or high instantaneous thresholds.

Potential extent of in-water entrained hydrocarbon exposure

At the depths of 0-10 m, the maximum entrained hydrocarbon exposure (over a 48-hour window) during summer and winter conditions was 2,182 ppb and 792 ppb, respectively. While there is potential (1-2% probability) of low (10 ppb) exposure (over a 48-hour window) in open waters surrounding the release location, none of the identified receptors were exposed at or above the moderate (10-100 ppb) or high (>1,000 ppb) thresholds.

Within the 0-10 m depth layer, the maximum entrained hydrocarbon exposure (over 1 hour) for the open waters surrounding the release location was 5,933 ppb and 5,046 ppb, during summer and winter conditions, respectively. For identified receptors, the probability of exposure to entrained hydrocarbons at or above the moderate threshold (100-1,000 ppb) ranged from 1% (Cape Patton sub-Local Government Area (sub-LGA)) to 8% (within Victorian State Waters) during summer conditions and 1% (Twelve Apostles MNP) to 16% (Apollo AMP) during winter conditions. No receptors were exposed at or above the high threshold (>1,000 ppb).

7.15.2 Predicted environmental impacts

The known and potential environmental impacts of a diesel spill are:

- 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 functions, interests or activities of other users

7.15.3 Consequence evaluation

The potential environmental impacts to receptors within the EMBA are discussed in Table 7-18 to Table 7-21.

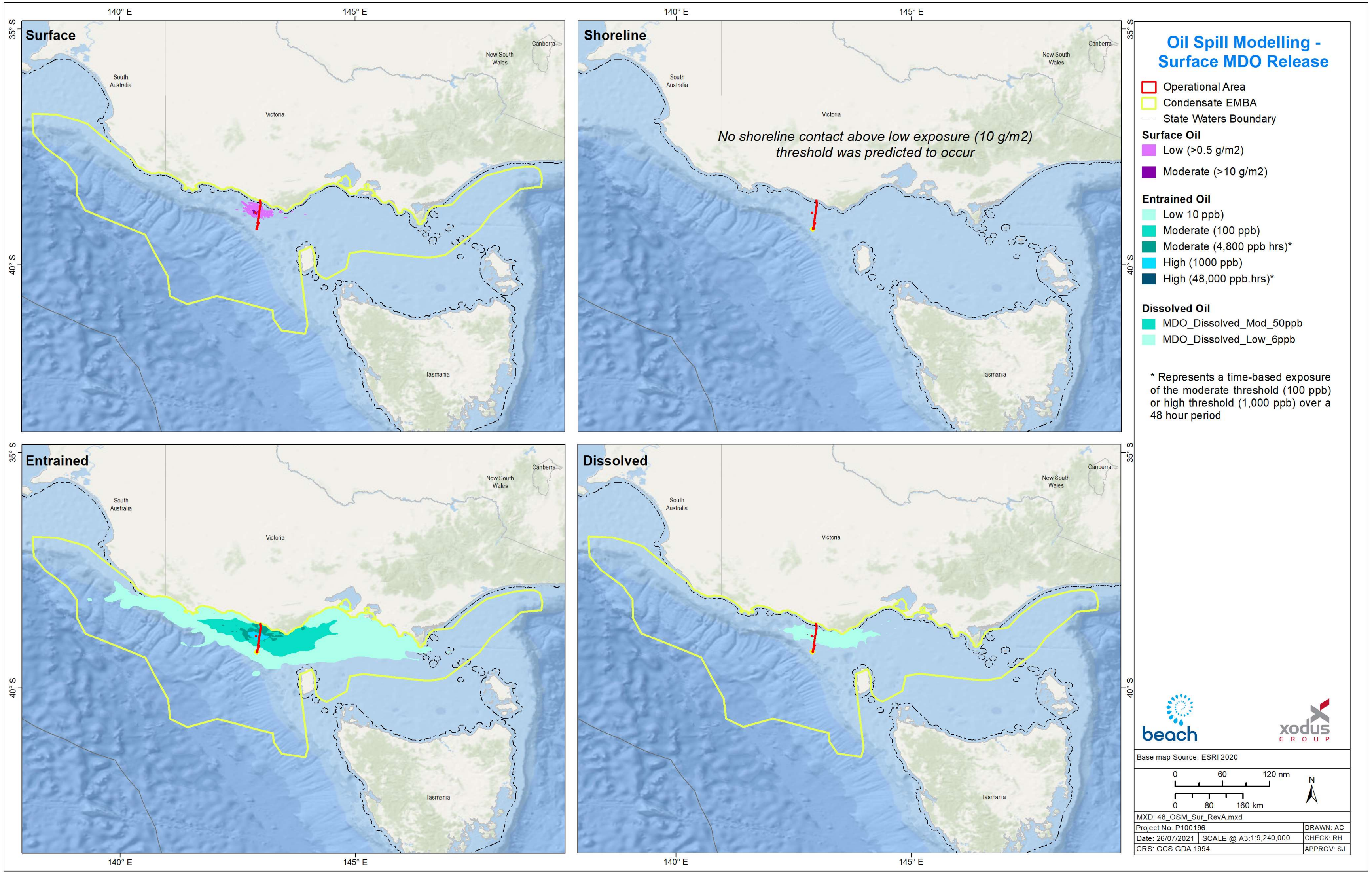

Figure 7-8: Environment potentially exposed to hydrocarbons from a hypothetical 300 m^3 diesel spill at Artisan-1 over 6 hours

Table 7-18: Consequence evaluation to ecological receptors within the EMBA – sea surface

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 12 km of the release location predicted to be exposed to moderate levels of surface hydrocarbons. Foraging BIAs for several albatross species, the wedge-tailed shearwater, common diving-petrel and short-tailed are present in the area Figure 5-27 and Figure 5-28) predicted to be above threshold. Foraging and breeding BIAs for little penguins are within the EMBA (Figure 5-27), however are well beyond the predicted area of surface exposure at >10 g/m^2, Colonies of little penguins, without defined BIAs, are known to along parts of Port Campbell Bay area; therefore, it is possible that little penguins may be present in the area exposed to surface hydrocarbon >10g/m^2.	When first released, diesel 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 out to 12 km from the release location) may be impacted; however, it is unlikely that many birds will be affected as volatile surface hydrocarbons are expected to evaporate over 3-4 days. 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 a diesel spill because of the limited period of exposure above 10 g/m^2. Sea surface oil >10 g/m^2 (10 µm) is only predicted for the first 36 hrs limiting the period when oiling may occur. Therefore, potential impact would likely be limited to individuals, however, impacts to aggregations may occur. Consequently, the potential consequence to seabirds is considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 7.15.4.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
	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 the species within this area (Section 5.6.7.5).	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 diesel 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 EMBA. Sea surface oil >10 g/m^2 (10 µm) is only predicted for the first 36 hrs limiting the period when oiling may occur. Therefore, potential impact would likely be limited to individuals, with population impacts not anticipated. Consequently, the potential consequence to marine turtles are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value Refer to management advice and evaluation of acceptability in Section 7.15.4.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
	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 surface hydrocarbons >10 g/m^2. No BIAs, breading colonies or haul outs areas are within the area of exposure (Section 5.6.7.7). There is a foraging BIA for the Australian sea-lion but it is outside of the predicted area of surface exposure at >10 g/m^2.	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 diesel 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 (Section 5.6.7.7). Sea surface oil >10 g/m^2 (10 µm) is only predicted for the first 36 hrs limiting the period when oiling may occur. Therefore, potential impact would be limited to individuals, with population impacts not anticipated. Consequently, the potential consequence to pinnipeds are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value Refer to management advice and evaluation of acceptability in Section 7.15.4.

	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 surface hydrocarbons of >10 g/m^2. Surface exposure of >10 g/m^2 is expected to extend out 12 km from the release location i.e., a relatively small areas compared to the overall distribution area of cetaceans. BIAs for foraging for pygmy blue whales and distribution for southern right whale are within the area predicted to be exposed to surface hydrocarbons >10 g/m^2 (Section 5.6.7.6).	Geraci (1988) found little evidence of cetacean mortality from hydrocarbon spills; however, some behaviour disturbance (including avoidance of the area) may occur. While this reduces the potential for physiological impacts from contact with hydrocarbons, 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 sea surface oil >10 g/m^2 (10 µm) is only predicted for the first 36 hrs limiting the period when oiling may occur. Also, the area exposed by moderate levels of surface hydrocarbons (12 km from the release location) is relatively small compared to the overall distribution area of cetaceans. Given this is a relatively small area of the total foraging BIA for pygmy blue whales and current core coastal range for southern right whales, the risk of displacement to whales is considered low. Otway Offshore Operations could occur at any time of year. Therefore, there is potential for interaction with southern right whales given the activity window overlaps with the northern migration period of May-June, the peak breeding (July-August) and southern migration period (September-November) (Section 5.6.7.6). The activity timing overlaps with the blue whale season for migration and foraging in the operational area and EMBA. Visual and acoustic surveys suggest that blue whales are present in the Otway region between November to June, peaking in February and March (Section 5.6.7.6). There is no population estimate for blue whales globally or in Australia and they are EPBC listed as endangered and migratory. Blue whales are highly mobile and widespread across the world's oceans. Aerial surveys in the Otway region recorded mean Blue whale group size of 1.3±0.6 per sighting with cow-calf pairs observed in 2.5% of the sightings (Gill et al. 2011). However, acknowledging there is scientific uncertainty with specific whale numbers within the vicinity of the Otway Offshore Operations location, and given activities may occur during upwelling events, it is expected that foraging whales would be

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				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. Consequently, the potential consequence to cetaceans are considered to be Moderate, as they could be expected to result in localised short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 7.15.4.
	Cetaceans (dolphins)	Change in fauna behaviour Injury / mortality to fauna	There may be dolphins in the area predicted to be exposed to surface oil (>10 g/m^2 - 12 km from the release location). However, there are no BIAs or habitat critical to the survival of the species (Section 5.6.7.6).	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. Direct surface hydrocarbon contact may pose little problem to dolphins due to their extraordinarily thick epidermal layer which is highly effective as a barrier to the toxic, penetrating substances found in hydrocarbons. 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 36 hours), this is not likely. Consequently, the potential consequence to dolphins are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 7.15.4.

Table 7-19: Consequence evaluation to socio-economic receptors within the EMBA – sea surface

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
Human systems	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 impacts to marine-based tourism from reduced visual aesthetic. The modelling predicts (visible surface rainbow sheen) surface sheens (0.5 g/m^2) may occur up to 93 km from the 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 relatively short duration means there may be short-term and localised consequences, which are ranked as Moderate. Refer also to: Cetaceans (whales) Refer to management advice and evaluation of acceptability in Section 7.15.4.
	Industry (shipping)	Displacement of other marine users	Shipping occurs within the area predicted to be exposed to surface hydrocarbons >10 g/m^2 (12 km from the 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 36 hours) deviation of shipping traffic would be unlikely.
	Industry (oil and gas)	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 (12 km from the release location).	No impact as there are no non-Beach oil and gas platforms located within the area predicted to be exposed to surface hydrocarbons.

Table 7-20: Consequence evaluation to physical and ecological receptors within the EMBA – in water

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
Habitat	Algae	Change in habitat	Macroalgae communities may be within the overall area potentially exposed to moderate levels of in-water entrained hydrocarbons. Video surveys confirmed the presence of high density macroalgae dominated epibenthos in waters shallower than 20 m, however, it is not a dominant habitat feature in eastern Victoria (Section 5.6.1.3). Note that the greater wave action and water column mixing within the nearshore environment will also result in rapid weathering of the MDO residue.	Smothering, fouling and asphyxiation are some of the physical effects that have been documented from oil contamination in marine plants (Blumer 1971; Cintron et al. 1981). The effect of hydrocarbons however is largely dependent on the degree of direct exposure, and the presence of morphological features (e.g. a mucilage layer and/or fine 'hairs') will directly influence the amount of hydrocarbon that will adhere to the algae. Generally, the effects of oil on macroalgae, such as kelp and many other species which dominate hard substrata in shallow waters is small due to their mucilaginous coating that resists oil absorption. Hydrocarbons may contact the intertidal shores as the tide ebbs, but it would be expected that this would be flushed with each flood tide. Natural flushing is more likely to reduce impacts in exposed areas of shoreline. Consequently, the potential consequence to algae are considered to be Minor, as they could be expected to result in localised low-level impacts.
	Soft Coral	Change in water quality Change in habitat	Corals do not occur as a dominant habitat type within the EMBA, however their presence has been recorded around areas such as Wilsons Promontory National Park and Cape Otway (Section 5.6.1.4). In-water exposure (entrained) is only predicted to occur within intertidal or shallow nearshore waters. Note that the greater wave action and water column mixing within the nearshore environment will also result in rapid weathering of the hydrocarbon.	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, no predicted dissolved in-water hydrocarbon exposure 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 smothering of isolated corals. Hydrocarbons may contact the intertidal shores as the tide ebbs, but it would be expected that this would be flushed with each flood tide. Natural flushing is more likely to reduce impacts in exposed areas of shoreline. Consequently, the potential consequence to corals are considered to be Minor, as they could be expected to result in localised low-level impacts.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
	Seagrass	Change in habitat	In-water exposure (entrained) is only predicted to occur within the surface layers with the potential to contain seagrasses. Note that the greater wave action and water column mixing within the nearshore environment will also result in rapid weathering of the MDO. 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) (Section 5.6.1.2). Exposure in nearshore and intertidal areas is predicted to only be at moderate thresholds (e.g. instantaneous exposure >100 ppb for entrained hydrocarbons only).	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). Given the restricted range of exposure (shallow nearshore and intertidal waters only), no predicted dissolved in-water hydrocarbon exposure and the predicted moderate concentrations of entrained hydrocarbons expected to be 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, 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 entrained 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 Section 5.6.4). 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.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				Consequently, given the limited area exposed by moderate levels of dissolved hydrocarbons, the potential consequence to plankton are considered to be Minor, 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 expected. Species located in shallow nearshore or intertidal waters may be exposed to in-water hydrocarbons. 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. However, the presence of an exoskeleton (e.g. crustaceans) reduces the impact of hydrocarbon absorption through the surface membrane. Invertebrates with no exoskeleton and larval forms may be more prone to impacts. 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, as they could be expected to result in localised short-term impacts to species of value.
	Fish	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,	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. 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 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

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			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 shark in the EMBA, however, it is not expected that this species spends a large amount of time close to the surface where thresholds may be highest.	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, as they could be expected to result in localised low-level short-term impacts. Refer to management advice and evaluation of acceptability in Section 7.15.4.
	Pinnipeds (seals and sea lions)	Injury/Mortality to fauna Change in fauna behaviour	The PMST report identified three pinnipeds that potentially occur in the EMBA (Australian sea lion, Australian and New Zealand fur-seal) (Section 5.6.7.7). There are no identified BIAs for seals within the EMBA. Known breeding colonies for Australian fur-seals are on islands off the coast; Kanowna Island, Rag Island, West Moncoeur Island, Lady Julia Percy Island and Seal Rocks (Vic). Cape Bridgewater is also a known haul out site. Seal Rocks on King Island is also a New Zealand fur-seal breeding colony. A foraging BIA for the Australian sea-lion is located west and north-west of Beachport within the EMBA. This BIA overlaps both South Australian State waters and the Bonney Coast Upwelling KEF, therefore the predicted hydrocarbon exposure to these areas is likely to also contact with the foraging BIA. There is no predicted exposure to the Bonney Coast Upwelling KEF at the low (48-hour) threshold exposure. A maximum entrained hydrocarbon exposure for a 1-hour window is predicted to be 98 ppb with a 22% probability of low instantaneous exposure to the KEF.	Exposure to moderate effect levels of hydrocarbons 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, their widespread nature, the low-level exposure zones and rapid loss of the volatile components of diesel in choppy and windy seas (such as that of the area exposed by moderate in-water hydrocarbon thresholds), the potential consequence to pinnipeds are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 7.15.4.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			There is no predicted dissolved exposure to South Australian State waters and the maximum time entrained hydrocarbon exposure for a 48-hour window is 31 ppb and 26 ppb for a 1-hour window based upon a 2% probability of contact. Known breeding colonies of Australian fur-seals are unlikely to be exposed to moderate in-water exposure thresholds, and the foraging BIA for the Australian Sea-lion is not within the predicted area of moderate in-water exposure. Given the mobility of pinnipeds, there may be small numbers of seals and sea-lions in the areas predicted to be temporarily exposed to moderate concentrations of in-water hydrocarbons in the water column, noting that in-water exposure (dissolved or entrained) is only predicted to occur within the upper layers of the water column.	
	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 an area predicted to be exposed to in-water hydrocarbons. Known BIAs are present for foraging for pygmy blue whales and distribution for southern right whale in area exposed to moderate in-water thresholds, i.e. >50 ppb for dissolved and >100 ppb for entrained.	Cetacean exposure to entrained hydrocarbons can result in physical coating as well as ingestion (Geraci and St Aubin, 1988). Such impacts are associated with 'fresh' 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

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				foraging BIA for pygmy blue whales and current core coastal range for southern right whales. Consequently, the potential consequence to cetaceans are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 7.15.4.

Table 7-21: Consequence evaluation to socio-economic receptors within the EMBA – in water

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
Human system	Commercial and recreational fisheries	Change in ecosystem dynamics Changes to the functions, interests or activities of other users	In-water exposure to entrained diesel 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 EMBA and overlap the spatial extent of the water column hydrocarbon predictions (Section5.7.8, Section 5.7.9 and Section 5.7.10).	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 diesel 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 Minor, as they could be expected to result in localised low-level short-term impacts. Refer to management advice and evaluation of acceptability in Section 7.15.4
	Recreation and tourism	Change in ecosystem dynamics	Tourism and recreation are also linked to the presence of marine fauna (e.g. whales), particular habitats and locations for	Any impact to receptors that provide nature-based tourism features (e.g. whales) may cause a subsequent negative impact to recreation and tourism activities. Refer also to:

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
		Changes to the functions, interests or activities of other users Change in aesthetic value Change in water quality	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 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.	Fish Birds Pinnipeds Cetaceans (whales and dolphins) Marine invertebrates Recreational fisheries 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, as they could be expected to result in localised short-term impacts. Refer to management advice and evaluation of acceptability in Section 7.15.4
Natural system	State Marine Protected Areas	Change in ecosystem dynamics Change in aesthetic value Change in water quality	State marine protected areas (e.g. Twelve Apostles Marine Park) occur within the area predicted to be exposed to in-water hydrocarbons at the instantaneous screening level of 100 ppb (entrained). Conservation values for these areas include high marine fauna and flora diversity, including fish and invertebrate assemblages and benthic coverage (sponges, macroalgae).	Refer to: Marine invertebrates Macroalgae The consequence to conservation values within the Twelve Apostles Marine Park is assessed as localised and short term and ranked as Moderate. Refer to management advice and evaluation of acceptability in Section 7.15.4.

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
	Australian Marine Parks	Change in ecosystem dynamics Change in aesthetic value Change in water quality	Stochastic modelling indicates in-water hydrocarbons at the instantaneous screening level of 100 ppb (entrained) may extend to within the boundaries of the Apollo Marine Park (Section 5.4.2). Conservation values for Apollo Marine Park include foraging habitat for seabirds, dolphins, seals and white sharks, and blue whales migrate through Bass Strait. A reduction in water quality will lead to a breach in management objectives for AMPs.	Refer to: Seabirds Cetaceans and pinnipeds Fish Plankton The concentration at which the water column within Apollo Marine Park may be exposed is within the moderate thresholds for entrained hydrocarbons. Given the nature of the exposure to foraging habitats, and transient nature of migrating and foraging marine fauna, the consequence is ranked as Moderate. Refer to management advice and evaluation of acceptability in Section 7.15.4.
Conservation Values and sensitivities	Key Ecological Features	Change in water quality Injury / mortality to fauna Change in fauna behaviour. Change in ecosystem dynamics.	The KEFs that overlap the spill EMBA are described in Section 5.4.13, however, the Bonney Coast Upwelling is the only KEF predicted to be exposed to in-water hydrocarbons from a potential MDO spill. MDO is classified as a light persistent oil, has a low specific gravity (and will therefore tend to remain afloat) and has a high proportion (~95%) of volatile components and only a small (5%) residual component. Due to this volatility most of this oil will evaporate from the water surface; depending on wind conditions the proportion of evaporated oil may vary between approximately 40% within the first day, with the remaining volatiles evaporating over 3-4 days depending upon the prevailing conditions. Under moderate winds, oil will begin to entrain into the water column. Entrained oil can persist for	Stochastic modelling indicates potential low-level and very short-term hydrocarbon exposure to the Bonney Coast Upwelling KEF resulting in a low-level reduction in water quality. This contact is predicted to be below the conservative environmental impact threshold for pelagic species i.e. moderate thresholds (refer Section 7.14) At the low instantaneous entrained exposure thresholds predicted, there is potential for chronic-level exposure to juvenile fish, larvae and planktonic organisms that might be entrained (or otherwise moving) within the entrained plumes (see Appendix B). Given the seasonal upwelling event supports regionally high productivity and high species diversity along the Bonney coast extending between Cape Jaffa, South Australia and Portland, Victoria. (DoE, 2015a) and the potential exposure is limited to low threshold contact to the eastern boundary of the Bonney Coast Upwelling KEF, some localised short-term impairment of ecosystem functioning during an upwelling event could occur. Consequently, the consequence of short-term effects including a potential regional decline in water quality during the upwelling season associated with the Bonney Coast KEF are considered to be

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
			extended periods of time, however if it re-floats it is subject to evaporation and is also subject to dissolution and natural degradation within the water column. There is no predicted surface or dissolved hydrocarbon exposure to any KEF from an MDO spill. The maximum time-entrained hydrocarbon exposure for a 48-hour window is predicted to be 125 ppb at the Bonney Coast Upwelling KEF with no predicted low (48-hour) threshold exposure. The maximum entrained hydrocarbon exposure for a 1-hour window is predicted to be 98 ppb at the Bonney Coast Upwelling KEF with a 22% probability of low instantaneous exposure.	Moderate, as they could be expected to result in localised short-term impacts to an area of recognised conservation value. Given the details above, Refer to management advice and evaluation of acceptability in Section 7.15.4.
	Wetlands	Change in water quality Change in ecosystem dynamics	Marine waters adjacent to the Port Phillip Bay and Bellarine Peninsula Ramsar site may be exposed to maximum time-entrained (for a 48-hour window) of 7 ppb with no exposure at low thresholds, and a maximum instantaneous exposure of 10 ppb with a 1% probability of exposure at low thresholds. No other Wetlands of International importance identified within the EMBA are predicted to be exposed to hydrocarbons from an MDO spill at any threshold. Nationally important wetlands, with a coastal interface, also occur within the EMBA and may be exposed to in-water hydrocarbons above low thresholds.	There is predicted low probabilities of low-level in-water hydrocarbon contact with marine waters adjacent to some wetlands (including both internationally important (Ramsar) and national important sites). Specifically, there is potential for a temporary decline in water quality that may impact on the ecological character of the following Ramsar sites: Port Philip Bay (Western shoreline) and Bellarine Peninsula. Wetland habitat can be of particular importance for some species of birds, fish and invertebrates. As such, in addition to direct impacts on wetland vegetation communities, oil that reaches wetlands may also affect these fauna utilising wetlands during their life cycle. Refer to other to receptor evaluations for in-water hydrocarbons, including: Seagrass Fish

Receptor Group	Receptor Type	Impact	Exposure Evaluation	Consequence Evaluation
				Marine invertebrates At the predicted low exposure levels for dissolved and entrained in-water contact there is unlikely to be lethal ecological impacts on any of the values (receptors) that contribute to the ecological character of wetlands, however, a conservative consequence of Moderate has been applied given the cultural significance and International and National Importance of the wetlands (Ramsar-listed wetlands) and there may be localised minor short-term impacts to some of these receptors in closer proximity to the release location where they may be exposed to moderate in-water hydrocarbon thresholds. Refer to management advice and evaluation of acceptability in Section 7.15.4

7.15.4 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Loss of Containment - diesel	
ALARP decision context and justification	ALARP Decision Context: Type B Vessels have been used for activities within the Otway Offshore Development including operations for over a decade with no major incident. Vessel activities are well regulated with associated control measures, well understood, and are implemented across the offshore industry. During stakeholder engagement, no concerns were raised regarding the acceptability of impacts from these events. However, if a diesel spill occurred from a vessel collision this could attract public and media interest. Consequently, Beach believes that ALARP Decision Context B should be applied.
Adopted Control Measures	**Source of good practice control measures**
CM#8: Ongoing consultation	Under the *Navigation Act 2012*, the Australian Hydrographic Office (AHO) are responsible for maintaining and disseminating hydrographic and other nautical information and nautical publications such as Notices to Mariners. AMSA also issue radio-navigation warnings. Relevant details in relation to the vessel activity will be provided to the AHO and AMSA and to relevant stakeholders to ensure the presence of the vessel is known in the area. See Section 9.8 (Ongoing Stakeholder Consultation).
	Under the *OPGGS Act 2006* there is provision for ensuring that petroleum activities are carried out in a manner that doesn't interfere with other marine users to a greater extent than is necessary or the reasonable exercise of the rights and performance of the duties of the titleholder. Beach ensures this is achieved by conducting suitable consultation with relevant stakeholders. Consultation with potentially affected fisheries ensures the risk of interaction with these users is limited.
CM#22 SMPEP or SOPEP (appropriate to class)	In accordance with MARPOL Annex I and AMSA MO 91 [Marine Pollution Prevention – oil], a Shipboard Marine Pollution Emergency Plan (SMPEP) or Shipboard Oil Pollution Emergency Plan (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.
CM#26: MO 21: Safety and emergency arrangements	AMSA MO 21: Safety and emergency arrangements gives effect to SOLAS regulations dealing with life-saving appliances and arrangements, safety of navigation and special measures to enhance maritime safety.
CM#27: MO 30: Prevention of collisions	AMSA MO 30: Prevention of collisions requires that onboard navigation, radar equipment, and lighting meets the International Rules for Preventing Collisions at Sea (COLREGs) and industry standards.

CM#28: MO 31: SOLAS and non-SOLAS certification	All vessels contracted to Beach will have in date certification in accordance with AMSA MO 31: SOLAS and non-SOLAS certification
CM#29: MO 27: Safety of navigation and radio equipment	AMSA MO 27: Safety of navigation and radio equipment gives effect to SOLAS regulations regarding radiocommunication and safety of navigation, and provides for navigation safety measures and equipment and radio equipment requirements.
CM#35: Vessel fuel type	Vessels contracted to conduct activities under this EP will only carry marine diesel.

Additional controls assessed			
Control	**Control Type**	**Cost/Benefit Analysis**	**Control Implemented?**
Eliminate or substitute the use of diesel.	Equipment	The use of diesel for fuel for vessels and machinery cannot be eliminated. Substituting for another fuel, i.e. Heavy Fuel Oil or bunker fuel oil, would have a higher environmental impact than diesel.	No

Consequence rating	Moderate (2)
Likelihood of occurrence	Highly Unlikely (2) based upon AMSA Annual Report 2017-18 (serious incident reports)
Residual risk	Medium
Acceptability Assessment	
To meet the principles of ESD	The risk of a loss of containment resulting in a diesel spill was assessed as medium and the highest consequence assessed as moderate which is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Internal context	The proposed management of the risk is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
External context	No objections or claims have been raised during stakeholder consultation regarding the potential for diesel spills.
Other Requirements	• Vessel activities undertaken during Otway Offshore Operations will adhere to relevant legislative requirements as detailed in the controls section. • The South-east Commonwealth Marine Reserves Network Management Plan 2013-23 (Director of National Parks, 2013) identifies oil pollution associated with shipping, other vessels and offshore mining operations as a pressure or source of pressure on the conservation values of the South-east Marine Reserves Network. No AMPs are predicted to be exposed to surface, high (instantaneous) thresholds for entrained hydrocarbons or moderate or high thresholds for dissolved hydrocarbons. Only the Apollo AMP is predicted to be exposed to moderate (instantaneous) thresholds of entrained hydrocarbons (up to 7% summer and 16% winter). Impacts to Apollo AMP major conservation values for fauna (blue, fin, sei and humpback whales, black-browed and

	shy albatross, Australasian gannet, short-tailed shearwater, and crested tern) are assessed as short-term and recoverable based on the majority of the exposure being to moderate level of dissolved hydrocarbons for a short period of time. Impacts to Apollo AMP major conservation values for ecosystems, habitats, communities and cultural and heritage sites are not predicted as in-water hydrocarbons are only predicted within 0 – 30 m of the water column which does not intersect with these values. • The following Conservation Advices / Recovery Plans identify pollution as a key threat: ◦ Conservation Advice *Balaenoptera borealis* (sei whale) (TSSC 2015g) ◦ Conservation Advice *Balaenoptera physalus* (fin whale) (TSSC 2015f) ◦ Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b), identified as acute chemical discharge (oil pollution) ◦ Conservation Advice *Calidris ferruginea* (curlew sandpiper) (DoE, 2015f) identified as Habitat degradation/ modification (oil pollution) ◦ National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPC 2011a) ◦ Conservation Advice for *Sterna nereis nereis* (fairy tern) (DSEWPC, 2011c) • The following Conservation Advices / Recovery Plans identify habitats degradation/modification as threat, which may be consequence of accidental release of hydrocarbon: ◦ Conservation Advice *Calidris canutus* (red knot) (TSSC 2016d) ◦ Conservation Advice *Limosa lapponica baueri* (bar-tailed godwit (western Alaskan)) (TSSC 2016a) ◦ Conservation Advice for Numenius madagascariensis (eastern curlew) (DoE 201e) • These Conservation Advices and Recovery Plan identify the following conservation actions: ◦ Minimise chemical and terrestrial discharge. Controls have been identified and will be implemented to minimise the risk of minimise chemical discharges. ◦ Ensure spill risk strategies and response programs include management for turtles and their habitats, particularly in reference to ‘slow to recover habitats’, e.g. nesting habitat, seagrass meadows or coral reefs. No habitats for turtles are identified within the diesel spill EMBA. OPEP and OSMP cover management of response to oiled turtles. ◦ Ensure appropriate oil-spill contingency plans are in place for the subspecies’ breeding sites which are vulnerable to oil spills. OPEP and OSMP cover response strategies for management breeding sites vulnerable to oil spills. ◦ Implement measures to reduce adverse impacts of habitat degradation and/or modification. Controls have been identified and will be implemented to reduce adverse impacts of habitat degradation and/or modification.
Monitoring and reporting	Loss of containment resulting in a diesel spill is required to be reported as per Section 8.10.

	Impacts as a result of a loss of containment resulting in a diesel spill will be monitored and reported in accordance with the OSMP.
Acceptability outcome	**Acceptable**

7.16 Loss of Containment - Condensate

7.16.1 Hazards

Several loss of containment (condensate) scenarios have been identified as credible during Otway Offshore Operations. These are described in Table 7-22. Loss of well containment represents the greatest potential extent of hydrocarbon exposure, and is therefore used to evaluate the potential consequences of a loss of containment (condensate).

Table 7-22 Credible Loss of Containment (Condensate) scenarios

Scenario	Description	Worst-case release volume and rate
Pipeline loss of containment	Loss of containment from the Otway Gas Pipeline or flexible flowline from the Geographe subsea facilities as a result of erosion, corrosion or external forces (e.g. dropped object; fishing vessel interactions). A release could occur anywhere along the flowline or pipeline.	A Flow Assurance assessment has calculated that the maximum credible spill volume from a pipeline loss of containment is 265 m^3. This is based on: • Thylacine platform flow rate = 10 MMscf/d • Geographe flow rate = 130 MMscf/d (Split =7:93) Export rate equivalent = 135 TJ/day
Loss of well containment	Loss of containment as a result of well integrity failure.	The highest maximum production rates for each producing field are: • TA-1 maximum production rate 60 MMscf/d with an associated condensate rate of 600 bbl/d. • G-4 maximum production rate 100 MMscf/d with an associated condensate rate of 1600 bbl/d. It is likely that these rates would decline by 2-3% per month of flowing time.

7.16.1.1 Characteristics of the condensate

Thylacine condensate has been used as an analogue. It has a low density, a low pour point and a low dynamic viscosity (Table 4-3), indicating that it will spread quickly when spilled at sea and thin out to low thicknesses, increasing the rate of evaporation (refer to Section 4.3 for further details).

On release to the marine environment, condensate would be evaporated, decayed and distributed over time into various components. Of these components, surface hydrocarbons, entrained hydrocarbons (non-dissolved oil droplets that are physically entrained by wave action) and dissolved aromatics (principally the aromatic hydrocarbons) have the most significant impact on the marine environment. These are discussed in further detail below.

7.16.1.2 Extent of potential hydrocarbon exposure

The extend of possible exposure to hydrocarbons is based upon a hypothetical worst-case subsea release of 222,224 bbl (2584 bbl/d) of condensate over 86 days (RPS 2019; Appendix B). The modelled release rate is greater than the expected maximum release rates from Thylacine and Geographe production wells and is therefore a conservative estimation of the extent of potential hydrocarbon exposure.

The extent of potential hydrocarbon exposure at moderate thresholds (including 48-hour time-based in-water dissolved and entrained) for a LOC scenario is presented in Figure 7-8.

Potential extent of hydrocarbon exposure to Australian Marine Parks

Only Apollo AMP is predicted to be exposed to moderate (instantaneous) thresholds of in-water hydrocarbons (up to 30% summer and 39% winter for dissolved; and up to 50% and 48% winter for entrained).

No AMPs are predicted to be exposed to high (instantaneous) thresholds of dissolved or entrained hydrocarbons.

Potential extent of hydrocarbon exposure to surface waters

During summer conditions, moderate (10 - 25 g/m^2) exposure to surface hydrocarbons were predicted to travel a maximum distance of 4 km from the release location. Under winter conditions, moderate exposure from surface hydrocarbons extended to a maximum distance of 3 km from the release location. Note, no high exposure was predicted on the sea surface for any of the seasons assessed.

Potential extent of hydrocarbon exposure to shorelines

The probability of contact to any shoreline was 16% and 57% for the summer and winter season, respectively. While the minimum time for visible surface hydrocarbons to reach a shoreline was 3 days and 5 days, respectively.

The maximum volume of hydrocarbons predicted to come ashore was 15 m^3 and 33 m^3, during summer and winter conditions, respectively, while the maximum length of shoreline contacted above the low threshold (10 – 100 g/m^2) was 7.0 km and 11 0 km, respectively. Note, no shoreline loading was predicted for the high threshold (above 1,000 g/m^2).

Cape Otway West Local Government Area was the receptor predicted with the greatest probability of contact above the moderate threshold during summer (15%) and winter (40%). The modelling results during winter conditions demonstrated additional shoreline contact to Moyne, Corangamite, Moonlight head and Childers Cove.

Potential extent of in-water dissolved hydrocarbon exposure

At the depth of 0-10 m, the maximum concentration of dissolved hydrocarbons over the 48-hour window was 30 ppb in summer and 34 ppb in winter, and hence no moderate or high exposure was predicted during either season.

None of the receptors identified within the spill model were exposed to moderate (50 – 400 ppb) or high (>400 ppb) dissolved hydrocarbons (over a 48-hour basis) during the summer or winter season.

Potential extent of in-water entrained hydrocarbon exposure

The maximum entrained hydrocarbon concentrations time-averaged over 48 hours for the summer and winter season was 559 ppb and 569 ppb, respectively. No moderate or high exposure was predicted for any of the receptors identified within the spill model for any of the seasons.

7.16.2 Predicted environmental risks

Known and potential environmental risks as result of an uncontrolled hydrocarbon release include:

- change in water quality
- injury / mortality to fauna
- change in fauna behaviour
- change in ecosystem dynamics
- changes to the functions, interests or activities of other users

7.16.3 Consequence Evaluation

The potential environmental impacts to receptors within the EMBA from condensate spill are discussed in Table 7-19 to Table 7-24.

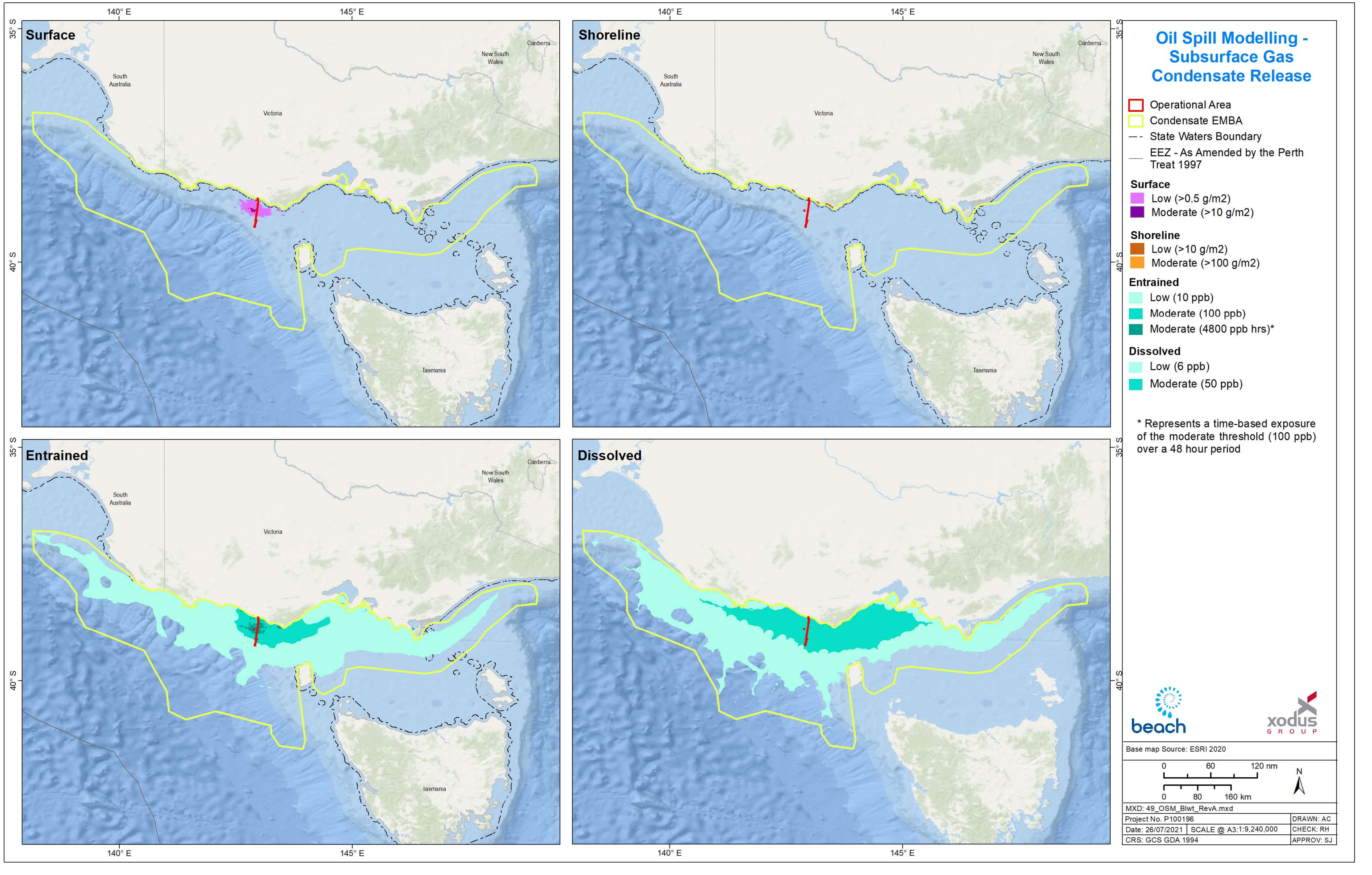

Figure 7-9: Environment potentially exposed to hydrocarbons from a hypothetical 222,224 bbl (2584 bbl/d) condensate release over 86 days

Table 7-23: Consequence evaluation to ecological receptors within the EMBA – sea surface

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 4 km of the release location predicted to be exposed to moderate levels of surface hydrocarbons. Foraging BIAs for several albatross species, the wedge-tailed shearwater, common diving-petrel and short-tailed shearwater (Section 5.6.7.4) predicted to be above threshold. Foraging and breeding BIAs for little penguins have been identified within the EMBA (Figure 5-27), however are well beyond the predicted area of surface exposure at >10 g/m^2. Colonies of little penguins, without defined BIAs, are known to along parts of Port Campbell Bay area; therefore, it is possible that little penguins may be present in the area exposed to surface hydrocarbon >10g/m^2.	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 >10g /m^2 out to 4 km from the release location) may suffer impacts however it is unlikely that a large number of birds will be affected. Seabirds rafting, resting, diving or feeding at sea have the potential to come into contact with localised areas of sheen >10 µm and may experience lethal surface thresholds for the duration of the spill. Contact with areas of high hydrocarbon exposure is highly unlikely (i.e. areas of concentrations >25 g/m^2 limited to immediate release location). As such, acute or chronic toxicity impacts (death or long-term poor health) to small numbers of birds may occur. Consequently, the potential consequence to seabirds is considered to be Serious, as they could be expected to result in localised serious short-term impacts to formally managed species/habitats of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 7.16.4.
	Marine reptiles	Injury / mortality to fauna Change in fauna behaviour	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 the species within this area (Section 5.6.7.5).	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

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				critical to the survival of the species present and the localised (4 km from the release location) extent of exposure above the 10 g/m^2 threshold; however, turtles may be transient within the EMBA. Therefore, potential impact would be limited to individuals, with population impacts not anticipated. Consequently, the potential consequence to marine turtles are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 7.16.4.
	Pinnipeds (seals and sea-lions)	Injury / mortality to fauna Change in fauna behaviour	The Australian and New Zealand fur-seals may occur within the area predicted to be exposed to surface hydrocarbons >10 g/m^2. No BIAs, breading colonies or haul outs areas are within the area of exposure (Section 5.6.7.7). There is a foraging BIA for the Australian sea-lion, but it is outside of the predicted area of surface exposure at >10 g/m^2.	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 condensate mean this is not likely. The number of pinnipeds exposed is expected to be low, with population impacts not anticipated. Due to the rapid weathering of condensate, the potential exposure time is short. Consequently, the potential consequence to pinnipeds are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value Refer to management advice and evaluation of acceptability in Section 7.16.4.
	Cetaceans (whales)	Injury / mortality to fauna Change in fauna behaviour	Several threatened, migratory and/or listed marine species have the potential to be foraging the area predicted to be exposed to surface hydrocarbons of >10 g/m^2. Surface exposure of >10 g/m^2 is expected to extend out 4 km from the release location i.e., a	Geraci (1988) found little evidence of cetacean mortality from hydrocarbon spills; however, some behaviour disturbance (including avoidance of the area) may occur. While this reduces the potential for physiological impacts from contact with hydrocarbons, active avoidance of an area may displace individuals or aggregations from important habitat, such as foraging.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			relatively small areas compared to the overall distribution area of cetaceans. Known BIAs are present for foraging for pygmy blue whales and distribution, aggregation, migration and connecting habitat for southern right whale within the EMBA (Section 5.6.7.6).	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 (<4 km from release location), this is not likely. Given this is a relatively small area of the total foraging BIA for pygmy blue whales and current core coastal range for southern right whales, the risk of displacement to whales is considered low. Otway Offshore Operations could occur at any time of year. Therefore, there is potential for interaction with southern right whales given the activity window overlaps with the northern migration period of May-June, the peak breeding (July-August) and southern migration period (September-November) (Section 5.6.7.6). The activity timing overlaps with the blue whale season for migration and foraging in the operational area and EMBA. Visual and acoustic surveys suggest that blue whales are present in the Otway region between November to June, peaking in February and March (Section 5.6.7.6). There is no population estimate for blue whales globally or in Australia and they are EPBC listed as endangered and migratory. Blue whales are highly mobile and widespread across the world's oceans. Aerial surveys in the Otway region recorded mean Blue whale group size of 1.3±0.6 per sighting with cow-calf pairs observed in 2.5% of the sightings (Gill et al. 2011). However, acknowledging there is scientific uncertainty with specific whale numbers within the vicinity of the Otway Offshore Operations location, and given activities may occur during upwelling events, 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. Consequently, the potential impacts and risks to cetaceans are considered to be Serious as they could be expected to result in

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				localised serious short-term impacts to formally managed species/habitats of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 7.16.4.
	Cetaceans (dolphins)	Injury / mortality to fauna Change in fauna behaviour	There may be dolphins in the area predicted to be exposed to surface hydrocarbons >10 g/m2. However, it is not identified as critical habitat, and there are no spatially defined aggregations (i.e. is not a BIA) in the EMBA (Section 5.6.7.6).	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. Direct surface hydrocarbon contact may pose little problem to dolphins due to their extraordinarily thick epidermal layer which is highly effective as a barrier to the toxic, penetrating substances found in hydrocarbons. 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 time is short. Consequently, the potential consequence to dolphins are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 7.16.4.

Table 7-24: Consequence evaluation to socio-economic receptors within the EMBA – sea surface

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
Human systems	Recreation and tourism (including recreational fisheries)	Changes to the functions, interests or activities of other users Change in aesthetic value	Marine pollution can result in impacts to marine-based tourism from reduced visual aesthetic. The modelling predicts (visible surface rainbow sheen) surface sheens (0.5 g/m^2) may occur up to 53 km from the 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 relatively short duration means there may be short-term and localised consequences, which are ranked as Moderate. Refer also to: Cetaceans (whales).
	Industry (shipping)	Changes to the functions, interests or activities of other users	Shipping occurs within the area predicted to be exposed to surface hydrocarbons >10 g/m^2.	Vessels may be present in the area where moderate levels of sea surface oil is present, however, due to the short duration of the surface exposure (approximately 12 hours) deviation of shipping traffic would be unlikely.
	Industry (oil and gas)	Changes to the functions, interests or activities of other users	There are no oil and gas platforms, or activities located within the area predicted to be exposed to surface hydrocarbons.	No impact as there are no oil and gas platforms located within the area predicted to be exposed to moderate thresholds of surface hydrocarbons.

Table 7-25: Consequence evaluation to physical receptors within the EMBA – shorelines

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
Shoreline	Saltmarsh	Change in habitat Change in ecosystem dynamics	Saltmarsh communities may be within the overall are potentially exposed to hydrocarbons ashore; and is present within estuaries and inlet/riverine systems. Some of the saltmarsh habitat along this coast may be representative of the Subtropical and Temperate Saltmarsh TEC. Shorelines predicted to be exposed by shoreline hydrocarbons >100 g/m^2 include Moyne, Corangamite, Colac Otway, Cape Otway West, Moonlight Head and Childers Cove. Therefore, exposure (with the risk of ecological impact) to known saltmarsh areas along the Otway coast is limited. Oil can enter saltmarsh systems during the tidal cycles, if the estuary/inlet is open to the ocean. Similar to mangroves, this can lead to a patchy distribution of the oil and its effects, because different places within the inlets are at different tidal heights. Oil (in liquid form) will readily adhere to the marshes, coating the stems from tidal height to sediment surface. Heavy oil coating would be expected to be restricted to the outer fringe of thick vegetation, although lighter oils can penetrate deeper, to the limit of tidal influence.	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 are considered to be Serious, as they could be expected to result in localised serious but recoverable impacts to species or habitats of recognized conservation value or to local ecosystem function.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
Marine fauna	Seabirds and shorebirds	Injury / mortality to fauna Change in fauna behaviour	Threatened, migratory and/or listed marine species have the potential to be foraging or breeding within the area predicted to be contacted by >100 g/m^2 shoreline exposure. The largest length of actionable shoreline oil (defined as >10 g/m^2) is predicted to reach up to 11 km. Predicted peak volume ashore of 33 m^3 was estimated during winter. Shorelines predicted to be exposed by shoreline hydrocarbons >100 g/m^2 include Moyne, Corangamite, Colac Otway, Cape Otway West, Moonlight Head and Childers Cove. Foraging and breeding BIAs for little penguins are within the EMBA (Figure 5-27). However, all known breeding BIAs are located outside of the predicted area of shoreline exposure at >100 g/m^2	Shoreline species may suffer both direct oiling and potential displacement from foraging and nesting sites. Acute or chronic toxicity impacts (death or long-term poor health) to birds is possible. Direct oiling of nesting sites is considered unlikely as hydrocarbon would typically accrue within the upper swash zone, and nests would occur above this level on a beach. However, oiled fauna may track oil into their nests, which may then have subsequent impacts on any eggs present. This would be more of a risk for fauna, such as the little penguin, that have to traverse the intertidal area to reach nesting sites. Whilst there are no known breeding BIAs for the little penguins along the Otway mainland coast, there is breeding colonies known to occur with Port Campbell Bay area – however, these are outside of the length of shoreline predicted to be exposed to shoreline oil accumulation of >100 g/m2. In addition, given the volatility of the exposed oil smothering of nests is unlikely. Given the potential for sensitive shoreline habitat to be exposed to hydrocarbons above the actionable >100 g/m2 shoreline exposure thresholds, the length of shoreline that has the potential to be exposed and the peak volume potentially accumulated ashore, the consequence has been ranked as Serious. Refer to management advice and evaluation of acceptability in Section 7.16.4.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
Natural System	Wetlands	Change in water quality Change in ecosystem dynamics	Nationally important wetlands that occur within the length of shoreline that may be impacted by oil accumulation of >100 g/m^2 include Lower Aire River Wetlands (Section 5.4.6.6). No shoreline contact above the minimum threshold (>10 g/m^2) was predicted at any Ramsar site for either of the seasons modelled.	These nationally important wetlands have continuity with the sea, including saline marsh areas and estuarine environments that support large numbers of water birds. Wetlands are considered to have a high sensitivity to hydrocarbon exposure. Wetland vegetation (which can include saltmarsh and other estuarine plants) typically have a large surface area for oil absorption and their structure traps oil. The degree of impact of oil on wetland vegetation are variable and complex, and can be both acute and chronic, ranging from short-term disruption of plant functioning to mortality. Spills reaching wetlands during the growing season will have a more severe impact than if oil reaches wetlands during the times when many plant species are dormant. Wetland habitat can be of particular importance for some species of birds, fish and invertebrates. As such, in addition to direct impacts on plants, oil that reaches wetlands also affects these fauna utilising wetlands during their life cycle. Refer also to other receptor evaluations for shoreline exposure, including: • saltmarsh • seabirds and shorebirds Given the potential for sensitive shoreline habitat including saltmarsh to be exposed to hydrocarbons above the actionable >100 g/m^2 shoreline exposure thresholds, the length of shoreline that has the potential to be exposed and the peak volume potentially accumulated ashore, the consequence has been ranked as Serious as they could be expected to result in localised serious impact to species or habitats of recognized conservation value or to local ecosystem function.

Table 7-26: Consequence evaluation to physical and ecological receptors within the EMBA – in water

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
Habitat	Algae	Change in habitat	In-water exposure (dissolved or entrained) is only predicted to occur within the surface layers; therefore, the only exposure to benthic habitat is possible within intertidal or shallow nearshore waters (Section 5.6.1.3). Note that the greater wave action and water column mixing within the nearshore environment will also result in rapid weathering of the condensate. Macroalgae may be present within reef and hard substrate areas within the area predicted to be exposed to in-water hydrocarbons (e.g. macroalgae is known to occur within Twelve Apostles Marine Park, and areas around Warrnambool). Noting also that exposure in nearshore and intertidal areas is predicted to only be at moderate thresholds (e.g. instantaneous exposure >50 ppb for dissolved and >100 ppb for entrained hydrocarbons).	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 hydrocarbons expected to be in these waters, any impact to macroalgae is not expected to result in long-term or irreversible damage. Consequently, the potential consequence to algae are considered to be Minor, 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 EMBA, however their presence has been recorded around areas such as Wilsons Promontory National Park and Cape Otway (Section 5.6.1.4). In-water exposure (dissolved or entrained) is only predicted to occur within the surface layers; therefore, the only exposure to benthic habitat is possible within intertidal or shallow nearshore waters. Note that the greater wave action and water column mixing within the nearshore	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.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			environment will also result in rapid weathering of the condensate. Corals may be present within reef and hard substrate areas within the area predicted to be to in-water hydrocarbons, noting also that exposure in nearshore and intertidal areas is predicted to only be at moderate thresholds (e.g. instantaneous exposure >50 ppb for dissolved and >100 ppb for entrained hydrocarbons).	Consequently, the potential consequence to algae are considered to be Minor, as they could be expected to result in localised low-level impacts.
	Seagrass	Change in habitat	In-water exposure (dissolved or entrained) is only predicted to occur within the surface layers; 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) (Section 5.6.1.2). Exposure in nearshore and intertidal areas is predicted to only be at moderate thresholds (e.g. instantaneous exposure >50 ppb for dissolved and >100 ppb for 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 moderate concentrations of hydrocarbons expected to be in these

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				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, as they could be expected to result in localised minor short-term impacts to habitat of recognised conservation value.
	Plankton	Injury / mortality to fauna	Plankton are typically more abundant in surface waters where in-water exposure (dissolved or entrained) is predicted to occur. Potential in-water dissolved hydrocarbon exposure at the instantaneous moderate threshold does occur in the Bonney Coast Upwelling KEF. While hydrocarbon presence would not affect the upwelling itself, if the spill occurs at the time of an upwelling event, it may result in plankton being exposed to low instantaneous concentrations of in-water hydrocarbons. While these levels are not expected to cause lethal effects on the plankton, if this did occur there is the potential for flow on effects to whales or other marine fauna that use this as a food source (i.e. reduced prey availability).	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 with in-water hydrocarbons. 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. However, any impact is expected to be localised and temporary, 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, 2011), 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, the potential consequence to plankton are considered to be Moderate, as they could be expected to result in short-term and localised impacts.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
	Marine invertebrates	Injury / mortality to fauna Changes to the functions, interests or activities of other users	The modelling indicates that area predicted to be exposed for dissolved hydrocarbons would predominately be at 0-10 m and 10-20 m water depth, with some patch exposure extending into the 20-30 m water depths. Modelling indicated entrained hydrocarbons to only expose the 0-10 m water depth. Impact by direct contact of in-water hydrocarbons to benthic species in the deeper areas of potential exposure are not expected. Species located in shallow nearshore or intertidal waters may be exposed to in-water hydrocarbons. Filter-feeding benthic invertebrates such as sponges, bryozoans, abalone and hydroids may be exposed to in-water hydrocarbons at concentrations with the potential for sub-lethal impacts. Tissue taint, if it occurs, may remain for several months in some species (e.g., abalone). In-water invertebrates of value that may be exposed to in nearshore/intertidal waters have been identified to include molluscs (scallops, abalone). Management areas for several commercial fisheries focussed on marine invertebrates are within the area predicted to be exposed to dissolved and entrained in-water hydrocarbons.	Acute or chronic exposure through contact and/or ingestion can result in toxicological risks. However, the presence of an exoskeleton (e.g. crustaceans) reduces the impact of hydrocarbon absorption through the surface membrane. Invertebrates with no exoskeleton and larval forms may be more prone to impacts. 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, 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, as they could be expected to result in localised short-term impacts to species of value.
Marine fauna	Fish	Injury / mortality to fauna	In-water exposure (dissolved or entrained) is only predicted to occur within 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	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

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			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 a known distribution and foraging BIA for the white shark in the EMBA, however, it is not expected that this species spends a large amount of time close to the surface where thresholds may be highest.	organisms, although impacts are not expected cause population-level impacts. 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. Refer to management advice and evaluation of acceptability in Section 7.16.4.
	Pinnipeds (seals and sea-lions)	Injury / mortality to fauna Change in fauna behaviour	The PMST report identified three pinnipeds that potentially occur in the EMBA (Australian sea lion, Australian and New Zealand fur-seal) (Section 5.6.7.7). There are no identified BIAs for seals within the EMBA. Known breeding colonies for Australian fur-seals are on islands off the coast; Kanowna Island, Rag Island, West Moncoeur Island, Lady Julia Percy Island and Seal Rocks (Vic). Cape Bridgewater is also a known haul out site. Seal Rocks on King Island is also a New Zealand fur-seal breeding colony. A foraging BIA for the Australian sea-lion is located west and north-west of Beachport within the EMBA (Section 5.6.7.7). The is no predicted moderate in-water exposure to this BIA.	Hydrocarbons in the water column or consumption of prey affected by the oil may cause sub-lethal impacts to pinnipeds, however given the localised nature of the spill, their widespread nature, no known breeding colony within the area of predicted ecological exposure (above time-based exposure concentrations), and the rapid loss of the volatile components of condensate in choppy and windy seas (such as that of the area exposed by moderate in-water hydrocarbon thresholds), the potential consequence to pinnipeds are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 7.16.4.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			Given the mobility of pinnipeds, there may be small numbers of seals and sea-lions in the areas predicted to be temporarily exposed to moderate concentrations of in-water hydrocarbons in the water column, noting that in-water exposure (dissolved or entrained) is only predicted to occur within the upper layers of the water column.	
	Cetaceans (whales and dolphins)	Injury / mortality to fauna Change in fauna behaviour	Several threatened, migratory and/or listed marine species have the potential to be migrating, resting or foraging within an area predicted to be exposed to in-water hydrocarbons. Known BIAs are present for foraging for pygmy blue whales and distribution for southern right whale in area exposed to moderate in-water thresholds, i.e. >50 ppb for dissolved and >100 ppb for entrained.	Cetacean exposure to entrained hydrocarbons can result in physical coating as well as ingestion (Geraci and St Aubin, 1988). Such impacts are associated with 'fresh' hydrocarbon; the risk of impact declines rapidly as the condensate weathers Otway Offshore Operations could occur at any time of year. Therefore, there is potential for interaction with southern right whales given the activity window overlaps with the northern migration period of May-June, the peak breeding (July-August) and southern migration period (September-November) (Section 5.6.7.6). The proposed activity timing overlaps with the blue whale season for migration and foraging in the operational area and EMBA. Visual and acoustic surveys suggest that blue whales are present in the Otway region between November to June, peaking in February and March (Section 5.6.7.6). There is no population estimate for blue whales globally or in Australia and they are EPBC listed as endangered and migratory. Blue whales are highly mobile and widespread across the world's oceans. Aerial surveys in the Otway region recorded mean blue whale group size of 1.3±0.6 per sighting with cow-calf pairs observed in 2.5% of the sightings (Gill et al. 2011). However, acknowledging there is scientific uncertainty with specific whale numbers within the vicinity of the Otway Offshore Operations, and given activities could occur during upwelling events, it is expected

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
				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. 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 current core coastal range for southern right whales, the risk of displacement to whales is considered low. Consequently, the potential consequence to cetaceans are considered to be Moderate, as they could be expected to result in localised minor short-term impacts to species of recognised conservation value. Refer to management advice and evaluation of acceptability in Section 7.16.4.

Table 7-27: Consequence evaluation to socio-economic receptors within the EMBA – in water

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
Human system	Commercial and recreational fisheries	Change in ecosystem dynamics Changes to the functions, interests or activities of other users	In-water exposure to in-water 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.	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-kill activities are

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			Several commercial fisheries operate in the EMBA and overlap the spatial extent of the water column hydrocarbon predictions (Section 5.7.8, 5.7.9 and 5.7.10.	enacted, therefore physical displacement to vessels is unlikely to be a significant impact. The consequence to commercial and recreational fisheries is assessed as localised and short term and assessed as Moderate. Refer to management advice and evaluation of acceptability in Section 7.16.4.
	Recreation and tourism	Change in water quality 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 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. whales) may cause a subsequent negative impact to recreation and tourism activities. Refer also to: • Fish • Birds • Pinnipeds • Cetaceans (whales and dolphins) • Marine invertebrates • Recreational fisheries 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.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
Natural system	State Marine Protected Areas	Change in ecosystem dynamics	State marine protected areas (e.g. Point Addis and Twelve Apostles Marine Park) occur within the area predicted to be exposed to in-water hydrocarbons. Conservation values for these areas include high marine fauna and flora diversity, including fish and invertebrate assemblages and benthic coverage (sponges, macroalgae).	Refer to: • Marine invertebrates • Macroalgae The consequence to conservation values in these protected marine areas is assessed as localised and short term and ranked as Moderate. Refer to management advice and evaluation of acceptability in Section 7.16.4.
	Australian Marine Parks (AMPs)	Change in ecosystem dynamics Change in water quality	Stochastic modelling indicates in-water hydrocarbons at the instantaneous screening level of 50 ppb (dissolved) and 100 ppb (entrained) may extend to within the boundaries of the Apollo AMP. Conservation values for Apollo AMP include foraging habitat for seabirds, dolphins, seals and white sharks, and blue whales migrate through Bass Strait.	Refer to: • Seabirds • Cetaceans and pinnipeds • Fish • Plankton The concentration at which the water column within Apollo Marine Park may be exposed is within the moderate thresholds for dissolved and entrained hydrocarbons. Given the nature of the exposure to foraging habitats, and transient nature of migrating and foraging marine fauna, the consequence is ranked as Moderate. Refer to management advice and evaluation of acceptability in Section 7.16.4.
	Key Ecological Features (KEFs)	Change in water quality Injury / mortality to fauna Change in fauna behaviour Change in ecosystem dynamics	The KEFs potentially exposed to in-water hydrocarbons include: • Bonney Coast Upwelling • Upwelling East of Eden • West Tasmanian Marine Canyons	Stochastic modelling indicates low likelihood potential for low-moderate in-water hydrocarbon exposure to the Bonney Coast Upwelling KEF resulting in a potential reduction in water quality over the duration of a LOC event (up to 86 days). Instantaneous

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			The West Tasmanian Canyons are located on the relatively narrow and steep continental slope west of Tasmania. 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. In-water hydrocarbons were only predicted to expose the 10 to 20 m water depth of the West Tasmanian Canyons. Given peak faunal coverage is at 200 to 300 m water depth it is not predicted to be exposed by in-water hydrocarbons. The maximum dissolved hydrocarbon exposure to the Bonney Coast Upwelling KEF for 48-hour window is 10ppb in summer and 6 ppb in winter with 1 % probability of low exposure over each season. The maximum dissolved instantaneous hydrocarbon exposure over a 1-hour window to the Bonney Coast Upwelling KEF is 97 ppb in summer and 86 bbp in winter with a 2% probably of moderate exposure for both seasons. The Upwelling East of Eden has a 1% probability of instantaneous low dissolved exposure in winter only. The maximum entrained hydrocarbon exposure to the Bonney Coast Upwelling KEF for 48-hour window is 36 ppb in summer and 32 ppb in winter with 1 % probability of low exposure over each season.	exposure to moderate levels of dissolved hydrocarbon may have chronic ecological effects on pelagic species, however, this is unlikely given both the instantaneous nature of the exposure and low probability of occurrence. At the low instantaneous entrained exposure thresholds predicted, there is potential for chronic-level exposure to juvenile fish, larvae and planktonic organisms that might be entrained (or otherwise moving) within the entrained plumes (see Appendix B). Given the seasonal upwelling event supports regionally high productivity and high species diversity along the Bonney Coast extending between Cape Jaffa, South Australia and Portland, Victoria. (DoEE) and the potential exposure is limited to low-moderate threshold contact to the eastern boundary of the Bonney Coast Upwelling KEF, some impairment of ecosystem functioning during an upwelling event could occur. Likewise, at the low-level exposure predicted at the Upwelling East of Eden, some impairment (although unlikely) of ecosystem functioning during an upwelling event could occur. Consequently, the consequence of short-term effects including a potential regional decline in water quality during the upwelling season associated with the Bonney Coast KEF or Upwelling East of Eden KEFs has been assessed as Serious.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			The maximum entrained instantaneous hydrocarbon exposure over a 1-hour window to the Bonney Coast Upwelling KEF is 53 ppb in summer and 42 bbp in winter with a 72% probably of low exposure in summer and 32% in winter. No moderate exposure is predicted for either season. The Upwelling East of Eden has a 21% probability of instantaneous low entrained exposure in winter only.	Refer to management advice and evaluation of acceptability in Section 7.16.4.
	Wetlands	Change in water quality Change in ecosystem dynamics	No in-water hydrocarbon contact is predicted with Glenelg Estuary, Lavinia or Piccaninnie Ponds Karst Wetlands Ramsar sites for either of the seasons modelled. The maximum <u>dissolved</u> hydrocarbon exposure (over the 48-hour window) at Western Port Ramsar site was predicted to be 1 ppb in summer. The maximum <u>dissolved</u> hydrocarbon exposure (over the 48-hour window) predicted at Western Port and Port Philip Bay and Bellarine Peninsula Ramsar sites was 3 ppb and 1 ppb respectively in winter. The maximum dissolved hydrocarbon exposure (over the 1-hour window) predicted at Western Port and Port Philip Bay and Bellarine Peninsula Ramsar sites was 22 ppb and 14 ppb respectively in winter with a 2% probability of low instantaneous exposure threshold in summer for both sites. The maximum <u>dissolved</u> hydrocarbon exposure (over the 1-hour window) at Western Port	There is predicted low probabilities of low-level in-water hydrocarbon contact with marine waters adjacent to some wetlands (including both internationally important (Ramsar) and national important sites). Specifically, there is potential for a temporary decline in water quality that may impact on the ecological character of the following Ramsar sites: • Corner Inlet • Port Philip Bay (Western shoreline) and Bellarine Peninsula • Western Port Wetland habitat can be of particular importance for some species of birds, fish and invertebrates. As such, in addition to direct impacts on wetland vegetation communities, oil that reaches wetlands may also affect these fauna utilising wetlands during their life cycle.

Receptor Group	Receptor Type	Impacts	Exposure Evaluation	Consequence Evaluation
			Ramsar site was predicted to be 2 ppb with a 2% probability of low instantaneous exposure threshold in summer. The maximum entrained hydrocarbon exposure (over the 48-hour window) at Corner Inlet, Port Philip Bay and Bellarine Peninsula and Western Port Ramsar sites was predicted to be 10 ppb, 19 ppb and 21 ppb respectively in summer and 10 ppb, 18 ppb and 16 ppb respectively in winter. However, no contact at low, medium or high 48-hour window thresholds was predicted at any Ramsar site for either summer or winter. The maximum entrained hydrocarbon exposure (over the 1-hour window) at Corner Inlet, Port Philip Bay and Bellarine Peninsula and Western Port Ramsar sites was predicted to be 11 ppb, 25 ppb and 24 ppb respectively in summer and 12 ppb, 23 ppb and 21 ppb in winter with a respective 10%, 27% and 30% probability of low instantaneous exposure threshold. The was no predicted moderate to high entrained hydrocarbon exposure (either 48-hour or 1-hour window) for any Ramsar site. Nationally important wetlands, with a coastal interface, also occur within the EMBA and may be exposed to in-water hydrocarbons above low thresholds.	Refer also to receptor evaluations for in-water exposure, including: • Seagrass • Fish • Marine invertebrates At the predicted low exposure levels for dissolved and entrained in-water contact there is unlikely to be lethal ecological impacts on any of the values (receptors) that contribute to the ecological character of the wetlands, however, a conservative consequence of Moderate has been applied given the cultural significance and International and National Importance of these wetlands (Ramsar-listed wetlands) and there may be moderate effects to some of these receptors in closer proximity to the release location where they may be exposed to moderate in-water hydrocarbon thresholds. Refer to management advice and evaluation of acceptability in Section 7.15.4.

7.16.4 Control measures ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Loss of Containment (condensate)	
ALARP decision context and justification	ALARP Decision Context: Type B Operations of wells, pipeline and subsea infrastructure have been ongoing within the Otway Offshore Development for over a decade with no major incident. Operations are highly regulated with associated control measures, well understood, and are implemented across the offshore industry. During stakeholder engagement, no concerns were raised regarding the acceptability of impacts from these LOC events. However, a LOC incident would likely attract public and media interest. Consequently, Beach believes that ALARP Decision Context B should be applied.
Adopted Control Measures	**Source of good practice control measures**
Preventative	
CM#8: Ongoing consultation	Under the *Navigation Act 2012*, the Australian Hydrographic Office (AHO) are responsible for maintaining and disseminating hydrographic and other nautical information and nautical publications such as Notices to Mariners. AMSA also issue radio-navigation warnings. Relevant details in relation to the operations will be provided to the AHO and AMSA and to relevant stakeholders as required. See Section 9.8 (Ongoing Stakeholder Consultation).
CM#9: Permanent Petroleum Safety Zone (PSZ)	PSZs, administrated by NOPSEMA under the OPGGS Act, are specified areas surrounding petroleum wells, structures or equipment which vessels or classes of vessel are prohibited from entering or being present in. Otway Pipeline System and Thylacine-A Wellhead Platform and Geographe subsea infrastructure PSZs are clearly marked on navigational charts
CM#3: Marking of Man-Made Offshore Structures	Lighting on the Thylacine-A Wellhead Platform meets Sections 2.1 and 2.2 of the Recommendation O-139 on The Marking of Man-Made Offshore Structures (IALA, Ed 2, 2013).
CM#30: NOPSEMA accepted WOMP	Part 5 of the Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011 set out the requirements for WOMPs. All production and suspended wells covered by this EP have a WOMP detailing • identify the risks to well integrity. • describe how the risks are controlled. • describe the management system in place to ensure the controls are effectively and consistently applied. • describe the design, construction, operations, management and monitoring of the wells showing how risks to well integrity is reduced to ALARP.
CM#23 NOPSEMA accepted Safety Case	Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009 set out the requirements for safety cases. The Thylacine-A Platform and Otway Pipeline System Safety Cases demonstrate how the risks to the integrity of the platform, pipeline and Geographe subsea facilities will be reduced to as low as reasonably practicable (ALARP). The safety cases: • identify the hazards and risks. • describe how the hazards and risks are controlled.

	• describe the management system in place to ensure the controls are effectively and consistently applied. • describe the operation, monitoring, inspection and maintenance of the platform, pipeline and Geographe subsea facilities. • Describe the leak detection, and emergency shutdown and isolations systems to reduce the extent of loss of containment of hydrocarbons in the event of a loss of containment of the platform, pipeline or Geographe subsea facilities.
Response	
CM#30: NOPSEMA accepted WOMP	Part 5 of the Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011 set out the requirements for WOMPs. All production and suspended wells covered by this EP have a WOMP detailing • identify the risks to well integrity. • describe how the risks are controlled. • describe the management system in place to ensure the controls are effectively and consistently applied. • describe the design, construction, operations, management and monitoring of the wells showing how risks to well integrity is reduced to ALARP.
CM#31: Source Control Contingency Plan (SCCP) and Relief Well Plan (RWP)	Emergency response capability to implement timely source control in the case of a loss of well integrity is maintained in accordance with well-specific SCCP. Beach SCCPs are consistent with International Oil and Gas Producers (IOGP) Report 594 - Subsea Well Source Control Emergency Response Planning Guide for Subsea Wells (January 2019). Specifically detailing: • the structure and function of the Beach Source Controls Incident Management Team (IMT). • a timeline for the effective implementation of source control key events / actions. • a well-specific worst-case discharge analysis. • casing design. • structural integrity analysis. • gas plume study. Beach relief well plans are developed in accordance with Beach Energy WECS Standard 21 – Source Control Contingency Plan (INT-1000-DRL-STD-17891671) and the Oil & Gas UK Guidelines on Relief Well Planning for Offshore Wells (the OGUK guidelines). Relief well plan ensures that Beach has considered the response requirements in order to: • reduce the time required to initiate relief well drilling operations in the event of a LOC. • allow the relief well to be completed in the shortest time practicable. Relief well plans include a detailed schedule with estimated times to: • source, mobilise and position a MODU. • drill and intercept the well. • complete the well kill successfully.

CM#32: NOPSEMA accepted OPEP	Under the OPGGS(E)R, NOPSEMA require that the petroleum activity have an accepted Oil Pollution Emergency Plan (OPEP) in place before the activity commences. In the event of a LOC, the OPEP will be implemented. The Offshore Victoria – Otway Basin OPEP was developed to support all Beach activities within the Otway Basin and includes response arrangements for a worst-case LOC scenario from a development well. The OPEP also includes Tactical Response Plans (TRPs) for identified protection priority areas within the region.
CM#33: NOPSEMA accepted OSMP	Under the OPGGS(E)R NOPSEMA require that the Implementation Strategy of the Environment Plan provides for monitoring of an oil pollution emergency. The Beach OSMP details: • operational monitoring to inform response planning; and • scientific monitoring to inform the extent of impacts from hydrocarbon exposure and potential remediation requirements.

Additional controls assessed

Control	Control type	Cost/benefit analysis	Control implemented?
Preventative			
Do not undertake production activities	Elimination	Production of fields in the Otway Basin is required to maintain gas supply to the Otway Gas Plant.	No
Source control			
MODU on standby	Equipment	Any MODU on standby would require an in-force Safety Case to operate in Australian Commonwealth waters. The key benefit would be a reduction in the overall shoreline loading from weathered, residual fractions of the condensate. The predicted maximum length of shoreline potentially impacted by moderate thresholds of hydrocarbon is between 4-8 km, with the average predicted being between 2-4 km. There is no predicted shoreline exposure at high thresholds. Having a MODU on standby would potentially halve the time to implement source control, therefore, the overall potential reduction in exposure to shorelines may halve. Halving the potential loading at a moderate threshold would produce a marginal overall environment benefit given the nature of weathered condensate. Having a MODU on standby would result in significant additional costs (approx. $800k / day) to Beach that that are considered grossly disproportionate to the level of environmental benefit gained given the relatively small level of potential shoreline oiling.	No
Capping Stack System (CCS)	Equipment	Well CCS is designed to stem the hydrocarbon flow prior to permanent plugging of the well. As detailed in Table 7-28: Response option feasibility, effectiveness, ALARP identified risks and capability needs analysis, Beach undertook a feasibility review of CCS for the Otway wells. The feasibility analysis combined with a review of the Otway Basin metocean conditions has confirmed that due to the technical complexity of deploying a capping stack in shallow waters with a gas	No

		plume environment and harsh metocean conditions, a relief well is the preferred means of primary source control for the development wells.	
Dispersant application	Equipment	Chemical dispersants are generally ineffective for gas-condensate hydrocarbon releases. However, dispersants may be effective to reduce VOCs at surface to below lower explosive limits. Given the installation of a capping stack is not a feasible response option for the production or suspended wells, and a relief well would be offset to the release location, there is no potential benefit with applying subsea dispersants.	No

Consequence rating	Serious (3)
Likelihood of occurrence	Remote (1) (7.2 x 10^{-5} per producing well based upon producing gas wells operated to North Sea Standard) ref IOGP Risk Assessment Data Directory Blowout Frequencies September 2019: https://www.iogp.org/bookstore/product/risk-assessment-data-directory-blowout-frequencies/
Residual risk	Low
Acceptability assessment	
To meet the principles of ESD	The risk of a loss of containment from a well or pipeline was assessed as low and the highest consequence assessed as serious as there is the potential to result in serious or irreversible environmental damage. However, this is assessed as acceptable based on: • There is little uncertainty associated with this aspect as the activities are well known, the cause pathways are well known, and activities are well regulated and managed. • The implementation of controls make it a remote likelihood that a LOC would occur resulting in a low residual risk. • The actual area of exposure for an individual spill event will be relatively small, with exposure shown to be transient and temporary due to the influence of waves, currents and weathering processes, thus no irreversible environmental damage is predicted. • It is not considered that there is significant scientific uncertainty associated with this risk. Therefore, the precautionary principle has not been applied.
Internal context	The proposed management of the risk is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the Implementation Strategy (Section 8).
External context	No objections or claims have been raised during stakeholder consultation regarding the potential for a LOC incident
Other requirements	• Operations and integrity of wells, pipeline and subsea equipment is managed as per the requirements of the EP, safety cases and WOMPs required under the OPGGS(E)R and Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations and Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011, respectively. • The South-east Commonwealth Marine Reserves Network Management Plan 2013-23 (Director of National Parks, 2013) identifies oil pollution associated with shipping, other vessels and offshore mining operations as a pressure or source of pressure on the conservation values of the South-east Marine Reserves Network. No AMPs are predicted to be exposed to surface or high (instantaneous) thresholds for dissolved or entrained hydrocarbons. Only the Apollo AMP is predicted to be exposed to moderate (instantaneous) thresholds of in-water hydrocarbons (up to 30% summer and 39% winter for dissolved; and up to 50% and 48% winter for entrained). Impacts to Apollo AMP major conservation values for fauna (blue, fin, sei and humpback whales, black-browed and shy albatross, Australasian gannet, short-tailed shearwater, and crested tern) are assessed as short-term and recoverable based on the majority of the

	condensate will evaporate readily when on the water surface, with a minimal amount of persistent components to remain on the water surface over time (RPS 2019). Impacts to Apollo AMP major conservation values for ecosystems, habitats, communities and cultural and heritage sites are not predicted as in-water hydrocarbons are only predicted within 0 – 30 m of the water column which does not intersect with these values. • The following Conservation Advices / Recovery Plans identify pollution as a key threat: ◦ Conservation Advice *Balaenoptera borealis* (sei whale) (TSSC 2015g) ◦ Conservation Advice *Balaenoptera physalus* (fin whale) (TSSC 2015f) ◦ Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b), identified as acute chemical discharge (oil pollution) ◦ Conservation Advice *Calidris ferruginea* (curlew sandpiper) (DoE, 2015f) identified as Habitat degradation/ modification (oil pollution) ◦ National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPC 2011a) ◦ Conservation Advice for *Sterna nereis nereis* (fairy tern) (DSEWPC, 2011c) • The following Conservation Advices / Recovery Plans identify habitats degradation/modification or deterioration of water quality as threat, which may be consequence of accidental release of hydrocarbon: ◦ Conservation Advice *Calidris canutus* (red knot) (TSSC 2016d) ◦ Conservation Advice *Limosa lapponica baueri* (bar-tailed godwit (western Alaskan)) (TSSC 2016a) ◦ Conservation Advice for *Numenius madagascariensis* (eastern curlew) (DoE 2015e) ◦ Draft National Recovery Plan for the Australian Painted Snipe (Commonwealth of Australia, 2019e) • These conservation advices and recovery plan identify the following conservation actions: ◦ Minimise chemical and terrestrial discharge. Controls have been identified and will be implemented to minimise the risk of minimise chemical discharges. ◦ Ensure spill risk strategies and response programs include management for turtles and their habitats, particularly in reference to ‘slow to recover habitats’, e.g. nesting habitat, seagrass meadows or coral reefs. No habitats for turtles are identified within the LOC spill EMBA. OPEP and OSMP cover management of response to oiled turtles. ◦ Ensure appropriate oil-spill contingency plans are in place for the subspecies’ breeding sites which are vulnerable to oil spills. OPEP and OSMP cover response strategies for management breeding sites vulnerable to oil spills. ◦ Implement measures to reduce adverse impacts of habitat degradation and/or modification. Controls have been identified and will be implemented to reduce adverse impacts of habitat degradation and/or modification.
Monitoring and reporting	Loss of containment resulting in a condensate spill is required to be reported as per Section 8.10. Impacts as a result of a loss of containment resulting in a condensate spill will be monitored and reported in accordance with the OSMP.
Acceptability outcome	**Acceptable**

7.17 Oil spill response

This section presents the risk assessment for oil spill response options as required by the OPGGS(E)R and OPGGS Regulations (Vic).

7.17.1 Response option selection

Not all response options and tactics are appropriate for every oil spill. Different oil types, spill locations, and volumes require different response options and tactics, or a combination of response options and tactics, to form an effective response strategy.

Table 7-28 provides an assessment of the available oil spill response options, their suitability to the potential spill scenarios and their recommended adoption for the identified events.

7.17.2 Hazards

The following activities have been identified for responding to a spill event:

- mobilisation, use and demobilisation of spill response personnel, plant and equipment; and
- handling, treatment and/or relocation of affected fauna (oiled wildlife response).

Response option feasibility, effectiveness, capability needs analysis and capability assessment is detailed in Table 7-28.

Table 7-28: Response option feasibility, effectiveness, ALARP identified risks and capability needs analysis

Response Option	Response Description	Hydrocarbon Type	Feasibility, Effectiveness & ALARP Analysis	Net Environmental Benefit	Capability Needs Analysis (See OPEP and OSMP for details)	Capability Assessment
Monitor and Evaluate	Visual – aerial & vessel Satellite Predictive modelling	Gas condensate	Feasible. Effective – Gas condensate expected to spread to a thin layers on the sea surface within 1 km of the release location. Monitoring used to inform both response planning and monitoring requirements. Hydrocarbons likely visible on sea surface for duration of LOC event. Visual and satellite operational monitoring implemented during LOC event. Scientific monitoring implemented to inform extent of impact and remediation requirements. Aerial surveillance is considered more effective than vessel to inform spill response and identify if oil has contacted shoreline or wildlife. Vessel surveillance limited in effectiveness in determining spread of oil. All feasible monitoring techniques have been applied and monitoring personnel and equipment are readily available for deployment. No further benefit gained by having additional monitoring capability. OSMP details the vessels and personnel to implement the appropriate scientific studies.	Yes	Actionable on-water hydrocarbon thresholds limited to immediate vicinity of well site. Up to 8 km of coastline subject to moderate oiling. 1 x plane & observer required and/or 1 x vessel & observer and / or 5 x vessels and OSMP study teams Remote oil spill trajectory modelling (OSTM)	As detailed in OPEP: • fixed wing contract in place • aerial observers available via AMOSC • vessel contract in place • OSTM contract in place and available via AMOSC • environmental monitoring consultants accessible Implement response as per OPEP and under direction of the State Control Agency (if in State waters) Capability in place and sufficient to implement timely response.
	Visual – aerial and vessel	MDO	Effective - MDO rapidly spreads to thin layers on surface waters. Monitoring used to inform both response planning and monitoring requirements. Aerial surveillance is considered more effective than vessel to inform spill response and identify if oil has contacted shoreline or wildlife. Vessel surveillance limited in effectiveness in determining spread of oil. Scientific monitoring implemented to inform extent of impact and remediation requirements. Both vessel and aerial monitoring capability in place. Trained aerial observers available via AMOSC Core Group and available for deployment. Vessel and aircraft contracts in place. No further benefit gained by having additional monitoring capability.	Yes		
Source Control	Relief well	Gas condensate	Due to the remote location of the Otway Basin, available MODU are monitored on a monthly basis throughout operations thus ensuring the mobilisation of a MODU remains feasible within the assumed timeframe of approximately 35 days (the largest time component of the relief well kill). The ongoing assessment of MODU availability shall be conducted with reference to: • MODU with a valid Australian Safety Case. • MODU with the ability to conduct relief well kill operations. • MODU ability to operate in shallow water. • proximity to the Otway Basin. • ability to engage in a mutual aid agreement with the Operator. MODU broker reports shall be used to monitor the MODU market on a monthly basis and, if required, assist in sourcing and contracting a suitable MODU: • The MODU broker can be contracted to identify and contract a suitably specified MODU (including Australian Safety Case status) within 14 days. This allows sufficient time to engage with other operators as well as drilling contractors to confirm availability of MODUs with suitable technical specifications to meet the required engineering well design. • To facilitate timely response, Beach is a signatory to the APPEA Memorandum of Understanding: Mutual Assistance for transfer of MODUs between operators in the case of an Emergency. A MODU that is not currently operating, or in transit to the next operating well, will be preferential and result in a reduced period from the 14 days	Yes	MODU – with Australian Safety Case Casing, drill pipe and consumables identified 3 x Support vessels Well control personnel as detailed in SCCP	As detailed in OPEP, SCCP and relief well plan: • access to MODU via APPEA MoU • contracts with Well Control Specialists • relief well mobilisation strategy and schedule • Source Control IMT Implement response as per OPEP, SCCP and relief well plan Capability in place and sufficient to implement timely response

Response Option	Response Description	Hydrocarbon Type	Feasibility, Effectiveness & ALARP Analysis	Net Environmental Benefit	Capability Needs Analysis (See OPEP and OSMP for details)	Capability Assessment
			allowed for engaging and selecting suitable MODUs. The full 14 days will be required where there are no suitable MODUs not currently in operation and the selected MODU will be required to safely suspend well operations on its existing well prior to commencing of mobilisation to Beach's location. • A MODU mobilised from the NW 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. • Rating of well control equipment: MODUs considered shall have equipment rated to at least 10,000 psi to perform the required well kill. • Pump capacity of MODU: Suitable to execute the dynamic well kill as per modelling. • Water depth: MODU being considered for relief well drilling must be rated for the minimum water depth of 70 m-100 m. Source control planning has identified all reasonable controls to implement relief well in a timely manner. Beach considers the potential environmental benefit gained by having a pre-positioned alternate MODU on location to be grossly disproportionate given the high financial and logistical support cost associated with having a MODU on standby. All reasonable pre-planning has been undertaken to facilitate the timely initiation of a relief well if required.			
	Capping stack system (CSS)	Gas condensate	To assess the feasibility of CSS deployment Beach engaged Trendsetter Engineering, as the OEM manufacturer of capping stacks, to review various capping stack options for the Otway Basin. The challenge with the Otway Basin is the shallow water (71 m – 101 m) were the production and suspended wells are located and the prevailing metocean conditions of the Otway Basin. The feasibility analyses are detailed in the following two studies: • Beach Energy Capping Stack Shallow Water Feasibility Assessment • GER-9002748_BE CS Non-Vertical Study The assessment focused on gaining a thorough understanding of the issues faced with shallow water deployment of a CSS in a shallow water, gas blowout well environment (such as a development well within the Otway Basin). Trendsetter reviewed available concepts promoted within industry and selected the two most viable deployment concepts for further evaluation with the various CSS. Two alternative offset installation (non-vertical access) methods were applied to four different CSS identified by Beach for potential use on a typical shallow water subsea blowout gas well. The two offset installation methods were: 1. Delmar offset installation method 2. Trendsetter offset installation method The methods are further summarised below. The feasibility analysis combined with a review of the Otway Basin metocean conditions has confirmed that due to the technical complexity of deploying a capping stack in shallow waters with a gas plume environment and harsh metocean conditions, a relief well is the preferred means of primary source control for the development and suspended wells. **Delmar Offset Installation Method** After the review of Delmar offset installation report of the capping stack, one major observation or assumption identified from Delmar's primary installation method was the requirement that the subsea blowout wellhead was left clear, with BOP stack removed previously or not installed at all, so that Delmar's subsea wellhead winches could be established for drawdown operations. For the Delmar method the subsea winch is the primary installation method, with the mudmat winch the secondary drawdown method. The positioning of the capping stack is solely dependent on the use of the drawdown winches.	N/A	N/A	N/A

Response Option	Response Description	Hydrocarbon Type	Feasibility, Effectiveness & ALARP Analysis	Net Environmental Benefit	Capability Needs Analysis (See OPEP and OSMP for details)	Capability Assessment
			The subsea hook up would need to be made with vessel support from outside the plume diameter, with adequate safety margin, estimated to be at least 335 m. Furthermore, with the Delmar method the vertical control is fully dependent on the positive buoyancy of the system, and successful deployment relies heavily on the precisely calculated buoyancy force of the chained buoys, with only minimum control or adjustable measures to compensate the required vertical lifting of the payloads. If the gas plume impact forecast to the buoys is not within the assumed design, then the buoyancy performance will be outside the calculated parameter range. The main disadvantages that impact the successful installation of the CSS using the Delmar method are thus summarised as: • dependent on success of BOP stack removal and installation of subsea winches. With a less heavy 7" 15,000 psi capping stack (Boots and Coots) the subsea drawdown becomes even more critical to success compared to a 18-5/8" 15,000 psi capping stack (OSRL and WWCI). • increased time for subsea installation of winches, mudmat installations. • gas plume impact on buoyancy modules needs to be well estimated given vertical control for deployment is dependent purely on the positive buoyancy of the system. • complexity of deployment with gas plume and the local metocean conditions makes deployment not operationally suitable. **Trendsetter Offset Installation Method** The Trendsetter method relies on a series of chained oceangoing barges to assist in lifting and deployment of the CSS and BOP adaptor spool. The barges are used to assist positioning and ensure the anchor handling vessel is maintained in a safe zone away from the gas plume. In addition, two subsea winches, may be deployed on clump weights on the seabed approximately 30 m from the wellhead and used for lowering and guidance of the capping stack over the damaged well. In general, the subsea drawdown system would be recommended with a less heavy 7" 15,000 psi capping stack (Boots and Coots) and also to assist with successful guidance of the CSS assembly. Unlike the Delmar method that uses buoyancy modules, these are not required for the Trendsetter method. Furthermore, the use of the drawdown capability is dependent on the wet weight of the stack and the up-thrust forces from the blowout well. The Trendsetter method does require additional vessels available, and also the successful deployment would be limited in the Otway Basin due to the weather and metocean conditions. The main disadvantages that impact the successful installation of the CSS using the Trendsetter method are thus summarised as: • Gas plume impact on oceangoing barges in exclusion zone above blowout well can impact success of the deployment. • Increased tie for subsea installation of winches, likely recommended to ensure successful guidance of the CSS assembly. With a less heavy 7" 15,000 psi capping stack (Boots and Coots) the subsea drawdown becomes even more critical to success compared to a 18-5/8" 15,000 psi capping stack (OSRL and WWCI). • Complexity of deployment with gas plume and the local metocean conditions makes deployment not operationally suitable. **Summary** Rough sea states (as per prevailing in the Otway Basin), including high waves and longer wave periods, can affect the safe operating limits of CSS deployment. The sea state can negatively impact the ability to safety deploy capping stack using a deck crane or A-frame located on the stern of the deployment vessel. Furthermore, if the vessel is experiencing too			

Response Option	Response Description	Hydrocarbon Type	Feasibility, Effectiveness & ALARP Analysis	Net Environmental Benefit	Capability Needs Analysis (See OPEP and OSMP for details)	Capability Assessment
			much heave due to wave action, the CSS could unintentionally hit the subsea wellhead during deployment causing damage to the equipment itself and to the wellhead. High winds can affect both relief well drilling operations and support vessel operations. Support vessels have wind ratings for routine and critical operations, above which, operations may be suspended, and high wind speeds will tend to increase wave heights in open water conditions which can further limit operations. Thus, defined operating limits of acceptable sea states are required for successful deployment of the equipment in adverse sea state environments such as the Otway Basin. The feasibility analysis confirmed a sea state limit of 2 m significant wave height (Hs) and 15 knots (27.8 km/h) winds for defining these limits. The Otway Basin is a predominant moderate to high wave energy environment with wave heights in the summer months average between 2.5 and 3.0 m (8.20 and 9.84 ft), and maximum heights range between 5.6 and 7.7 m (18.4 and 23.0 ft). Wave conditions are more severe in winter, when mean heights range from 3.1 to 3.7 m (10.2 to 12.1 ft) and maximum heights are between 7.6 and 10.3 m (25.0 to 33.8 ft), but all seasons show a relatively high level of wave activity. Winds in the eastern Otway and western Bass Strait area also are generally strong, exceeding 13 knots (more than 23.4 km/h) for 50% of the time. The conditions are thus not operationally suitable for deployment of the CSS. Furthermore, the gas plume environment in shallow water conditions is manifestly different to a deeper water environment due to the exclusion zone above the wellhead preventing vertical installation of the equipment. The feasibility analysis has confirmed that due to the technical complexity of deploying a CSS in shallow waters with a gas plume environment and harsh metocean conditions the use of a capping stack is not operationally suitable for Beach wells within the Otway Basin. Additionally, given the use of a CSS is not operationally suitable for the development wells, the debris clearance tooling as part of the SFRT is not required.			
	Right stricken vessel Transfer MDO to secure tank	MDO	Effective – primary response strategy for all spills in accordance with vessel SMPEP/SOPEP. For MDO source control in Commonwealth waters, AMSA is the Control Agency and has access to NatPlan resources, therefore no further controls are considered. For MDO source control in Victorian state waters, Department of Jobs, Precincts and Regions (DJPR) is the Control Agency. Upon establishment of incident control by DJPR, Beach shall continue to provide planning and resources as required by the EMT Leader. Beach will make available to DJPR an Emergency Management Liaison Officer (EMLO) who can mobilise to the incident control centre. Equipment within the respective port region will be utilised as per the Maritime Emergencies (NSR) Plan through Vic DJPR Emergency Management Branch (EMB). In the event of a cross-jurisdictional response (i.e. where a response is required in State and Commonwealth waters), Beach and DJPR will establish a Joint Strategic Coordination Committee (as per the DJPR guidance) to facilitate effective co-ordination between DJPR and AMSA.	Yes	Contract vessels	Vessel contract in place Capability available at request of AMSA as Control Agency
	Shut-down of production pipeline	Gas condensate	Effective – primary response strategy for all spills resulting from loss of containment from the Otway Pipeline System System pressures are monitored via the distributed control system (DCS) onshore, and the platform and pipeline can be shut down via the DCS or emergency shut down (ESD) can be implemented from the Central Control Room at the Otway Gas Plant.	Yes	None required – remote ESD	None required
Offshore Containment and Recovery	Booms and skimmers	Gas condensate	Not feasible. Actionable surface thickness of 10 g/m^2 is expected in the vicinity of the release location (<1 km) for both seasons and within a response exclusion zone in the event of a LOC scenario.	N/A	N/A	N/A

Response Option	Response Description	Hydrocarbon Type	Feasibility, Effectiveness & ALARP Analysis	Net Environmental Benefit	Capability Needs Analysis (See OPEP and OSMP for details)	Capability Assessment
		MDO	Not feasible. MDO spreads rapidly to less than 10 g/m² and suitable thicknesses for recovery are only present for the first 36 hours for a large offshore spill, and there is insufficient mobilisation time to capture residues. In general, this method only recovers approximately 10-15% of total spill residue, creates significant levels of waste, requires significant manpower and suitable weather conditions (calm) to be deployed.			
Protection and Deflection	Booms and skimmer	Gas condensate	Potentially feasible. Partially effective. The maximum length of actionable shoreline oil is approximately 8 km with initial shoreline contact predicted to occur within 3 days of the release with a maximum loading of 33 m³ predicted. If operational monitoring indicates shorelines are potentially exposed to actionable levels of hydrocarbons and accessible to response personnel and equipment, protection and deflection may be an effective technique for reducing shoreline loadings. Given Beach have access to both AMOSC equipment and Core Group personnel available for timely deployment as per Tactical Response Plans, no further controls have been identified.	Subject to operational NEBA	Response personnel Booms & skimmers Waste facilities	As detailed in OPEP: • Core responders and equipment available via AMOSC • NRT and NRST available via Control Agency request under NatPlan. • Environmental monitoring providers accessible • Waste contracts in place Tactical Response Plans developed for: • Aire River; • Princetown; • Port Campbell Bay; and • Curdies Inlet Implement response as per OPEP and under direction of the State Control Agency Capability in place and sufficient to implement timely response
		MDO	Potentially feasible. MDO spreads rapidly to less than 10 µm and suitable thicknesses for recovery are only present for the first ~ 36 hours for a worst-case spill. There may be insufficient mobilisation time to capture residues prior to hydrocarbons reaching the shore. In addition, corralling of surface hydrocarbons close to shore may not be effective for MDO depending on sea surface conditions. However, if operational monitoring indicates river mouths and inlets are potentially exposed to actionable levels of hydrocarbons and accessible to response personnel and equipment, protection and deflection may be an effective technique for reducing oil within these inland water ways.	Subject to operational NEBA	Response personnel Booms & skimmers Waste facilities	
Shoreline Clean-up	The active removal and/or treatment of oiled sand and debris	Gas condensate	Feasible. Unlikely to be effective in coastal environments of Cape Otway West. The maximum length of actionable shoreline oil is approximately 8 km with initial shoreline contact predicted to occur within 3 days of the release with a maximum loading of 33 m³ predicted. If operational monitoring indicates shorelines are potentially exposed to actionable levels of hydrocarbons and accessible to response personnel and equipment, protection and deflection may be an effective technique for reducing shoreline loadings. The nature of condensate means that it is difficult to collect from shorelines and can easily be mobilised into lower layers of sand or saltmarsh as may be case in Cape Otway West. Given Beach have access to both AMOSC equipment and Core Group personnel available for timely deployment as per Tactical Response Plans, no further controls have been identified.	Subject to operational Net Environmental Benefit Analysis (NEBA) – unlikely to present net benefit	Based up a clean-up rate of 1 m³ per day per person, a single clean-up team (10 persons) could clean 10 m³ / day. Based on a waste generation (bulking) factor of 10:1, waste clean-up and recovery could take up to 1 month for a team of 10 people. This assumes that all 33 m³ of stranded hydrocarbon is both accessible and retrievable. In reality, the total retrievable volume (if any) would be smaller.	As detailed in OPEP: • Core Group responders and equipment available via AMOSC • NRT and NRST available via Control Agency request under NatPlan. • Waste contracts in place Tactical Response Plans developed for: • Aire River; • Princetown; • Port Campbell Bay; and • Curdies Inlet Implement response as per OPEP and under direction of the State Control Agency Capability in place and sufficient to implement timely response
		MDO	Feasible. May be effective at reducing shoreline loading where access to the shoreline is possible. If operational monitoring indicates shorelines are potentially exposed to actionable levels of hydrocarbons and accessible to response personnel and equipment, protection and deflection may be an effective technique for reducing shoreline loadings.			
Oiled Wildlife Response (OWR)	Capture, cleaning and rehabilitation of oiled wildlife.	Gas condensate	Feasible. Effective. At the conservative environmental impact threshold (10 g/m²) the predicted exposure is limited to the vicinity of the release location (up to 12 km for diesel and 4 km for condensate). No exposure is predicted at the high threshold (25 g/m²). It is unlikely that wildlife would be oiled within the offshore environment, but some oiling of wildlife may occur along the maximum predicted 8 km length of coast exposed to moderate loading thresholds.	Yes	Personnel Equipment Triage and waste facilities	As detailed in OPEP: • Core Group responders and equipment available via AMOSC • NRT and NRST available via Control Agency request under NatPlan.

Response Option	Response Description	Hydrocarbon Type	Feasibility, Effectiveness & ALARP Analysis	Net Environmental Benefit	Capability Needs Analysis (See OPEP and OSMP for details)	Capability Assessment
		MDO	Feasible. Effective. Unlikely to require shoreline oiled wildlife response given no predicted shoreline loading. Potential that individual birds could become oiled in the offshore environment.			DELWP are the State agency responsible for responding to wildlife affected by a marine pollution emergency in Victorian waters. DELWP's response to oiled wildlife is undertaken in accordance with the Victorian Wildlife Response Plan for Marine Pollution Emergencies. The Tasmanian Oiled Wildlife Response Plan (WildPlan) is administered by the Resource Management and Conservation Division of the DPIPWE. If an incident occurs in Commonwealth waters which affects wildlife, AMSA may request support from DELWP or DPIPWE to assess and lead a response if required. Both DELWP & DPIPWE have a number of first strike kits as well as access to AMOSC oiled wildlife equipment. Capability in place and sufficient to implement timely response
Chemical Dispersant Application	Application of chemical dispersants either surface or subsea	Gas condensate	Feasible. Not recommended for Group I oils such as condensate due to the very low viscosity and high volatility – generally no environmental benefit gained by the application of dispersant on Group I oils. Subsea dispersant injection (SSDI) may reduce volatile organic compounds (VOCs) at sea surface within the response area, therefore creating a safer work environment for responders. Given the use of a CSS is not operationally suitable for the development wells, the application of chemical dispersants to reduce surface VOC's is not required.	No	N/A	N/A
		MDO	Feasible. Although "conditional" for Group II oil, the size of potential spill volume and the natural tendency of spreading into very thin films is evidence that dispersant application will be an ineffective response. The dispersant droplets will penetrate through the thin oil layer and cause 'herding' of the oil which creates areas of clear water and should not be mistaken for successful dispersion (see ITOPF – Technical Information Paper No. 4: The Use of Chemical Dispersants to Treat Oil Spills).	No	N/A	N/A

7.17.3 Relief Well Drilling

In the event of a loss of well containment, the Otway and Bass Relief Well Plan (RWP) (T-5100-35-MP-005) will be implemented. This involves mobilising a MODU to site and drilling a deviated well to kill the well in question. This process is described in the RWP.

A relief well is typically drilled as a straight hole down to a planned kick-off point, where it is turned toward the target well using directional drilling technology and tools to get within 30-60 m of the original well. The aim is to align the two wellbores at an incident angle of 3-5° for the eventual intersect rather than aiming directly at the blowout wellbore. The drilling assembly is then pulled and a magnetic proximity ranging tool is run on wireline to determine relative distance and bearing from the target well. Directional drilling continues to about half the distance to the planned intersection, and another magnetic ranging run is made to update relative distance and bearing. Once the target well is penetrated, dynamic kill commences by pumping mud and/or cement downhole to seal the original well bore.

7.17.3.1 Capability Assessment

Beach has put in place the following capabilities to implement a relief well drilling activity:

- The use of qualified and experienced offshore drilling engineers and drilling superintendents to implement source control including a relief well. The Beach Wells Team has competent well engineers that would project manage the relief well in conjunction with Wild Well Control and be guided by the Beach Well Engineering & Construction Management System Standard (WECS) workflow and technical standards.
- Access to a MODU through either:
    - The APPEA MoU.
    - A MODU broker (with monthly reports provided).
- Contracts with world-renowned well control contractors (Wild Well Control and Cudd Well Control) for the provision of specialist personnel and equipment.
- An EMT and Source Controls IMT (and associated plans) that is trained and undertakes regular drills and exercises to maintain a state of preparedness.
- A RWP that outlines a kill well design, MODU mobilisation times and technical considerations that has been prepared in line with international standards.

7.17.3.2 Known and potential environmental impacts

Known and potential environmental risks from mobilising and drilling of a relief well include:

- Localised and temporary impacts to marine users and fishing due to physical presence of the MODU (similar to those described and assessed in Section 7.1);
- Localised and temporary disturbance to marine fauna due to increased light, atmospheric and noise emissions (similar to those described and assessed in Sections 7.3, 7.4 and 7.5);

- Localised and temporary impacts to water quality due to increased nutrient and turbidity levels from discharge of putrescible wastes, sewage and grey water, cooling and brine water and bilge water/deck drainage (similar to those described and assessed in Sections 7.7, 7.8, 7.9 and 7.10);
- Localised and temporary impacts to water quality and the benthic environment due to the discharge of drill muds, cuttings and cement;
- Localised and temporary disturbance to the benthic environment due to MODU anchoring; and
- Impacts associated with the introduction of IMS (Section 7.13).

7.17.3.3Consequence Evaluation

Beach's Otway Development Drilling and Well Abandonment EP (CDN/ID S4100AH717905) describes and assesses the impacts and risks associated with drilling activities, and they are therefore not repeated here in their entirety. A brief assessment of the key impacts and risks associated with drilling a relief well are presented here (Refer to Otway Development Drilling and Well Abandonment EP - NOPSEMA website at https://info.nopsema.gov.au/environmentplans/469/showpublic).

<u>Physical presence</u>

The physical placement of a MODU will result in physical disturbance of the sea floor. This impact would result in localised physical disturbance to benthic habitats. Surveys of previous seabed disturbances from drilling activities of the Victorian coast Basin indicate that recovery of benthic fauna in soft sediment substrates occurs within 6 to 12 months of cessation of drilling (Currie, 2004).

A safety exclusion zone would be required around the MODU, which has potential to impact fisheries and shipping activities. Such impacts are not likely to be any greater than those discussed for the Thylacine-A Wellhead Platform which are assessed as Minor (1). No significant additional impacts on fishing or maritime activities are expected to result from relief well drilling activities.

<u>Routine emissions - light, air and noise</u>

Lights are required for safe operation and navigational safety of a MODU, with visibility considered one of the key controls in place to prevent collisions with third-party vessels. The impacts of lighting will be similar to those from the platform and vessels, which are addressed in Section 7.2 and determined to have a Minor (1) impact.

Air emissions associated with drilling relate to the combustion of MDO on the MODU and in support vessels. As with the impacts assessed in Section 7.3, these are considered to have a Minor (1) environmental impact.

The noise emitted from a MODU consists of a combination of down-hole drill pipe operations including conductor driving and onboard machinery. This typically produces a low intensity but continuous sound for the duration of the drilling activity. The primary concern arising from noise generation from drilling is the potential effect on marine fauna. Impacts on marine fauna from noise from vessels and operations is addressed in Section 0 of this EP. The noise generated from a MODU is unlikely to result in significant physiological or behavioural impacts when considered individually or cumulatively with existing noise sources. It is expected that any impacts on marine fauna will be limited to behavioural changes of individuals close to the location and will not result in effects at a species population or ecosystem level. The impacts of sound from the MODU are similar to those of vessels and as outlined in Section 0, these impacts are considered Minor (1).

<u>Routine discharges – putrescible waste, sewage and grey water, cooling and brine water, bilge water/deck drainage</u>

Routine discharges from a MODU are very similar to those as described for vessels and assessed in Sections 7.8 of this EP.

The key difference is that a MODU contains more POB (typically about 100 people), so there is an increased volume of putrescible and sewage and grey water discharges (though for a short time only). As with the routine discharges of waste from vessels, the impacts of such discharges from a MODU are considered Minor (1).

<u>Introduction of IMS</u>

The introduction of IMS from vessels is addressed in Section 7.10 of this EP. The same issues apply to the operation of a MODU and support vessels due to ballast water discharges and hull fouling. The MODU and support vessels will be required to have relevant biosecurity certifications and be in possession of a ballast water discharge log. This risk is likely to be low to medium.

<u>Discharge of drilling muds and cuttings</u>

Drilling fluids are used to transport drilling cuttings to the surface, prevent well control issues, preserve wellbore stability, and cool and lubricate the drill bit and drill string during drilling. Drill cuttings are rock, gravel and sand removed from the well during the drilling process. The characteristics of the cuttings to be discharged can be predicted from the lithology of other wells drilled in the region and are anticipated to be dominated by calcarenite, shale and sandstone. The cuttings are expected to range in size from fine to course, with a mean size no larger than one centimetre.

The most appropriate drilling fluid for the conditions will be used for relief well drilling. It is likely that water-based muds (WBM) would be used, and the assessment of impacts provided below assumes this. Use of synthetic based muds (SBM), although unlikely, cannot be entirely discounted as it is not possible to define specific drilling requirements for all scenarios where relief well drilling may be required. All drilling products selected will have the lowest environmental risk ranking practicable based on CHARM and OCNS. It is likely that bulk discharge of muds would occur at the conclusion of a relief well drilling campaign, as per normal offshore drilling practice.

The known impacts arising from the discharge of WBM drilling fluids and cuttings are:

- Increased turbidity in the water column;
- Burial of benthic organisms; and
- Alteration of the benthic substrate.

There is a substantial amount of literature demonstrating that impacts from the discharged cuttings and muds are generally very localised (100 to 250m from the well), short-lived (less than 24 months), and concentrations of metals or hydrocarbons are generally not detectable beyond 1,000 m (Hinwood et al., 1994).

Potential impacts to water quality and benthic organisms are discussed in the following sections. Note that the volume of muds used will be minimised by use of solids control equipment to ensure maximum retention of fluids within the active mud system.

Water quality and turbidity

Disposal of cuttings with adhered fluid and bulk mud discharges during drilling operations will create plumes of increased turbidity below the point of discharge. Within this plume the larger particles (90-95%) quickly settle on the seabed, usually within a radius of 100-200 m from the MODU. Such particle behaviour has been demonstrated by Terrens et al (1998) at the Fortescue platform in eastern Bass Strait drilling locations.

The dilution of cuttings and drilling fluid plumes is rapid. Data compiled by the US Environmental Protection Agency (US EPA) from numerous studies on the growth and dilution of drilling mud discharge plumes found that the mud had been diluted by approximately one million times by the time it reached a distance of 1 km from the discharge point (USEPA 1985). Nonetheless, drilling cuttings and muds in suspension have the potential to impact components of the marine ecosystem entrained in a discharge plume. Such exposure will in most cases be short term, episodic or pulse-wise depending on plume behaviour.

Some studies have demonstrated minor adverse impacts from turbidity induced by WBM discharges on hard bottom fauna abundance (Hyland et al., 1994), scallops (Cranford et al., 1999) and the blue mussel (Bechmann et al., 2006). These studies indicate that the effect mechanism of cuttings and drilling fluid plumes is mainly physical stress, although chemical toxicity cannot unequivocally be ruled out. The levels of suspended WBM and cuttings causing effects have been above 0.5 mg/L. Such levels are typically restricted to a radius of less than 1-2 km in the water masses (Neff, 1987).

During drilling of a relief there will be an increase in turbidity the immediate area of drilling activity as a result of discharges of cuttings and muds. However, this will be a temporary effect. Tidal currents are substantial, and the interaction of surface and oceanic currents facilitates the dispersion and dilution of cuttings and muds discharged from the MODU, aiding in minimising water column turbidity.

Any reductions in primary productivity (i.e., plankton growth) in the water column as a result of discharges of cuttings and muds will be very localised in the context of the surrounding marine environment. The water depth at the Thylacine and Geographe fields is beyond the photic zone (depth of ocean that receives sufficient sunlight for photosynthesis to occur). Any shading effect of the discharge plume, therefore, will be very low.

In summary, environmental impacts of a turbid plume of cuttings and muds in the highly localised area around the MODU are expected to be Minor (1).

Burial of benthic organisms

Most offshore field studies have shown a minor impact of WBM discharges on benthic fauna except immediately adjacent to platforms where cuttings piles form and persist. Some changes in the local infaunal community structure will occur due to burial and the altered sediment character. The increased bottom micro relief afforded by the accumulation of cuttings may also attract fish and other motile animals and alter the character of epibenthic infaunal communities. Bakke et al (1986) found that fauna recolonisation on sediments capped with 10 mm of WBM cuttings differed little in overall diversity from that on natural sediment after 1 year, but the species composition was clearly different, which was thought to be due to the WBM cuttings being classified as 'very fine sand ' as opposed to the natural sediment being 'medium sand'.

Monitoring in the North Sea has not revealed any in situ effects of WBM cuttings on sediment macrofauna community structure, implying that any such effects, if present, will be confined to the innermost stations in these studies (i.e., nearer than 25-250 m from the discharge point) (various studies cited in Bakke et al., 2013).

Environmental studies undertaken at the Fortescue platform in 70 m depth in western Bass Strait showed that effects to benthic communities from discharge of cuttings and water-based fluids were generally localised and short-lived, with most benthic organisms recovering within four months (Currie et al., 2004). This study showed no detectable trace element indicators when water-based fluids alone were used.

For Apache's East Spar Development in Commonwealth Waters, the area of impact from WBM discharges was not more than 100 m from the drill site and short lived with recovery in less than 18 months (SKM, 1996; Kinhill, 1998). Other studies of the effects of WBM cuttings on sediment fauna also suggest that the impact is normally restricted to within 100-250 m and recovery is rapid (various studies cited in Bakke et al., 2013). There is therefore strong evidence to conclude that sedimentation of WBM cuttings onto the seafloor has only local and short-term effects on the sediment fauna.

In summary, impacts to benthic organisms from the discharge of muds and cuttings from drilling of a relief well are expected to be highly localised and short-term. As the seabed sediments in the Otway Basin are generally uniform and widespread, any consequences at the ecosystem level due to impacts in the highly localised area of the drilling location are expected to be Minor (1).

Discharge of cement

Cementing of a relief well is required to provide effective isolation of the well, and to abandon the well afterwards. Most cement is pumped downhole, however, a small amount of overfill and cement-contaminated mud is likely to occur during the grouting of the uppermost surface casings. No technology currently exists to prevent cement from the uppermost casing wellbores being fully cemented to surface without cement releasing onto the sea floor.

Cement discharges may result in localised, temporary increases in pH at the discharge site. Discharges on the seabed may result in smothering of benthic organisms and areas where cement is overlying sediments will not be suitable for recolonisation by benthic species. Chemicals in the cement mix may result in localised reductions in water quality at the time of the discharge.

The cement chemicals selected for any relief well drilling will be selected in accordance with the chemical selection process (described in Section 8.11.2 of this EP) in order to minimise the impact on the environment of the cement prior to setting as an inert aggregate.

7.17.4 Other Oil Spill Response activities

7.17.4.1 Known and potential environmental impacts

Impacts and risks associated with monitoring and evaluation, source control and protection and deflection response strategies (in responding to a hydrocarbon spill) are similar to those discussed for vessel and ROV operations in Section 7. This section covers detailed impact and risk evaluations for source control, oiled wildlife response, shoreline protection and clean-up and the application of chemical dispersants.

Oiled wildlife response

Untrained resources capturing and handling native fauna may cause distress, injury and death of the fauna. AMSA as the Control Agency for a vessel spill in Commonwealth waters will managed any OWR and Beach will only undertake OWR if directed by AMSA. Potential impacts are:

- injury/Mortality of fauna
- change in fauna behaviour

Shoreline protection and clean up

Sensitive/protected shoreline habitats may be degraded, or marine fauna and flora and other users of the land may be disturbed due to movement of human responders and removal of oiled material on shorelines. Potential impacts are:

- change in fauna behaviour
- injury/Mortality of fauna
- change in habitat
- changes to the functions, interests or activities of other users

7.17.4.2 Consequence evaluation

This section assesses the impacts and risks specific to OWR and shoreline clean spill response strategies.

Oiled wildlife response

OWR includes pre-emptive techniques such as hazing, capturing and relocating of un-oiled fauna as well as post-oiling techniques such cleaning and rehabilitation. Deliberate disturbance of wildlife from known areas of ecological significance (e.g. resting, feeding, breeding or nesting areas) to limit contact of individuals with hydrocarbons may result in inhibiting these species from accessing preferred habitats or food sources. This approach may also result in additional disturbance/handling stress to the affected species with little benefit as many species tend to display site fidelity and return to the location from which they have been moved.

The incorrect handling of oiled fauna has also the potential to result in increased stress levels which has may result in increased fauna mortality. Although fauna interactions from oiled wildlife response and shoreline clean-up techniques are expected to be limited to the duration of the response, there is the potential that these effects may result in longer term impacts to local populations where a large proportion of the local population may be exposed to oil and subsequently oiled wildlife response.

Oiled wildlife preparedness and response shall be undertaken in accordance with the relevant EPOs and EPSs detailed within the Offshore Victoria – Otway Basin Oil Pollution Emergency Plan (CDN/ID S4100AH717907).

Oiled wildlife surveillance and wildlife impact studies are detailed within the Offshore Victoria Operational and Scientific Monitoring Plan (CDN/ID S4100AH717908).

Shoreline protection and clean up

Damage or removal of habitat (such as sand from beaches) from shoreline protection and clean-up techniques may expose shorelines to erosion processes or decrease in fauna and flora. Damage to intertidal shoreline habitats and communities may have indirect effects on ecosystem dynamics through impacts on food chains of the macrofauna communities which they support.

Shoreline clean-up or protection actions could affect significant stretches of coastline, with prolonged effects on areas and populations located with increased response effort (such as tourism sites). The presence of accumulated hydrocarbons on shorelines as well as the presence of clean-up operations will necessitate the implementation of exclusion zones (e.g. beach closures). The exclusion of local residents and tourists from coastal areas has the potential to impact local tourism businesses and local settlements. As exclusion zones may be in place for the entire duration of the spill and beyond to account for clean-up periods once the spill has been contained, impacts to tourism and local residents may last for extended periods of time.

The movement of spill response personnel, vehicles and equipment through coastal areas has the potential to disturb or damage artefacts or sites of cultural heritage significance. Adverse effects are expected to be localised to the area of disturbance. For known recognised sites, relocation of artefacts or implementation of exclusion zones may be considered as part of the operational NEBA. There is a potential to affect the internationally significant Ramsar wetlands at localised locations. Shoreline clean up and protection will endeavour to prevent impact to the ecological characteristics of Ramsar sites.

Shoreline protection and Clean up preparedness and response shall be undertaken in accordance with the relevant EPOs and EPSs detailed within the Offshore Victoria – Otway Basin Oil Pollution Emergency Plan (CDN/ID S4100AH717907).

Hydrocarbon on shorelines and shoreline sediment impacts studies are detailed within the Offshore Victoria Operational and Scientific Monitoring Plan (CDN/ID S4100AH717908).

7.17.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: oil spill response	
ALARP decision context and justification	ALARP Decision Context: B The purpose of implementing spill response activities is to reduce the severity of impacts from an oil spill to the environment. However, if the strategies do more harm than good (i.e. they are not having a net environmental benefit) then the spill response is not ALARP.

Control measures	Source of good practice control measures		
All spill response control measures and associated Environmental Performance Outcomes (EPOs) and Environmental Performance Standards (EPSs) are detailed within the Offshore Victoria – Otway Basin Oil Pollution Emergency Plan (CDN/ID S4100AH717907).			
All relevant operational and scientific monitoring studies are detailed within the Offshore Victoria Operational and Scientific Monitoring Plan (CDN/ID S4100AH717908).			
Additional controls assessed			
Control	**Control type**	**Cost/benefit analysis**	**Control implemented?**
Monitor and evaluate: AUVs	Engineering Risk Assessment	This control measure is not expected to provide significant environmental benefit as the development wells are in close proximity to shore (54 km – 70 km), and mobilisation of in-field monitoring, or aerial surveillance may be implemented rapidly via existing contracts.	No
Monitor and evaluate: Night-time monitoring – infrared	Engineering Risk Assessment	Side looking airborne radar, systems are required to be installed on specific aircraft or vessels. The costs of sourcing such vessels/aircraft is approximately $20,000 per day. Infrared may be used to provide aerial monitoring at night-time, however the benefit is minimal given trajectory monitoring (and infield monitoring during daylight hours) will give good operational awareness. In addition to this, satellite imagery may be used at night to provide additional operational awareness.	No
OWR: Pre-positioning of oiled wildlife response resources.	Precautionary approach	Oiled wildlife response equipment containers for first strike activities are positioned in Geelong. Positioning the equipment any closer to the potential spill area is not considered to provide a considerable environmental benefit considering that any visible shoreline contact is not predicted until day 3 of the spill, therefore there is adequate time to deploy equipment positioned in Geelong. Additionally, spill modelling indicates potential (hypothetical) areas of exposure to hydrocarbons, post-spill operational monitoring would be required to predict actual or likely exposure locations, therefore determining an area to pre-position equipment may be inaccurate pre-spill.	No
Shoreline protection and clean up: Tactical Response Plans	Precautionary approach	Identified areas for priority protection have pre-populated tactical response	Yes

		plans to reduce response planning timeframes in the event of potential shoreline exposure. Refer to OPEP for TRPs. CM#32: NOPSEMA accepted Oil Pollution Emergency Plan (OPEP)	
Chemical Dispersant: Pre-positioning of dispersant and application equipment.	Precautionary approach	No clear benefit identified as stockpiles of dispersant already available in Melbourne and elsewhere in Australia. Application equipment and dispersant can be readily mobilised to site, with no identified restriction on logistics pathways or response timing.	No

Consequence rating	Moderate (2)
Residual impact category	Low
Acceptability assessment	
To meet the principles of ESD	The activities were evaluated as having the potential to result in a Moderate (2) consequence thus is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required. While some response strategies may pose additional risk to sensitive receptors, to not implement response activities may potentially result in greater negative impact to the receiving environment and a longer recovery period. Response activities will be undertaken in accordance with controls which reduce and/or prevent additional risks. The mutual interests of responding and protecting sensitive receptors from further impact due to response activities will be managed using a NEBA during response strategy planning in preparedness arrangements, as well as during a response. Proposed response activities are consistent with industry practice. No impact to KEFS, RAMSAR Wetlands, BIAs or state marine protected areas are expected during spill response.
Internal context	The proposed management of the impact is aligned with the Beach Environment Policy. Activities will be undertaken in accordance with the SCCP including relief well plan, OPEP, Tactical Response Plans and OSMP.
External context	No stakeholder concerns have been raised with regards to impacts of the spill response activities on relevant persons. During any spill response, a close working relationship with key regulatory bodies (Control Agencies) will occur and thus there will be ongoing consultation with relevant persons during response operations.
Other requirements	Response has been developed in accordance with: • OPGGS Act; • AMSA Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities (AMSA, 2015); and NOPSEMA (2017).

	• South-east Commonwealth Marine Reserves Network Management Plan 2013-23 (Director of National Parks, 2013) • The following Conservation Advices / Recovery Plans identify pollution as a key threat: ◦ Conservation Advice *Balaenoptera borealis* (sei whale) (TSSC 2015g) ◦ Conservation Advice *Balaenoptera physalus* (fin whale) (TSSC 2015f) ◦ Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b), identified as acute chemical discharge (oil pollution) ◦ Conservation Advice *Calidris ferruginea* (curlew sandpiper) (DoE, 2015f) identified as habitat degradation/ modification (oil pollution) ◦ National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPC 2011a) ◦ Conservation Advice for *Sterna nereis nereis* (fairy tern) (DSEWPC, 2011c) • The following Conservation Advices / Recovery Plans identify habitats degradation/modification as threat, which may be consequence of accidental release of hydrocarbon: ◦ Conservation Advice *Calidris canutus* (red knot) (TSSC 2016d) ◦ Conservation Advice *Limosa lapponica baueri* (bar-tailed godwit (western Alaskan) (TSSC 2016a) ◦ Conservation Advice for *Numenius madagascariensis* (eastern curlew) (DoE 2015e) • These Conservation Advices and Recovery Plans identify the following conservation actions: ◦ minimise chemical and terrestrial discharge. ◦ ensure spill risk strategies and response programs include management for turtles and their habitats, particularly in reference to 'slow to recover habitats', e.g. nesting habitat, seagrass meadows or coral reefs. ◦ ensure appropriate oil-spill contingency plans are in place for the subspecies' breeding sites which are vulnerable to oil spills. ◦ implement measures to reduce adverse impacts of habitat degradation and/or modification; or ◦ no explicit relevant management actions; oil pollution is recognised as a threat. In regard to oil spill response, activities associated with Otway Offshore Operations will not be conducted in a manner inconsistent with the objectives of the respective zones of the AMPs, and the principles of the IUCN Area Categories applicable to the values of the AMPs.
Monitoring and reporting	Impacts will be monitored in accordance with Section 8.9.3.
Acceptability outcome	**Acceptable**

7.18 Environmental Performance Outcomes, Standards and Measurement Criteria

Beach uses EPOs, EPSs and measurement criteria to demonstrate it is managing its environmental impacts and risks. Outcomes have been developed for each of the identified environmental impacts and risks and have been based around the key identified controls from the control assessment and are aligned with Beach's HSE Policy (refer Figure 8-2). For each EPO and EPS has been developed in conjunction with measurement criteria. The EPOs, EPSs and measurement criteria related to operations are provided in Table 7-29; and those related to IMR and vessel operations in Table 7-30.

Table 7-29: Environmental performance outcomes, standards and measurement criteria - Operations

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
EPO1: No death or injury to fauna, including listed threatened or migratory species, from the activity. **EPO3:** Biologically important behaviours within a BIA or outside a BIA can continue while the activity is being undertaken. **EPO4:** No substantial reduction of air quality within local airshed caused by atmospheric emissions produced during the activity. **EPO5:** Reduce Beach GHG emissions by 25 per cent	CM#3: Marking of Man-Made Offshore Structures	• When platform unmanned lighting is restricted to navigational lighting.	Platform inspection	Operations Manager
	CM#5: Maintenance Management System	• Power generation systems on platform will be operated in accordance with maintenance management system to ensure efficient operation. • Equipment used to treat planned discharges shall be maintained in accordance with manufacturer's specification as detailed within the preventative maintenance system.	Maintenance Management System (MMS) records	Operations Manager
	CM#6: Venting Procedures	• Venting is conducted as per operational and maintenance isolation procedures. • Emergency blow down system designed to blow down topside only. • Drain vents purge set points set to meet the minimum operational requirements. • Drain vents purge set points checked as part of platform pre-departure checklist.	Operations and maintenance isolation procedures Blow down system design Platform pre-departure checklist	Operations Manager

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
by FY25 against FY18 levels. **EPO6:** Beach to achieve net zero Scope 1 and Scope 2 GHG emissions by 2050. **EPO7**: No impact to water quality or sediment quality at a distance > 500 m from planned activities from planned marine discharges. **EPO8:** Seabed and associated biota disturbance will be within the operational area.	CM#38: Beach Sustainability Standard	Per the requirements of the OEMS Sustainability Standard and for each asset, Beach will maintain a register of opportunities for carbon emission reduction to reduce: • emissions • energy consumption • venting and flaring These opportunities will be evaluated according to the criteria in the GHG Management Plan (CM#39), the criteria including cost per tonne of CO_2 equivalent abated and Net Present Value. Completion of GHG reduction opportunities will be independently tracked through to completion via Beach's Sustainability Steering Committee as a standing agenda item. These opportunities will be included in the yearly budget cycle for review, assessment, and approval where appropriate.	Opportunities register Yearly budget cycle documents Sustainability Steering Committee meeting minutes	Operations Manager
	CM#39: Beach GHG Management Plan	Beach Energy will develop and implement a GHG Management Plan by 1 January 2023. The GHG Management Plan will formalise the framework and specific techniques used to ensure that GHG emission related EPOs will be met over the life of the facility. In particular, the GHG Management Plan will set out the requirements for: • Monitoring of Scope 1, Scope 2 and Scope 3 GHG emissions. • Methodology used to determine yearly indirect emissions estimates generated by the production, transport, and use of the hydrocarbon products from the Otway Offshore Operations. • A program to monitor indirect (Scope 3) GHG emissions by: ◦ Monitoring GHG emission reduction commitments of customers.	Beach Energy GHG Management Plan developed and implemented Annual Scope 1, Scope 2 and Scope 3 GHG emissions monitoring reports Customer GHG emission reduction policy and implementation reviews Records demonstrate review of decarbonisation	Head of Sustainability and Energy Solutions responsibilities

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
		◦ Working with Beach customers to explore GHG emission reduction opportunities. • Review of the GHG Management Plan to assess its effectiveness by comparison of Scope 1 and 2 emissions against targets and Scope 3 against predictions in the EP. • Maintaining of a record of opportunities related to reductions of fuel, flare and venting Scope 1 emissions. • Establishing a LDAR program at each facility documenting the scope, methodology, frequency, and repair guidance. • Assessment criteria to be used to assess merits of emissions reduction opportunities and decision making criteria for adoption.	opportunities with customers Documented GHG Management Plan effectiveness review	
	CM#40: Fugitive Leak Detection and Repair Program	Implement an offshore leak detection and repair (LDAR) fugitive emissions surveys aligned with the LDAR program for onshore facilities as per the GHG Management Plan (CM#39) in which the scope, extent, frequency, method, and repair decision-making criteria are detailed to meet the Protocol for Environmental Management (Minimum control requirements for stationary sources) - EPA Publication 829.	LDAR surveys implemented as per GHG Management Plan requirements LDAR fugitive emissions report	Operations Manager
	CM#41: NGERS Reporting	GHG emissions will be reported as required by NGERS regulatory requirements. Both Scope 1 and Scope 3 GHG emissions, generated by the Otway Offshore Operations, will be compared annually to the EP estimates in EP Section 7.3.1.1 and the Estimate Emissions Inventory Figures 7-4 and 7-5 respectively. The annual review will be undertaken as per the methodology details in the GHG Management Plan (CM#39).	Annual review of direct and indirect GHG emissions. GHG emissions regulatory requirement reports.	Head of Sustainability and Energy Solutions responsibilities

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
	CM#18: Bird Deterrent system	• Bird deterrent system has been developed as per the recommendations of the bird management specialists. • Water sprinkler used when birds are present. • Operators of the bird deterrent systems are trained and following standard operating systems.	Bird deterrent system report Operator training records	Operations Manager
	CM#14: Beach Chemical Management Plan	• Chemicals that could be discharged to the marine environment will meet the requirements of the Beach Chemical Management Plan (Section 8.11.2).	Completed and approved chemical assessment Register of approved chemicals	Operations Manager
	CM#15: Hydraulic Control System	• Hydraulic system is fitted with low pressure and low level alarms that are monitoring at the Otway Gas Plant. • Hydraulic control system inventory levels are monitored monthly, and any excess use is investigated. • Hydraulic control system inspected and maintained in accordance with the Maintenance Management System.	Hydraulic system alarm records Monthly monitoring report Excess use investigation Maintenance Management System records	Operations Manager
EPO9: Undertake the activity in a manner that will not interfere with other marine users to a greater extent than is necessary for the exercise of right conferred by the titles granted.	CM#8: Ongoing consultation	• Notifications for any on-water activities and ongoing consultations shall be undertaken as per Section 8.12.9 (Stakeholder Consultation).	Notification records Communication records	Offshore Project Manager
	CM#9: Permanent Petroleum Safety Zone (PSZ)	• A permanent PSZ shall be maintained for the Thylacine-A wellhead platform and Geographe subsea infrastructure. • Otway Pipeline Systems and Thylacine-A wellhead platform and Geographe subsea infrastructure PSZ marked on navigational chart.	PSZ Gazetted Notice Navigational chart	Operations Manager

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
	CM#10: Beach Fair Ocean Access Procedure	• The Beach Fair Ocean Access Procedure (Appendix D for overview) shall be implemented with Fishers who have identified they fish in the area and have a commercial loss due to Beach's activities.	Communication records	Community Manager
	CM#11: Navigation and communication aids	• Platform is provided with navigational lights, RACON and foghorn in accordance with International Association of Lighthouse Authorities (IALA) requirements: • Foghorn is provided with its own battery back-up which will supply power for 96 hours. • Navigational lights on the Thylacine-A wellhead platform are in accordance with Navigation Act 2012 (Cth) (Chapter 6, Part 3, Division 2 – Collisions, Lights and Signals).	Platform inspection CMMS	Operations Manager
EPO11: No unplanned discharge of waste to the marine environment.	CM#19: MO 95: Marine Pollution Prevention – Garbage	• Waste with potential to be windblown shall be stored in covered containers.	HSE inspection records Garbage record book Incident report	Operations Manager
	CM#20: Fabric Maintenance	• Grit blasting on the platform jacket and topsides uses containment and recovery to minimise losses to the ocean. • Grit blasting material will meet the chemical acceptance criteria as per Section 8.21.	Maintenance activity reports	Operations Manager
EPO12: No spills of chemicals or hydrocarbons to the marine environment.	CM#23: NOPSEMA accepted Safety Case	• Pipelines and subsea infrastructure and integrity managed in accordance with the accepted Safety Case.	Accepted Safety Case in place Inspection records	Operations Manager
	CM#21: Spill containment	• Suitable bunding will be installed to prevent unplanned spills of chemicals entering the environment. • Spill kits are present on the platform.	Platform / vessel inspection	Operations Manager

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
	CM#24: Thylacine-A Wellhead Platform Hose Integrity Management Plan	• Hoses are managed and maintained as per Thylacine-A Wellhead Platform Hose Integrity Management Plan.	Thylacine-A Wellhead Platform Hose Integrity Management Plan	Operations Manager
	CM#8: Ongoing consultation	• Notifications for any on-water activities and ongoing consultations shall be undertaken as per Section 8.12.9 (Stakeholder Consultation).	Notification records Communication records	Offshore Project Manager
	CM#3: Marking of Man-Made Offshore Structures	• Lighting on the Thylacine-A Wellhead Platform meets Sections 2.1 and 2.2 of the Recommendation O-139 on The Marking of Man-Made Offshore Structures.	Platform inspection	Operations Manager
	CM#30 NOPSEMA accepted WOMP	• Wells and well integrity managed in accordance with the accepted WOMP.	Accepted WOMP in place Inspection records	Operations Manager
	CM#31: Source Control Contingency Plan (SCCP) and Relief Well Plan (RWP)	• Emergency response capability to implement timely source control in the case of a loss of well integrity is maintained in accordance with well-specific SCCP and RWP.	Capability as per SCCP and RWP in place	Wells Manager Otway Offshore
		The SCCP shall be consistent with the International Oil and Gas Producers (IOGP) Report 594 - Subsea Well Source Control Emergency Response Planning Guide for Subsea Wells (2019), Specifically detailing: • the structure and function of the Beach Source Controls Incident Management Team. • a timeline for the effective implementation of source control key events / actions. • a well-specific worst-case discharge analysis. • casing design. • structural integrity analysis. • gas plume study.	Capability as per SCCP and RWP in place	Wells Manager Otway Offshore

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
		The relief well plan ensures that Beach has considered the response requirements in order to: • reduce the time required to initiate relief well drilling operations in the event of a LOC. • allow the relief well to be completed in the shortest time practicable. The relief well plan includes a detailed schedule with estimated times to: • source, mobilise and position a MODU. • drill and intercept the well. • complete the well kill successfully.		
	CM#32: NOPSEMA accepted OPEP CM#33: NOPSEMA accepted OSMP	Emergency spill response capability is maintained in accordance with the OPEP	Outcomes of internal audits and tests demonstrate preparedness	Senior Crisis, Emergency & Security Advisor
		Implement spill response in accordance with relevant EPOs and EPSs in the accepted OPEP.	EMT log	Beach EMT
		Operational and scientific monitoring capability is maintained in accordance with the OSMP.	Outcomes of internal audits and tests demonstrate preparedness	Senior Crisis, Emergency & Security Advisor

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
EPO13: All structures, equipment and property associated within the Beach title areas in Table 2 2 will be maintained in good condition and repair to ensure it can be removed, unless there is agreement at that time from NOPSEMA to do otherwise through an accepted EP.	CM#34: Beach OEMS Element 6 Asset Management	IMR programs are undertaken to maintain structures, equipment and property in good condition and repair until it is removed, unless there is agreement at that time from NOPSEMA to do otherwise through an accepted EP, by • Wells and well integrity managed in accordance with the accepted WOMP. • Thylacine-A platform, pipelines and subsea infrastructure and integrity managed in accordance with the accepted Safety Case. If during the Geographe well installation and commissioning campaign equipment cannot be recovered it will be: • Left insitu i.e. not moved and placed on the seabed. • Will be stabilised to ensure it does not move. If not recovered will be inspected as part of the well inspections program as the accepted WOMP.	Accepted Safety Case in place Accepted WOMP in place Inspection records	Operations Manager

Table 7-30: Environmental performance outcomes, standards and measurement criteria – IMR, Geophysical Surveys and Support Operations

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
EPO1: No death or injury to fauna, including listed threatened or migratory species, from the activity. **EPO2:** Sound emissions in BIAs will be managed such that any whale, including blue whales, continue to utilise the area without injury, and is not displaced from a foraging area. **EPO3:** Biologically important behaviours within a BIA or outside a BIA can continue while the activity	CM#1: Light Management Procedure	• Vessels will have a Lighting Management Procedure (or equivalent) to minimise light spill by: ◦ keeping lights off when not needed. ◦ directing lighting onto work areas. ◦ screening interior lights with curtains and blinds. ◦ developing a program for handling grounded birds. ◦ reporting requirements.	Lighting Management Procedure (or equivalent) Vessel inspection	Vessel Master
	CM#7: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans	• Vessel operators shall adhere to the distances and vessel management practices of EPBC Regulations (Part 8) and report vessel interactions with dolphins specifically: i. Do not approach a dolphin. ii. Maintain a distance of 150 m from a dolphin. iii. If a dolphin approaches the vessel try to maintain the separation distances without changing direction or moving into the path of the animal. • Vessel operators shall adhere to the distances and vessel management practices of EPBC Regulations (Part 8) and report vessel interactions with whales, specifically: i. Do not approach a whale. ii. Maintain a distance of 500 m from a whale. • If a whale approaches the vessel it will try to maintain the separation distances without changing direction or moving into the path of the animal. • Helicopters will not fly lower than 1650 ft when within 500 m horizontal distance of a cetacean except when landing or taking off and will not approach a cetacean from head on. • Marine mammal sightings will be recorded and submitted to DCCEEW via the National Marine Mammal Data Portal. Sighting will be reported within 1 month of sighting occurring or two months of the end of a geophysical survey.	Project induction DCCEEW cetacean sighting sheets	Vessel Master

is being undertaken. **EPO4:** No substantial reduction of air quality within local airshed caused by atmospheric emissions produced during the activity.	CM#36 Otway Operations Vessel Whale Management Procedure	• Prior to an activity commencing a pre-activity survey will be undertaken of the activity survey zone for the activity: ▪ Resupply – 7.5 km ▪ Inspection – 3 km ▪ Maintenance and repair – 3 km • Surveys will be undertaken for 30 min prior to the activity commencing. If a whale is sighted within the pre-activity survey zone the activity will not commence until: ▪ No whales are observed for 30 min within the pre-activity survey zone; or ▪ Whales are observed leaving the pre-activity survey zone. • Once the activity has commenced observations will be undertaken within the activity survey zone: ▪ Resupply – 7.5 km ▪ Inspection – 3 km ▪ Maintenance and repair – 3 km • If a whale is sighted within the activity survey zone the following will occur: ▪ If the vessel can do so it will move away from the whale and maintain a minimum separation distance equal to the activity survey zone. ▪ If the vessel cannot move away from the whale, the vessel will reduce thrusters if safe to do so. The activity will cease as soon as it is safe, and the vessel will move out of the activity survey zone. • Activities can commence at night or in low visibility conditions (i.e., when observations cannot be undertaken) if no more than three whales have been seen in the activity survey zone in the preceding daylight hours. • During the period that drilling is occurring for the Otway Development the following will be undertaken to inform operations activities in relation to the presence of whales within the Otway Development and Operations areas: ▪ One week prior to an activity being undertaken a review of whale data is undertaken to determine if blue and/or southern right whales have been observed in the area. • When undertaking an activity presence of whales observed from drilling or operations activities will be communicated via radio.	Daily report MMO report Review of whale data	Operations Manager Activity Offshore Representative Vessel Master

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
	CM#36a: Otway Operations Vessel Marine Mammal Observer	• A dedicated MMO with experience in whale observation, distance estimation and reporting, will undertake activity survey zone observations for vessel activities undertaken over a period greater than 24 hours. • In addition, vessel crew who act as Officer of the Watch will receive training from the MMO in whale observation and distance estimation to assist the MMO during daylight hours. • For vessel activities greater than 5 consecutive days at sea an additional dedicated MMO trained in whale observation, distance estimation and reporting will be onboard the vessel to support the experienced MMO. • For vessel activities that will be undertaken over a period less than 24 hours the vessel Officer of the Watch will undertake the activity survey zone observations. They will be trained in the Vessel Whale Management Procedure, whale observation and distance estimation.	MMO qualifications Daily report MMO report Officer of the Watch training	Operations Manager Activity Offshore Representative Vessel Master
	CM#36b SRW Exclusion Zone	No IMR activities will be planned within 3 km of a southern right whale BIA or emerging aggregation area during May to end of October when SRW are potentially present in the BIAs or emerging aggregation area.	IMR schedule	Operations Manager
	CM#2a: Geophysical survey pre-start visual observation	For the geophysical survey: • a prestart visual observation period of 30 mins will be applied to 500 m prior to the start of SBP equipment activation. • if during the prestart visual observation period a whale is sighted within 500 m of the vessel the SBP equipment activation will be delayed until the whale has moved outside of the 500 m zone or 30 minutes has lapsed since the last whale sighting within 500 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 last 24 hours. • Once the survey has comments CM#7 applies where the vessel is required to maintain a 500 m distance to all whales.	Daily report details pre-start Observation period, any sightings and any actions required.	Activity Offshore Representative

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
	CM#2b: Geophysical survey Marine Mammal Observer	For geophysical surveys utilising SBP a dedicated MMO will be present on the vessel to undertake prestart visual observations and implement the 500 m distance to any whales during: • 1 November to 30 June within the operational area • 1 May to 30 November within the Victorian coastal migration and resting on migration BIA and emerging aggregation area. The MMO will have proven experience in whale observation, distance estimation and reporting. At other times at least one crew member onboard the vessel will have proven experience in whale observation, distance estimation and reporting to ensure the safe operating distances are implemented.	MMO resume. Daily report detailing MMO observations.	Activity Offshore Representative
	CM#2c Geophysical survey adaptive management	For geophysical surveys utilising SBP if whale numbers are greater than expected such that pre-start observations are delayed three times in a 24-hour period or the vessel must move away from a whale or a pod of whales three times in a 24-hour period, a review of the controls in place will be undertaken by the Activity Offshore Representative, Activity Project Manager and Environment Advisor. • the review will be initiated within 2 hours of the adaptive management trigger being reached. the review will be documented and will be undertaken against the Implementation of the EPBC Act Policy 2.1 Part A requirements to identify if further controls need to be applied to ensure that impacts and risks are ALARP and within the defined acceptable level.	Adaptive management review report	Activity Offshore Representative
	CM#4: MO 97: Marine Pollution Prevention – Air Pollution	• Use of very low sulphur fuel oil (VLSFO) (e.g. maximum 0.50% S VLSFO-DM, maximum 0.50% S VLSFO-RM). • Vessels with diesel engines>130 kW must be certified to emission standards (e.g. International Air Pollution Prevention [IAPP]). • Vessels shall implement their Ship Energy Efficiency Management Plan to monitor and reduce air emissions (as appropriate to vessel class).	Bunker receipts Ship Energy Efficiency Management Plan (SEEMP) records Certification documentation Vessel inspection	Vessel Master

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
	CM#5: Maintenance Management System	• Power generation and propulsion systems on vessels will be operated in accordance with maintenance management system to ensure efficient operation.	Maintenance Management System (MMS) records Vessel inspection	Vessel Master
	CM#37 Contractor Supplier HSE Prequalification and Capability Assessment	• The tender evaluation for the IMR and support vessels contract will include an evaluation of air and GHG emissions management.	Contractor Supplier HSE Prequalification and Capability Assessment	IMR Project Manager Operations Manager
EPO7: No impact to water quality or sediment quality at a distance > 500 m from planned activities from planned marine discharges. **EPO8:** Seabed and associated biota disturbance will be within the operational area.	CM#12: IMR Scope of Work	• IMR scope of work will detail activities that may disturb the seabed and how these activities will limit the area of disturbance.	IMR Scope of Work	IMR Project Manager
	CM#13: *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and Marine Order 96 (Marine pollution prevention — sewage) 2018 giving effect to MARPOL Annex IV.	• Oil contaminated water shall be treated via a MARPOL (or equivalent) approved oily water separator and only discharge if oil content less than 15 ppm. • Sewage discharged at sea shall be treated via a MARPOL (or equivalent) approved sewage treatment system. • Food waste only discharged when macerated to ≤25 mm and at distance greater than 3 nm from land.	Oil record book MARPOL certification Garbage record book Vessel inspection	Vessel Master

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
	CM#5: Maintenance Management System	• Equipment used to treat planned discharges shall be maintained in accordance with manufacturer's specification as detailed within the preventative maintenance system.	Maintenance Management System (MMS) records Vessel inspection	Vessel Master
	CM#14: Beach Chemical Management Plan	• Chemicals that will be or have the potential to be discharged to the marine environment will meet the chemical acceptance criteria as per Section 8.11.2.	Completed and approved chemical assessment Register of approved chemicals	Vessel Master
EPO9: Undertake the activity in a manner that will not interfere with other marine users to a greater extent than is necessary for the exercise of right conferred by the titles granted.	CM#8: Ongoing consultation	• Notifications for any on-water activities and ongoing consultations shall be undertaken as per Section 8.12.9 (Stakeholder Consultation).	Notification records Communication records	IMR Project Manager
	CM#10: Beach Fair Ocean Access Procedure	• The Beach Fair Ocean Access Procedure (Appendix D for overview) shall be implemented with Fishers who have identified they fish in the area and have a commercial loss due to Beach's activities.	Communication records	Community Manager

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
EPO10: No introduction of a known or potential invasive marine species	CM#16: Beach Domestic IMS Biofouling Risk Assessment Process	Prior to the initial mobilisation into the operational area of any vessel or submersible equipment, Beach shall undertake a domestic IMS biofouling risk assessment as per Section 8.22 of this EP to: • validate compliance with regulatory requirements (Commonwealth and State) in relation to biosecurity prior to engaging in petroleum activities within the operational area; • identify the potential IMS risk profile of vessels and submersible equipment prior to deployment within the operational area; • identify potentially deficiency of IMS controls prior to entering the operational area; • identify additional controls to manage IMS risk; and • prevent the translocation and potential establishment of IMS into non-affected environments (either to or from the operational area).	Domestic IMS Biofouling Risk Assessment records	IMR Project Manager
EPO11: No unplanned discharge of waste to the marine environment.	CM#19: MO 95: Marine Pollution Prevention – Garbage	Waste with potential to be windblown shall be stored in covered containers.	Vessel inspection Garbage record book Incident report	Vessel Master
EPO12: No spills of chemicals or hydrocarbons to the marine environment.	CM#21: Spill containment	Materials and equipment that have the potential to spill onto the deck or marine environment shall be stored within a contained area.	Vessel inspection.	Vessel Master
	CM#22: SMPEP or SOPEP (appropriate to class)	Vessels shall have a SMPEP (or equivalent appropriate to class) which is: • implemented in the event of a spill to deck or marine environment. • tested as per the vessel test schedule. • spill response kits shall be available and routinely checked to ensure adequate stock is maintained.	Vessel SMPEP Vessel inspection Vessel exercise schedule	Vessel Master
	CM#8: Ongoing consultation	Notifications for any on-water activities and ongoing consultations shall be undertaken as per Section 8.12.9 (Stakeholder Consultation).	Notification records Communication records	IMR Project Manager

Environmental performance outcome	Control measure #	Environmental performance standard	Measurement criteria	Responsible person
	CM#26: MO 21: Safety and emergency arrangements	Vessels shall meet the safety measures and emergency procedures of the AMSA MO 21.	Vessel inspection	Vessel Master
	CM#27: MO 30: Prevention of collisions	Vessels shall meet the navigation equipment, watchkeeping, radar and lighting requirements of AMSA MO 30.	Vessel inspection	Vessel Master
	CM#28: MO 31: SOLAS and non-SOLAS certification	Support vessels will meet survey, maintenance and certification of regulated Australian vessels as per AMSA MO 31.	Vessel certification	Vessel Master
	CM#29: MO 27: Safety of navigation and radio equipment	Vessels shall meet the safety of navigation and radio equipment requirements of AMSA MO 27. Vessels shall ensure their navigation status is set correctly in the ship's AIS unit.	Vessel inspection	Vessel Master
	CM#35: Vessel fuel type	Vessels contracted to conduct activities under this EP will only carry marine diesel.	Vessel inspection	Operations Manager Project Manager

8 Implementation Strategy

Regulation 14 of the OPGGS(E)R requires that the EP must contain an implementation strategy for the activity.

The Beach Operations Excellence Management System (OEMS) will be used to govern the activity. The OEMS provides guidance on how Beach will meet the requirements of its Environmental Policy (Figure 8-2). The Beach 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 Implementation Strategy described in this section provides a summary of the OEMS elements and how they will be applied to effectively implement the control measures detailed in this EP. Specifically, it describes:

- the OEMS
- environment-specific roles and responsibilities
- arrangements for monitoring, review and reporting of environmental performance
- preparedness for emergencies
- arrangements for ongoing consultation

8.1 Operations Excellence Management System

The OEMS documents the Environmental Policy, the 11 OEMS Elements and 30 OEMS Standards. It provides a management framework for achieving the requirements in a systematic way but allows flexibility to achieve this in a manner that best suits the business. 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 Environmental Policy (Figure 8-2) and management of potential HSE impacts and risks (Figure 8-1, Table 8-1). The Elements, via the nominated expectations, sponsor 30 Beach OEMS Standards, which provide more granular minimum compliance rule sets under which the company operates. At the business level, the system is complemented by asset and site procedures and plans such as this EP.

Whilst Beach is the titleholder for the activity, the vessel contractor maintains operational control as per the requirements of their management system. The application of OEMS Elements and Standards relevant to the activity are described in the following sections.

Figure 8-1: Beach OEMS

Table 8-1: Beach OEM Elements and Standards

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
		Finance 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

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 Health, Safety and Environment 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.

Matt Kay
Managing Director and CEO
December 2019

Figure 8-2: Beach's Environmental Policy

8.2 Element 1 – Partners, Leadership and Authority

Element 1 focuses on ensuring the organisation is equipped, structured and supported to ensure a healthy, efficient and successful company. Communications with internal and external bodies, including joint venture partners, is essential to delivering successful projects and operations. The leadership styles and actions demonstrated within Beach will influence the performance of all staff and contractors. Clear levels of authority are necessary to remove organisational ambiguity and to support effective decision making.

The Beach Energy CEO has the ultimate responsibility for ensuring that Beach Energy has the appropriate organisation in place to meet the commitments established within this EP. However, the Otway Operations Manager has the responsibility and delegated authority to ensure that adequate and appropriate resources are allocated to comply with OEMS and this EP.

Figure 8-3 shows the organisation chart for the key roles for the EP implementation and the roles responsible for the implementation, management and review of this EP are detailed in Table 8-2.

Roles and responsibilities for an oil pollution emergency response are described in the OPEP.

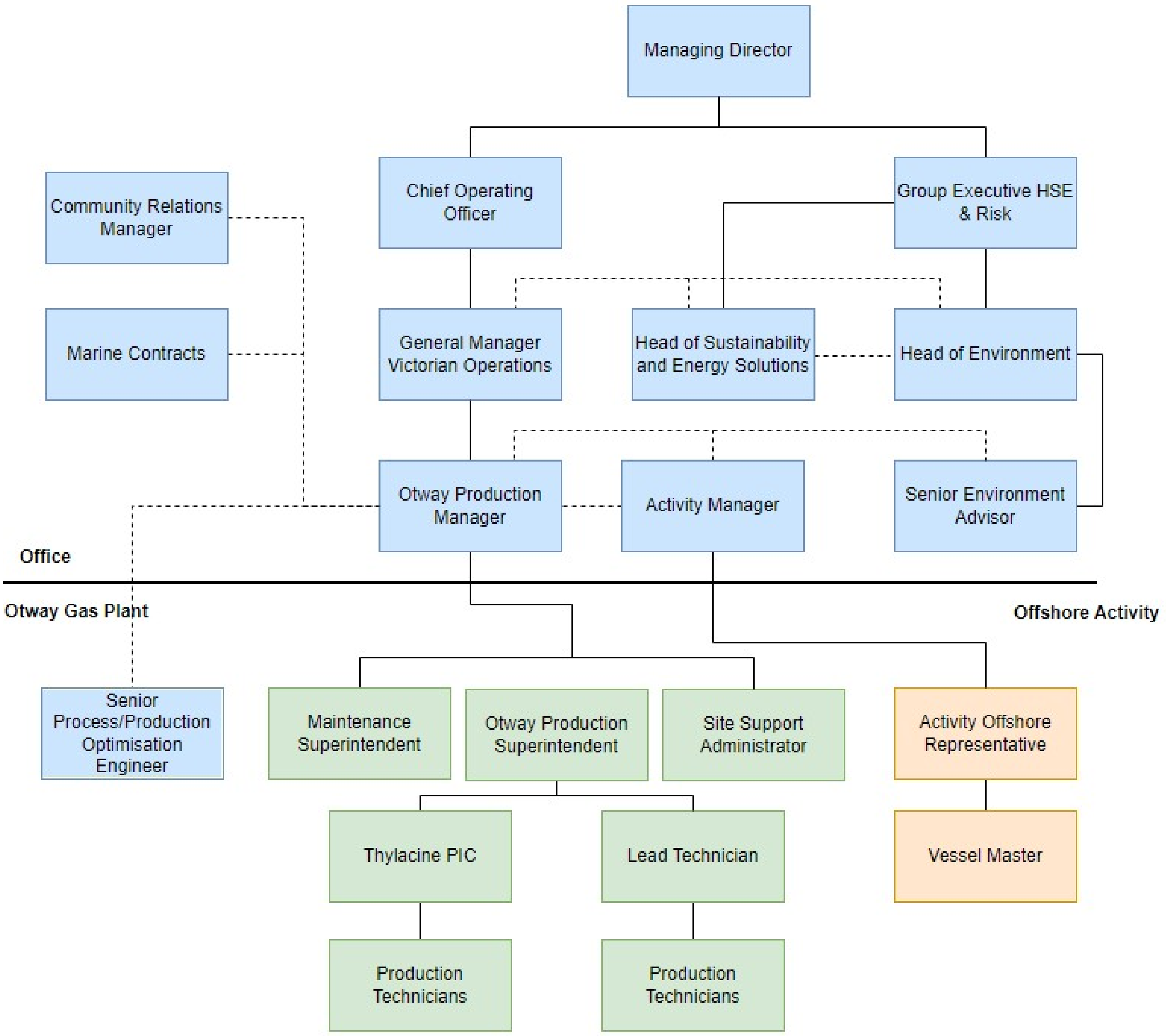

Figure 8-3: Otway Operations key roles for the EP implementation

Table 8-2: Roles and responsibilities for key roles for the EP implementation

Role	Responsibilities
Office	
Managing Director	• Responsible for HSE performance of all Beach activities. • Ensures policies and systems are in place to guide the company's environmental performance.
Chief Operating Officer	• Responsible for HSE performance of all Beach operational assets and their activities. • Ensures policies and systems are in place to guide the company's environmental performance. • Ensures adequate resources are available for the safe operation of all facilities and operations. • Ensures that the OEMS continues to meet the evolving needs of the company.
General Manager Victorian Operations	• Responsible for HSE performance of all activities across their asset

Role	Responsibilities
	• Responsible Person/Person Conducting Business Undertaking for the development, implementation and compliance with the asset's Safety Cases, Safety Management System, Safety Management Plans and Operations and Environmental Management Plans. • Ensuring the Production Manager and Production Superintendent have the required skills and can fulfil their duties as the 'Accountable Person' for managing HSE performance at each site. • Implementing and ensuring compliance with the OEMS. • Ensuring that appropriate reporting, verification, authorisation and escalation processes are in place for the review and actioning of all incidents, defects, hazards, inadequacies of procedures. • Maintaining relationship and reporting relevant requirements under the Safety Cases, Safety Management Systems, Safety Management Plans, Operations and Environmental Management Plans and HSE legislation.
Otway Operations Manager	• Responsible for the safe day-to-day operations of the facility. Ensure: • Compliance with the Environment Policy, regulatory and other requirements, and this EP. • Records associated with the activity are maintained as per Section 8.4.2. • Personnel who have specific responsibilities pertaining to the implementation of this EP or Oil Pollution Emergency Plan (OPEP) know their responsibilities and are competent to fulfil their designated role. • Assurance Processes as detailed in Section 8.12.2 are undertaken to confirm that control measures detailed in the EP are effective in reducing the environmental risks of the activity to ALARP and acceptable levels, and the EPOs and EPSs are continually met. • Environmental impacts and risks associated with the activity have been identified and any new or increased impacts or risks are managed via the Management of Change process detailed in Section 8.8.1. • Incidents are managed and reported as per Section 8.10. • EP report is submitted to NOPSEMA not more than three months after the anniversary date of the EP acceptance. • Changes to equipment, systems and documentation where there may be a new or change to an environmental impact or risk or a change that may impact the EP are assessed Management of Change process detailed in Section 8.8.1. • Oil spill response arrangements are tested as per Section 12.2 of the OPEP. • Audits and inspections are undertaken in accordance with Section 8.12.4.
Group Executive Health, Safety, Environment and Risk	• Ensures adequate environmental resources are available for the implementation of this EP.
Head of Environment	• Ensures this EP is revised as required. • Reviews EP audits. • Leads the investigation and reporting of any environmental incidents. • Reviews and approves reportable incident reports to the regulators. • Reviews changes to operations for their environmental and regulatory implications.
Senior Environment Advisor	• Maintains ongoing communications with the PIC regarding regulatory requirements and environmental management in general. • Prepares environmental inductions and training packages.

Role	Responsibilities
	• Monitors environmental performance against this EP. • Undertakes Assurance Processes as detailed in Section 8.12.2 to confirm that control measures detailed in the EP are effective in reducing the environmental risks of the activity to ALARP and acceptable levels, and the EPOs and EPSs are continually met. • Prepares and submits monthly recordable incident reports to the regulators. • Prepares reportable incident reports for submission to the regulators. • Supports the Management of Change (MoC) process with regard to environmental issues impacting on operations. • Supports the investigation and reporting of any environmental incidents. • Prepares and submits reportable incident reports to the regulators. • Reviews changes to operations with the Head of Environment.
Head of Sustainability and Energy Solutions	• Ensures the GHG Management Plan is developed and implemented by 1 January 2023. • Ensures NGERS and NPI reporting requirements are met. • Ensures the Scope 1 and Scope 3 GHG emissions generated by the Otway Offshore Operations are compared annually to the EP estimates in EP Section 7.3.1.1. • Ensures a program to monitor indirect (Scope 3) GHG emissions by monitoring GHG emission reduction commitments of customers and working with Beach customers to explore GHG emission reduction opportunities is undertaken as per the GHG Management Plan requirements.
Community Relations Manager	• Ensures that relevant persons (as defined in Chapter 9) are consulted about operations issues that may impact their functions or interests. • Maintains a record of stakeholder communications. • Reports stakeholder concerns to the PIC and Senior Environment Advisor for resolution. • Keeps relevant persons informed of emergency events that may impact their functions or interests.
Marine Contracts	• Ensures vessels used for Otway Operations comply with the requirements of this EP. • Undertakes Assurance Processes for vessels as detailed in Section 8.12.2 to confirm that control measures detailed in the EP are effective in reducing the environmental risks of the activity to ALARP and acceptable levels, and the EPOs and EPSs are continually met.
Senior Production Optimisation Engineer	• Ensure that all asset monitoring and inspection programs are completed in line with the CMMS, associated plans and procedures. • Participate in environmental inductions and training. • Participate in environmental risk reviews and assessments. • Report asset performance to Otway Production Manager. • Maintain Otway operations emissions and discharge records. • Assist in environmental incident investigations and implementation of environmental related corrective actions.
Otway Gas Plant	
Otway Production Superintendent	• Responsible for the safe day-to-day operations of the facility. • Ensures compliance with the Environment Policy. • Communicates environmental hazards to the facility crew.

Role	Responsibilities
	• Delivers environmental inductions (as required). • Reports environmental incidents to the Otway Production Manager. • Acts as the onsite Emergency Response Team (ERT) Leader in the event of major incidents, in line with the ERT structure.
Maintenance Superintendent	• Inspects and maintains plant and equipment in line with the CMMS to ensure all plant and equipment is operating safely and within OEM specifications. • Ensures all maintenance contractors and staff abide by HSE standards, management plans and procedures and works have been adequately risk assessed with controls implemented prior to starting works.
Site Support Administrator	• Ensure records associated with inductions and training are maintained.
Thylacine PIC / Lead Technician	• Reports environmental incidents to the Otway Production Superintendent. • Ensures the facility-based environmental inspections and audits are resourced and completed as per the CMMS.
Production Technicians	• Ensures asset monitoring and inspection programs are completed in line with the CMMS, associated plans and procedures. • Participates in environmental inductions and training. • Follows good housekeeping practices. • Reports environmental hazards and incidents promptly to their supervisor. Considers environmental issues in JSAs and PTWs.
Gas Plant personnel	• Complete inductions. • Report hazards and/or incidents via company reporting processed. • Stop any task that they believe to be unsafe or will impact on the environment.
Offshore Activity	
Activity (Geophysical survey or IMR campaign) Manager	Ensures: • Activity is carried out in accordance with regulatory requirements and this EP. • Vessel personnel are competent to fulfil their designated role. • HSE issues are communicated via systems such as the daily report and daily pre-start meetings. • Emissions and discharges identified in Section 8.12.8 are recorded and provided to the Senior Environment Advisor. • Personnel who have specific responsibilities pertaining to the implementation of this EP or Oil Pollution Emergency Plan (OPEP) know their responsibilities and are competent to fulfil their designated role. • Assurance Processes as detailed in Section 8.12.2 are undertaken to confirm that control measures detailed in the EP are effective in reducing the environmental risks of the activity to ALARP and acceptable levels, and the EPOs and EPSs are continually met. • Environmental impacts and risks associated with the activity have been identified and any new or increased impacts or risks are managed via the Management of Change process detailed in Section 8.8.1. • Incidents are managed and reported as per Section 8.10. • EP report is submitted to NOPSEMA not more than three months after the anniversary date of the EP acceptance. • Changes to equipment, systems and documentation where there may be a new or change to an environmental impact or risk or a change that may impact the EP are assessed Management of Change process detailed in Section 8.8.1.

Role	Responsibilities
	• Oil spill response arrangements are tested as per Section 12.2 of the OPEP. • Audits and inspections are undertaken in accordance with Section 8.12.4.
Activity (Geophysical survey or IMR campaign) Offshore Representative	Ensures: • Activity is carried out in accordance with regulatory requirements and this EP. • Vessel personnel complete the environmental component of the activity induction. • Vessel distances and vessel management practices for marine mammals as per the control measures and environmental performance standards detailed in Table 7-29 and Table 7-30 are communicated to Vessel Master and crew. • Vessel personnel are competent to fulfil their designated role. • HSE issues are communicated via systems such as the daily report and daily pre-start meetings. • Environmental incidents are managed and reported as per Section 8.10. • Emissions and discharges identified in Section 8.12.8 are recorded and provided to the Activity Manager. • Activity Manager is informed of any changes to equipment, systems and documentation where there may be a new or change to an environmental impact or risk or a change that may impact the EP as per Section 8.8.1. • Chemicals that will or may be discharged offshore are assessed as per Section 8.11.2 prior to use. • Weekly vessel inspections are undertaken to ensure ongoing compliance with the EP as per Section 8.12.4.
Vessel Master	Ensure: • Vessel operations are carried out in accordance with regulatory requirements and this EP. • Vessel adheres to the distances and vessel management practices for marine mammals as per the control measures and environmental performance standards detailed in Table 7-29 and Table 7-30. • Environmental incidents are reported to the Activity Offshore Representative within required timeframes as per Section 8.10. • Oil spill response arrangements are in place and tested as per the vessel's SMPEP or equivalent.
Vessel personnel	• Complete project induction. • Report hazards and/or incidents via company reporting processed. • Stop any task that they believe to be unsafe or will impact on the environment.

8.3 Element 2 – Financial Management and Business Planning

Element 2 seeks to ensure robust and achievable business plans are developed and supported by a consistent and realistic understanding of facility constraints. It drives robust analysis and accountable decision-making to deliver assets that maximise lifecycle value, providing clear cost control throughout the life of an asset.

There are four standards (Table 8-1) and ten outcomes to be delivered under this element.

This EP does not cover the risks involved in financial management and impact on the activity. The relevant impacts of financial and business planning risks are managed under the other OEMS elements described in this chapter.

8.4 Element 3 – Information Management and Legal

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.

There are three standards (Table 8-1) and seven outcomes to be delivered under this element. The standards relevant to the implementation of this EP are described below.

8.4.1 Standard 3.1 – Regulatory Compliance Standard

Standard 3.1 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 Regulator engagement can be maintained across all its activities including permissions, project execution, operating and reporting.

Chapter 2 of this EP details the key environmental legislation applicable to the activity. The acceptability discussion for each aspect is assessed in Chapter 6 and specifically details the legislation pertaining to each aspect.

8.4.2 Standard 3.2 – Document Management Standard

Standard 3.2 specifies the minimum requirements to ensure that all Beach documents and records are managed in alignment with legal, regulatory and stakeholder requirements. It requires documents to be classified, developed, authorised, published, stored, accessed, reviewed and disposed consistently and in a manner that complies with company and statutory obligations. The document management system will clearly support the safe and efficient operations of the Company.

In accordance with Regulations 27 and 28 of the OPGGS(E), documents and records relevant to the implementation of this EP are stored and maintained in the Beach document control system ('BoardWalk') for a minimum of five years. These records will be made available to regulators in electronic or printed form upon request.

8.4.3 Standard 3.3 – Information Management Standard

Standard 3.3 ensures that Beach implements appropriate Information Management practices to ensure information is managed as a corporate asset, enabling it to be exploited to support corporate objectives as well as satisfying Beach's legal and stakeholder requirements.

8.5 Element 4 – People, Capability and Health

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).

There are two standards (Table 8-1) and four outcomes to be delivered under this element. Standard 4.1 is discussed below, noting that the health management standard is not relevant to the EP.

8.5.1 Standard 4.1 – Training and Competency Standard

Standard 4.1 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 EP shall have the appropriate competencies to fulfil their designated role.

To ensure that personnel are aware of the EP 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 as per Section 8.4.2. The induction will at a minimum cover:

- description of the environmental sensitivities and conservation values of the operational 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.
- Beach Vessel Whale management Procedure.

In addition to the activity-specific induction, each employee or contractor with specific responsibilities pertaining to the implementation of this EP shall be made aware of their responsibilities, and the specific control measures required to maintain environmental performance and legislative compliance.

8.5.2 Communications

The Otway Operations Manager has responsibility for ensuring that systems are in place to facilitate the communication of HSE issues. Communication is typically via the daily report and daily pre-start meetings; and through the monthly Operations HSE meeting.

The meetings are used to identify and communicate:

- Issues associated with implementation of the EP;
- Any proposed changes to equipment, systems or methods of operation of equipment, where these may be HSE implications; and

- Any proposals for the continuous improvement of environmental protection, including the setting of environmental objectives and training schemes.

8.6 Element 5 – Contracts and Procurement

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.

There are two standards (Table 8-1) and four outcomes to be delivered under this element.

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).

Section 8.12.4 details how the contractors will be assessed to ensure they have the capabilities and competencies to implement the control measures identified in Section 7.

8.7 Element 6 – Asset Management

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 risk 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).

There are five standards (Table 8-1) and eight outcomes to be delivered under this element.

Equipment that have been identified as a control measure for the purpose of managing potential environmental impacts and risks from the activity have an associated EPS that details the performance required as detailed in Section 6.

8.8 Element 7 – Operational Control

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.

There are three standards (Table 8-1) and ten outcomes to be delivered under this element. The standard of relevance to this EP Management of Change is discussed below.

8.8.1 Standard 7.3 – Management of Change Standard

Standard 7.3 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 managed using an electronic tracking database (called 'Stature'), which provides 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 8.9 identify a change in impacts, risks or controls (compared to those described and assessed in Chapter 6), and triggers a regulatory requirement to revise this EP, the revision shall be defined, endorsed, completed and communicated in accordance with the MoC Standard.

8.9 Element 8 – Risk Management and Hazard Control

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.

There are three standards (Table 8-1) and seven outcomes to be delivered under this element. The standards of relevance to this EP are discussed below.

8.9.1 Standard 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 Standard defines the purpose and use of risk assessments and risk registers. The environmental risk management framework applied to the activity is described in Chapter 5 and applied to all the aspects assessed in Chapter 6 of this EP.

As described in Section 8.12.5, Beach will undertake a review of this EP 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 EP 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 this EP is trigged though a change in risk or controls, the revision process shall be managed in accordance with the MoC process outlined in Section 8.8.1.

Additional, or increased, impacts or risks, are identified, outside of the management of change process by the assurance process detailed in Table 8-7.

8.9.2 Standard 8.3 – Emergency and Security Management Standard

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.

The emergency response framework to be applied to the activity is outlined below.

Emergency Response Framework

The Beach Crisis and Emergency 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, as outlined in Figure 8-4. This framework is described in the Beach Emergency Management Plan (EMP) (CDN/ID 128025990).

The responsibilities of the Emergency Response Team (ERT), Emergency Management Team (EMT) and Crisis Management Team (CMT) are outlined in Table 8-3

The key emergency response arrangements for the activity are outlined herein.

<u>Beach Emergency Management Plan</u>

The Beach EMP provides the standard mechanism for the 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.

IMR Activity Emergency Response Plan

For IMR activities Beach will prepare a bridging emergency response plan (ERP) that bridges to the emergency response measures in the vessel contractor's vessel-specific ERP to ensure that all emergency management functions are accounted for. The Bridging ERP will be supported by the Beach EMP.

The Bridging ERP will describe the emergency roles and responsibilities for those on the vessel and outline the actions to be taken for potential activity-specific scenarios (e.g., loss of containment, vessel collision, fire, man overboard, fatality, etc). The Bridging ERP will define the communication requirements to notify both the company and external bodies of the incident so as to obtain assistance where needed and to fulfil reporting obligations.

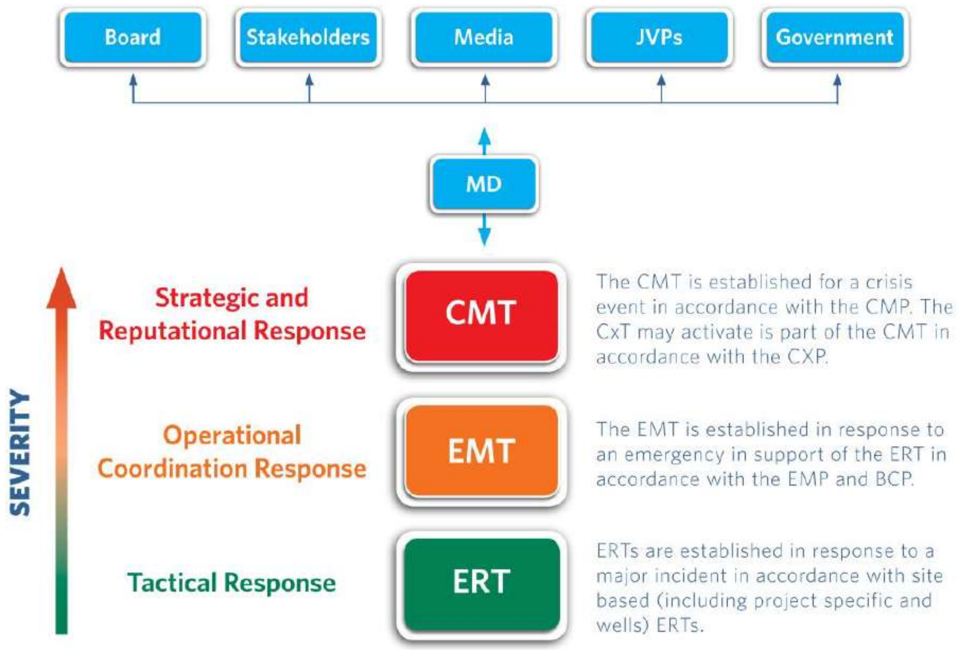

Figure 8-4: Beach Crisis and Emergency Management Framework

Table 8-3: Responsibilities of the Beach Crisis and Emergency Management Teams

Team	Base	Responsibilities
CMT	Adelaide head office	• Strategic management of Beach's response and recovery efforts in accordance with the Crisis Management Plan. • Provide overall direction, strategic decision-making as well as providing corporate protection and support to activated response teams.

Team	Base	Responsibilities
		• Activate the Crisis Management Team (CMT) if required.
EMT	Adelaide, Melbourne	• Provide operational management support to the Emergency Response team to contain and control the incident. • implement the Business Continuity Plan. • Liaise with external stakeholders in accordance with the site-specific Emergency Response Plan. • Regulatory reporting.
ERT	Site Vessel	• Respond to the emergency in accordance with the site-specific ERP.

8.9.3 Oil Pollution Emergency Plan

Oil spill response arrangements associated with Otway Offshore Operations are detailed within the Offshore Victoria – Otway Basin Oil Pollution Emergency Plan (OPEP) (CDN/ID S4100AH717907).

The COVID-19 pandemic has resulted in restrictions or measures being implemented to address the pandemic. These restrictions or measures can potentially impact oil spill response arrangements. For all Beach activities within the Otway Development area, which includes the Otway Offshore Operations, the environmental risk profile has been reviewed with respect to the commitments in EPs and the Otway Offshore OPEP.

Section 8.12.4 Audits and Assessments and the Otway Offshore OPEP Section 12 On-Going Preparedness and Exercises detail the processes that Beach will complete to ensure that oil spill response requirements can be met during operations and for IMR activities.

8.9.4 Operational and Scientific Monitoring Plan

Operational and scientific monitoring arrangement associated with Otway Offshore Operations are detailed within the Offshore Victoria Operational and Scientific Monitoring Plan (OSMP) (CDN/ID S4100AH717908) and Otway Offshore Operations OSMP Addendum (CDN/ID 18987652).

Table 8-4 and Table 8-5 detail particular values and sensitivities that may require monitoring in the event of a worst-case discharge, using Artisan-1 well location as a proxy indicator for the production wells and based upon conservative (low exposure) in-water thresholds, specifically: AMP, MNP, Marine Park (MP) and RAMSAR wetlands. There was shoreline contact at low exposure thresholds predicted for condensate release, but no intersection with RAMSAR wetlands; there was no shoreline contact predicted for the diesel release. Surface exposure was typically restricted to the immediate vicinity of the release location, however a low probability (1%) of exposure to the Apollo MP was predicted for the diesel release, and a low probability (3%) of exposure to the Twelve Apostles Marine National Park was predicted for the condensate release. These identified values and sensitivities are not exhaustive, as other receptors may also require monitoring in the event of a Level 2 or Level 3 hydrocarbon spill but provide an indication of the potential extent of hydrocarbon contact to formally managed areas.

8.9.5 Testing of Spill Response Arrangements

Section 12.2 of the OPEP details the oil spill response testing arrangements.

Table 8-4: Environment potentially exposure to low in-water thresholds – diesel release from Artisan-1 well location

		Summer				Winter			
		Probability (%) of instantaneous dissolved >6ppb	**Maximum instantaneous dissolved hydrocarbon exposure (ppb)**	**Probability (%) of instantaneous entrained >10ppb**	**Maximum instantaneous entrained (ppb)**	**Probability (%) of instantaneous dissolved >6ppb**	**Maximum instantaneous dissolved hydrocarbon exposure (ppb)**	**Probability (%) of instantaneous entrained >10ppb**	**Maximum instantaneous entrained (ppb)**
Receptor type	**Receptor name**								
AMP	Apollo	3	22	25	406	5	24	54	501
	Beagle	-	-	-	-	-	-	2	11
MNP	Discovery Bay	-	-	3	25	-	-	-	-
	Point Addis	-	-	-	-	-	-	2	17
	Port Philip Heads	-	-	-	-	-	-	4	19
	Twelve Apostles	-	-	26	278	-	-	15	283
	Wilsons Promontory	-	-	-	-	-	-	3	16
MP	Lower South East	-	-	2	22	-	-	-	-
RAMSAR	Port Philip Bay and Bellarine Peninsula	-	-	-	-	-	-	1	10

Table 8-5: Environment potentially exposure to low in-water thresholds – condensate release from Artisan-1 well location

		Summer				Winter			
		Probability (%) of instantaneous dissolved >6ppb	**Maximum instantaneous dissolved hydrocarbon exposure (ppb)**	**Probability (%) of instantaneous entrained >10ppb**	**Maximum instantaneous entrained (ppb)**	**Probability (%) of instantaneous dissolved >6ppb**	**Maximum instantaneous dissolved hydrocarbon exposure (ppb)**	**Probability (%) of instantaneous entrained >10ppb**	**Maximum instantaneous entrained (ppb)**
Receptor type	**Receptor name**								
AMP	Apollo	98	225	98	255	100	237	100	225
	Beagle	2	10	14	15	13	37	40	24
	Murray	-	-	1	10	-	-	-	-
	Nelson	3	18	-	-	-	-	-	-
	Zeehan	4	23	8	14	-	-	-	-
MNP	Bunurong	1	7	19	14	10	34	29	15
	Cape Howe	-	-	-	-	-	-	11	14
	Churhill Island	2	7	12	13	1	8	16	16
	Discovery Bay	15	41	20	17	-	-		
	Point Addis	14	34	49	41	41	51	72	38
	Port Philip Heads	7	21	49	35	8	15	59	30
	Twelve Apostles	99	217	100	302	100	155	100	230
	Wilsons Promontory	4	13	22	26	23	66	74	84
MP	Batemans	-	-	-	-	-	-	8	12

		Summer				**Winter**			
		Probability (%) of instantaneous dissolved >6ppb	**Maximum instantaneous dissolved hydrocarbon exposure (ppb)**	**Probability (%) of instantaneous entrained >10ppb**	**Maximum instantaneous entrained (ppb)**	**Probability (%) of instantaneous dissolved >6ppb**	**Maximum instantaneous dissolved hydrocarbon exposure (ppb)**	**Probability (%) of instantaneous entrained >10ppb**	**Maximum instantaneous entrained (ppb)**
Receptor type	**Receptor name**								
	Lower South East	3	16	16	13	-	-	-	-
RAMSAR	Corner Inlet	-	-	2	11			10	12
	Port Philip Bay and Bellarine Peninsula	4	31	39	25	2	14	27	23
	Western Port	2	12	19	24	2	22	30	21

8.10 Element 9 – Incident Management

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.

There is one standard (Table 8-1) and five outcomes to be delivered under this element, with the standard discussed below.

8.10.1 Standard 9.1 – Incident Management Standard

Standard 9.1 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.

Reportable and recordable incidents are identified by the incident notification processes. In addition, recordable incidents are also identified as per the assurance processes detailed in Table 8-7.

As part of the review and investigation of incidents additional, or increased, environmental impacts or risks may be identified. These are managed as per the Management of Change process detailed in Section 8.8.1.

Notification and reporting requirements for environmental incidents to external agencies are provided in Table 8-6.

Table 8-6: Regulatory incident reporting

Requirement	**Timing**	**Contact**	**Responsible Person**
Recordable incident As defined within the OPGGS(E)R a recordable environmental incident is a breach of an EPO or EPS in the EP that applies to the activity that is not a recordable incident.			
As a minimum, the written monthly recordable report must include a description of: • all recordable incidents which occurred during the calendar month; • all material facts and circumstances concerning the incidents that the operator knows or is able to reasonably find out;	Before the 15th day of the following calendar month	• NOPSEMA – submissions@nopsema.gov.au	Otway Operations Manager

Requirement	Timing	Contact	Responsible Person
• corrective actions taken to avoid or mitigate any adverse environmental impacts of the incident; and • corrective actions that have been taken, or may be taken, to prevent a repeat of similar incidents occurring. Regulation 26B of the OPGGS(E)R requires a recordable incident report to be submitted if there is a recordable incident, thus nil reports are not required.			
Reportable incident As defined within the OPGGS(E)R, a reportable incident is an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage. In the context of the Beach Environmental Risk Matrix moderate to significant environmental damage is defined as any incident of actual or potential consequence category Serious (3) or greater. These risks include: • pipeline or well loss of containment. • vessel collision resulting in a loss of containment or otherwise. • introduction of marine pests to the operational area			
Verbal notification The notification must contain: • all material facts and circumstances concerning the incident; • any action taken to avoid or mitigate the adverse environmental impact of the incident; and • the corrective action that has been taken or is proposed to be taken to stop control or remedy the reportable incident.	Within two hours of becoming aware of incident	• NOPSEMA – 1300 674 472 • NOPSEMA – submissions@nopsema.gov.au • DJPR – marine.pollution@ecodev.vic.gov.au (0409 858 715) • NOPTA – reporting@nopta.gov.au	Otway Operations Manager
Written notification Verbal notification of a reportable incident to the regulator must be followed by a written report. As a minimum, the written incident report will include: • the incident and all material facts and circumstances concerning the incident; • actions taken to avoid or mitigate any adverse environmental impacts; • the corrective actions that have been taken, or may be taken, to	Not later than 3 days after the first occurrence of the incident	• NOPSEMA – submissions@nopsema.gov.au	Otway Operations Manager

Requirement	Timing	Contact	Responsible Person
prevent a recurrence of the incident; and • the action that has been taken or is proposed to be taken to prevent a similar incident occurring in the future.			
Written incident reports to be submitted to NOPTA and DJPR (for incidents in Commonwealth waters).	Within 7 days of written report submission to NOPSEMA	• DJPR – marine.pollution@ecodev.vic.gov.au • NOPTA – reporting@nopta.gov.au	Otway Operations Manager
Vessel spill to marine environment All discharges /spills or probable discharges/spills to the marine environment of oil or oily mixtures, or noxious liquid substances in the marine environment from vessels. Reporting info: http://www.amsa.gov.au/forms-and-publications/AMSA1522.pdf.	Verbal notification ASAP	Immediate notification by the Vessel Master to AMSA. Follow-up with Marine Pollution Report (POLREP). • Ph: 1800 641 792 • Email: rccaus@amsa.gov.au • AMSA POLREP: https://amsa-forms.nogginoca.com/public/	Vessel Master
Australian Marine Park (AMP) In the event an AMP may be exposed to hydrocarbons	Verbal notification ASAP	• Marine Park Compliance Duty Officer – 0419 293 465 Notification must be provided to the Director of National Parks and include: • titleholder details; • time and location of the incident (including name of marine park likely to be affected); • proposed response arrangement; • confirmation of providing access to relevant monitoring and evaluation reports when available; and • contact details for the response coordinator.	EMT Lead (or delegate)
Vessel strike with cetacean	Within 72 hours	• DCCEEW – online National Ship Strike Database https://data.marinemammals.gov.au/report/shipstrike	Vessel Master
	ASAP for cetacean	• Department of Environment, Land, Water and Planning	Vessel Master / Operations

Requirement	Timing	Contact	Responsible Person
	injury assistance	(Whale and Dolphin Emergency Hotline) – 1300 136 017 • Seals, Penguins or Marine Turtles 136 186 (Mon-Fri 8am to 6pm) or AGL Marine Response Unit 1300 245 678.	Environment Advisor
Injury to or death of EPBC Act-listed species	Within seven days	• DCCEEW – 1800 803 772 • EPBC.Permits@environment.gov.au	Operations Environment Advisor
Suspected or confirmed Invasive Marine Species introduction	Verbal notification ASAP	• Department of Environment, Land, Water and Planning – 136 186	Operations Environment Advisor
Identification of any historic shipwrecks, aircraft or relics	Written notification within 1 week	• written notification via the notification of discovery of an historic shipwreck or relic online submission form.	Otway Operations Manager

8.11 Element 10 – Environment and Community

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 activities are clearly identified, minimised to ALARP and mitigated where there is an economic loss to a stakeholder directly impacted by Beach activities.

There are two standards (Table 8-1) and three outcomes to be delivered under this element, with the standards discussed below.

8.11.1 Standard 10.1 – Environment Management Standard

Standard 10.1 ensures that Beach implements appropriate plans and procedures to conduct its operations in an environmentally responsible and sustainable manner. The standard defines the requirement to assess environmental impacts and risks that may result from the company's operations and for site-specific management plans to protect the environment from harm. The standard covers land disturbance, reinstatement and rehabilitation activities, and defines obligations for management of biodiversity, water systems, air quality, noise and vibration, amenities and waste.

This EP provides the key means of satisfying this OEMS standard. Two process identified as controls in Section 6 are described below.

8.11.2 Chemical Management Plan

The Hazardous Materials and Secondary Containment Directive addresses the management of hazardous substances and dangerous goods (termed "hazardous materials") on Beach controlled sites/facilities.

The Beach Chemical Management Plan (S400AD719917) is used to assess chemicals that could be discharged to the marine environment to ensure that the impacts and risks associated with offshore discharge are reduced to ALARP. It considers aquatic toxicity, bioaccumulation and persistence data, along with the discharge concentration, duration, frequency, rate, and volume to assess chemicals that may or will be discharged to the marine environment. The assessment and outcome is recorded on the Offshore Chemical Register.

Figure 8-5 provides a summary of the offshore chemical environmental risk assessment process.

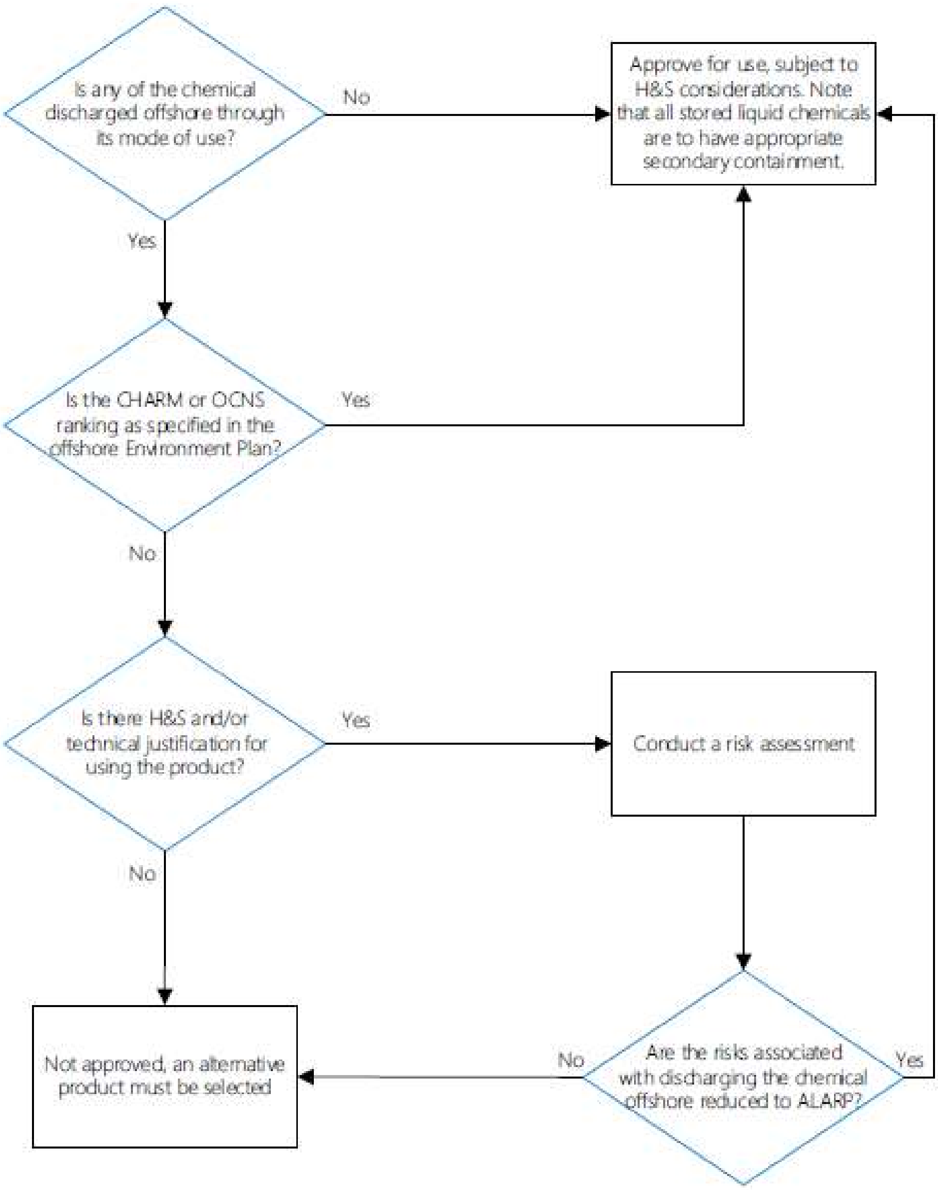

Figure 8-5: Beach offshore chemical environmental risk assessment process summary

8.11.3 Beach Energy Domestic IMS Biofouling Risk Assessment Process

Scope

All MODUs, vessels and submersible equipment mobilised from domestic waters to undertake offshore petroleum activities within the operational area must complete the Beach Domestic IMS Biofouling Risk Assessment Process as detailed in the Beach Introduced Marine Species Management Plan (S400AH719916) prior to the initial mobilisation into the operational area.

This domestic IMS biofouling risk assessment process does not include an evaluation of potential risks associated with ballast water exchange given all MODU and vessel operators contracted to Beach must comply with the most recent version of the Australian Ballast Water Management Requirements.

Purpose

- Validate compliance with regulatory requirements (Commonwealth and State) in relation to biosecurity prior to engaging in petroleum activities within the operational / project area;
- Identify the potential IMS risk profile of MODUs, vessels and submersible equipment prior to deployment within the operational / project area;
- Identify potential deficiencies of IMS controls prior to entering the operational area;
- Identify additional controls to manage IMS risk; and
- Prevent the translocation and potential establishment of IMS into non-affected environments (either to or from the operational / project area).

Screening Assessment

Prior to the initial mobilisation of the MODU, vessels or submersible equipment to the operational / project area, a screening assessment must be undertaken considering:

- All relevant IMO and regulatory requirements under the Australian Biosecurity Act 2015 and/or relevant Australian State or Territory legislation must be met;
- If mobilising from a high or uncertain risk area, the MODU / vessel / submersible equipment must have been within that area for fewer than 7 consecutive days or inspected and deemed low-risk by an independent IMS expert, within 7 days of departure from the area;
- Vessels must have valid antifouling coatings based upon manufacturers specifications;
- Vessels must have a biofouling control treatment system in use for key internal seawater systems; and
- MODUs and vessels must have a Biofouling Management Plan and record book consistent with the International Maritime Organization (IMO) 2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (IMO Biofouling Guidelines).

Where relevant criteria have been met, no further management measures are required, and the MODU / vessel / submersible equipment may be deployed into the operational / project area.

Where relevant criteria have not been met, or there is uncertainty if these criteria have been met, Beach must engage an independent IMS expert to undertake a detailed biosecurity risk assessment, and the MODU / vessel / submersible equipment must be deemed low-risk prior to mobilisation into the operational / project area.

Basis of Detailed IMS Biofouling Risk Assessment

The basis by which an independent IMS expert evaluates the risk profile of a MODU / vessel / submersible equipment includes:

- The age, type and condition of the MODU / vessel / submersible equipment;
- Previous cleaning and inspection undertaken and the outcomes of previous inspections;
- Assessment of internal niches with potential to harbour IMS;
- The MODU / vessel / equipment history since previous inspection;
- The origin of the MODU / vessel / submersible equipment including potential for exposure to IMS;
- Translocation risk based upon source location in relation to activity location – both in relation to the water depth / proximity to land at the point of origin and the potential survivorship of IMS from the point of origin to the operational / project area;
- The mobilisation method – whether dry or in-water (including duration of low-speed transit through high or uncertain risk areas);
- For vessels, the application, age and condition of antifouling coatings;
- presence and condition of internal seawater treatment systems;
- Assessment of Biofouling Management Plan and record book against IMO Biofouling Guidelines; and
- Where appropriate, undertake in-water inspections.

8.11.4 Standard 10.2 – Community Engagement Standard

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 8 of this EP.

8.12 Element 11 – Assurance and Reporting

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.

There are two standards (Table 8-1) and four outcomes to be delivered under this element, with the standards relevant to the activity discussed below.

8.12.1 Standard 11.1 – Sustainability Standard

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.

8.12.2 Standard 11.2 – Assurance Management Standard

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 the organisation 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.

8.12.3 EP Assurance

Table 8-7 provides a summary of the processes (*specific measures*) undertaken by Beach to ensure that for the duration of the activity:

- the environmental impacts and risks of the activity continue to be identified and reduced to a level that is ALARP.
- control measures detailed in this EP are effective in reducing the environmental impacts and risks of the activity to ALARP and an acceptable level.
- environmental performance outcomes and standards set out in this EP are being met.

Non-compliances and opportunities for improvements identified via the assurance processes in Table 8-7 and 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 detailed in Section 8.8.1.

Where an assurance processes identifies a breach of an EPO or EPS in the EP this will be reported as a recordable incident as per Table 8-6.

Table 8-7: Otway Operations EP Assurance Processes

Process	Frequency	Responsible
EP Assurance Checks covering: • EPOs, EPS and implementation strategy requirements. See Section 8.12.4.	As detailed in Table 8-8.	Senior Environment Advisor
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.	Weekly	Senior Environment Advisor
• Reporting and investigation of incidents to identify recordable and reportable incidents and any additional, or increased, environmental impacts or risks. See Section 8.10.	As required	Otway Production Manager with support from Senior Environment Advisor
Otway Operations 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.	Annually	Senior Environment Advisor
Activity (geophysical survey or IMR campaign impact) and 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.	As required	Project Manager
EP Performance Report covering: • Review of EPOs and EPs. See Section 8.12.7.	Annually	Senior Environment Advisor
Otway Operations emissions and discharge records See Section 8.12.8.	As detailed in Table 8-10	Senior Optimisation Engineer

8.12.4 Audits and Inspections

The Otway Offshore Operations Environment Plan Assurance Checklists (TAS 9100 ENV REG) details the assurance checks required to ensure that for the duration of the EP:

- 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.

Table 8-8 details the Assurance Checks undertaken and the timing of these checks.

The assurance checks are scheduled in CMMS to ensure they are undertaken as per the timing in Table 8-8.

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 detailed in Section 8.8.1. 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.

Where an assurance check identifies a breach of an EPO or EPS in the EP this will be reported as a recordable incident as per Table 8-6.

The assurance checks inform the annual performance report submitted to the relevant regulator as per Section 8.12.7.

Table 8-8: Otway EP Assurance Checks

Timing	Assurance Check
Once	EPOs, EPSs and implementation strategy requirements to be reviewed once during the life of the EP. These have been identified as those requirements that are not likely to change over the 5-year period of the EP or are only implemented or undertaken once during the lifetime of the EP.
Vessel including platform support, geophysical surveys and IMR	EPOs and EPSs and implementation strategy requirements applicable to vessels used to support the platform or undertake geophysical surveys or IMR campaigns. This checklist is undertaken prior to a vessel being engaged be Beach for an activity under this EP.
Annual Office	EPOs and EPSs and implementation strategy requirements that can be reviewed in the office. These have been identified as those requirements that are not likely to change over a one-year period or are only undertaken annually.
Annual Platform including workovers	EPOs and EPSs and implementation strategy requirements that are required to be reviewed on the platform or require information from the platform. These have been identified as those requirements that are not likely to change over a one-year period or are only undertaken annually.
6 Monthly Office	EPOs and EPSs and implementation strategy requirements that can be reviewed in the office. These have been identified as those requirements that are likely to change or are required to be undertaken within a 6 -month period. They are also more likely to be critical controls.

Timing	Assurance Check
6 Monthly Platform	EPOs and EPSs and implementation strategy requirements that are required to be reviewed on the platform or require information from the platform. These have been identified as those requirements that are likely to change or are required to be undertaken within a 6 -month period. They include critical controls.
Quarterly Platform	EPOs and EPSs and implementation strategy requirements that are required to be reviewed on the platform or require information from the platform. These have been identified as those requirements that are likely to change or are required to be undertaken within a quarterly period. They include critical controls.

Operations

As detailed in Table 8-8 assurance checks are undertaken for Otway operations based on a defined interval which has been determined based on the frequency that the control is implemented or undertaken and how critical the control is in managing the impact or risk to an acceptable level and ALARP.

The assurance check consists of reviewing this EPs EPOs, EPSs and implementation strategy requirements applicable to the Otway operations.

Where a vessel assurance check identifies a breach of an EPO or EPS in the EP that applies to the activity this will be reported as a recordable incident as per Table 8-6.

IMR or geophysical surveys – Vessel Activities

As detailed in Table 8-8 a pre-mobilisation assurance check isundertaken at least two weeks prior to commencement of vessel operations. The assurance check consists of reviewing this EPs EPOs, EPSs implementation strategy requirements applicable to the vessel activity (platform support, geophysical survey or IMR campaign).

In addition, for geophysical surveys and IMR campaigns the following will be undertaken:

- vessel weekly offshore inspection throughout the activity to ensure ongoing compliance with relevant EP requirements. Inspection will include, but not be limited to:
  - spill preparedness such as spill kit checks.
  - waste management.
  - review of any new or changed chemicals that maybe discharged offshore.
  - validation compliance with EPOs and EPSs relevant to vessel activity are maintained.

Where a vessel assurance check identifies a breach of an EPO or EPS in the EP that applies to the activity this will be reported as a recordable incident as per Table 8-6.

8.12.5 Environment Plan Review

Beach may determine that a review of the EP is required when one or more of the following occurs:

- changes to impacts and risks and/or controls identified during the activity.

- annual environmental performance reporting identifies issues in the EP that require review and/or updating.
- implementation of corrective actions to address internal audits findings or external inspection recommendations.
- an environmental incident and subsequent investigation identify issues in the EP that require review and/or updating.
- a modification of the activity is proposed that is not significant but needs to be documented in the EP.
- changes to risk and controls identified through the Risk Management Processes as per Section 8.9.
- new information or changes in information from stakeholders, research and studies, protected species, legal and other requirements. This shall be achieved by:
  - subscription to regulator and relevant industry distribution lists (such as APPEA and IOGP);
  - subscription to the NOPSEMA website to identify any new petroleum activities within the Otway Basin that may overlap with the Otway Operations locations and timings;
  - annual review of the EP inclusive of relevant regulatory requirements (when in force for longer than 12 months); and
  - ongoing Stakeholder communications.

Where the EP is revised the changes are to be logged in the EP Revision Change Register in Appendix C. Any revisions to the EP are to be assessed against the criteria for submission of a revised EP to NOPSEMA as detailed in Table 8-9 and Management of Change as per Section 8.8.1 shall be evaluated.

8.12.6 Environment Plan Revision

In accordance with Regulation 17 of the OPGGS(E)R, a revision of this EP shall be submitted to NOPSEMA as per the regulatory requirements in Table 8-9.

Table 8-9: Regulatory requirements for submission of a revised EP

OPGGS(E)R	EP Revision Submission Requirements
17(1)	With the regulator's approval before the commencement of a new activity.
17(5)	Before the commencement of any significant modification or new stage of the activity that is not provided for in the EP as currently in force.
17(6)	Before, or as soon as practicable after, the occurrence of any significant new or significant increase in environmental impact or risk; or The occurrence of a series of new or a series of increases in existing environmental impacts or risks which, taken together, amount to the occurrence of a significant new or significant increase in environmental impact or risk.
17(7)	A change in titleholder that results in a change in the manner in which the environmental impacts and risks of an activity are managed.

8.12.7 Annual Performance Report

In accordance with OPGGS(E) Regulation 14(2), Beach will submit a report on the environmental performance of the activity to NOPSEMA. Performance will be measured against the EPOs and EPSs described in this EP. The report will be submitted not more than three months after the anniversary date of the EP acceptance by NOPSEMA. The interval between reports will not be more than one year.

8.12.8 Emissions and Discharge Records

In accordance with OPGGS(E) Regulation 14(7), emissions and discharges shall be recorded for the duration of the activity. Table 8-10 details the types of emissions and discharges that shall be recorded including the monitoring method and frequency of reporting. Air emissions (from fuel combustion and venting) are reported annually as part of statutory National Greenhouse and Energy Act (NGER) 2007 reporting and National Pollution Inventory (NPI) reporting.

Table 8-10: Emissions and discharges monitoring requirements

Emission / Discharge	Monitoring parameter	Recording method	Reporting frequency	Responsibility
Fuel	Volume of gas used	Monthly monitoring	Monthly	Otway Operations Manager
Venting	Volumes	Monthly monitoring	Monthly	Otway Operations Manager
Hydraulic control fluids	Chemical name Volume discharged	Monthly monitoring, calculated annually based on tank replenishment and cargo manifests	Monthly	Otway Operations Manager
IMR Vessel				
Fuel	Volume used	Daily report	Monthly	Vessel Operator
Bilge	Volume discharged	Oil record Book	As required	Vessel Operator
Sewage	Volume discharged	Garbage record book	As required	Vessel Operator
Putrescible food	Volume discharged	Garbage record book	As required	Vessel Operator

8.12.9 Marine Mammal Sighting Reports

Marine mammal sightings will be recorded and submitted to DCCEEW via the National Marine Mammal Data Portal. Sighting will be reported within 1 month of sighting occurring or two months of the end of a geophysical survey.

9 Stakeholder Consultation

Stakeholder consultation was undertaken in line with current NOPSEMA guidelines on consultation requirements under the OPGGS(E)R.

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 risks.

9.1 Regulatory requirements

Section 280 of the OPGGS Act states that a person carrying out activities in an offshore permit area should not interfere with other users of the offshore area to a greater extent than is necessary for the reasonable exercise of the rights and performance of the duties of the first person.

In relation to the content of an EP, more specific requirements are defined in the OPGGS (E) Regulation 11(A). This regulation requires that the Titleholder consult with 'relevant persons' in the preparation of an EP. A relevant person is defined as:

a. 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;

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;

c. the Department of the responsible State Minister, or the responsible Northern Territory Minister;

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;

e. any other person or organisation that the titleholder considers relevant.

Regulation 9(8) of the OPGGS(E)R requires all sensitive information (if any) in an environment plan, and the full text of any response by a relevant person to consultation under regulation 11A in the course of preparation of the plan, must be contained in the sensitive information part of the plan and not anywhere else in the plan.

Regulation 9AB of the OPGGS(E)R requires the Regulator must publish (the EP) on the Regulator's website.

Regulation 14(9) of the OPGGS(E)R also defines a requirement for ongoing consultation to be incorporated into the Implementation Strategy. In addition, Regulation 16(b) of the OPGGS(E)R requires that the EP contain a summary and full text of this consultation. It should be noted that the full text is not made publicly available for privacy reasons.

9.2 Stakeholder consultation objectives

The objectives of Beach's stakeholder consultation in preparation of the EP were to:

- identify all relevant persons for stakeholder consultation.

- engage with stakeholders and the community in an open, transparent, timely and responsive manner.
- minimise community and stakeholders concern where practicable.
- build and maintain trust with stakeholders and the local community.
- demonstrate that stakeholders have been consulted in line with the requirements of the relevant regulations.

The objectives were achieved by:

- identifying stakeholders whose functions, interests or activities may be affected by the activity.
- confirming, through consultation, 'relevant persons' (stakeholders) and engaging them at the earliest opportunity.
- providing sufficient information to allow relevant persons to make an informed assessment of the possible consequences of the activity on their functions, interests or activities.
- ensuring relevant persons are informed about the process for consultation and their feedback is considered in the development of the EP.
- ensuring that issues raised by relevant persons are adequately assessed, and where requested or relevant, responses to feedback are communicated back to them.
- providing a copy of this EP to NOPSEMA for publication on the NOPSEMA website as per regulation 11B of the OPGGS(E)R.
- ensuring that relevant person sensitive information is not made publicly available.

9.3 Consultation approach

The approach Beach has undertaken for consultation is:

- identify stakeholders that may be potentially affect by the activities by reviewing its stakeholder database and consulting with existing stakeholders to identify other relevant stakeholders. Beach, previously as Lattice Energy and Origin Energy, has operated in the area since 2010 and has built an extensive database of stakeholders from ongoing engagement in relation to the current Operating assets and in executing the Otway Development Phase 4 and Phase 5 including the Otway Offshore Drilling program in 2021.
- determine 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.
- provide 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.

- allow a reasonable period of time for the stakeholder to review and respond to any information provided, typically two to four weeks.
- provide further information requested by the stakeholder or that became 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.
- ensure relevant stakeholders were informed about the consultation process and how their feedback, questions and concerns were considered in the EP.

9.4 Fair Ocean Access Procedure

The Fair Ocean Access Procedure was developed by Beach after consultation with stakeholders in particular SETFIA and BSSIA, the stakeholder records can be found in the Prion 3D Marine Seismic Survey EP.

The procedure supersedes Beach's Commercial Fisher Operating Protocol. The Fair Ocean Access Procedure Information Sheet can be found in Appendix G.

9.5 Stakeholder identification

Relevant stakeholders were identified by reviewing:

- social receptors identified in the existing environment section.
- existing stakeholders within Beach's stakeholder register.
- reviewing consultation record for previous Otway Basin activities undertaken by Beach and Lattice.
- Commonwealth and State fisheries jurisdictions and fishing effort in the region.
- the Australian Government Guidance Offshore Petroleum and Greenhouse Gas Activities: Consultation with Australian Government agencies with responsibilities in the Commonwealth Marine Area.

The Otway Development commenced production in late February 2008. Woodside Energy, the titleholder at the time, undertook significant consultation with the community, non-government organisations and Government departments. Consultation has been ongoing through the change of titleholders to Origin Energy and then Lattice Energy and now Beach.

Origin Energy also undertook three marine seismic surveys between 2014 and early 2017 and had regular and detailed engagement with both fishing industry associations and individual fishers over this period. In 2017 Lattice commenced consultation in relation to the Otway Development Phase 4 and associated seabed assessment and drilling activities. Beach then commenced consultation with stakeholders in early 2019 when they decided to progress with the Otway Development Phase 4. Consequently, Beach consider that they have effectively identified relevant stakeholders and have a good understanding of issues and areas of concern within the Otway Development area. Table 9-1 details the relevant stakeholders identified and groups them by the categories listed under OPGGS(E) Regulation 11A. It should be noted that no fishing effort by Tasmanian fisheries was identified within the operational area.

9.6 Provision of information

The OPGGS(E)R require titleholders to give each relevant person sufficient information to allow the relevant person to make an informed assessment of the possible consequences of the activity on the functions, interests or activities of the relevant person. Additionally, a copy of this EP was published on the NOPSEMA website in June 2019 as per regulation 11B of the OPGGS(E)R.

To determine the type of information to provide to a stakeholder an Information Category was developed and is detailed in Table 9-2.

9.7 Summary of stakeholder consultation

Table 9-4 provides a summary of the stakeholder consultation undertaken as part of the review of the EP. The summary provides details of the information sent to stakeholders and any response received. It also details the assessment undertaken of any objection or claims. Where an objection or claim was substantiated via evidence such as publicly available credible information and/or scientific or fishing data, this were assessed as per the risk assessment process detail in section 9.2 and controls applied where appropriate to ensure impacts and risks are managed to ALARP and an acceptable level.

Where an objection or claim was raised by a stakeholder, they were provided feedback as to whether the objection or claim was substantiated, how it was assessed and if any additional controls were required to manage the impact or risk to ALARP and an acceptable level or if not substantiated why.

On 12th May 2021 an email containing the information sheet GD21-0090_Otway Offshore Operations EP was sent to the stakeholders identified in Table 9-1. A follow-up email was sent on 2nd June 2021 to the same stakeholders as no response had been received to the first email. A record of the content of the emails and information sent is in 0. Table 9-4 provides any stakeholder responses received during the consultation and details any objections and claims made.

Table 9-1: Relevant stakeholders for the activity (refer to Table 9-2 for information category definition)

Stakeholder	**Relevance**	**Information category**
Department or agency of the Commonwealth to which the activities to be carried out under the EP may be relevant		
Australian Fisheries Management Authority (AFMA)	Australian Government agency responsible for the efficient management and sustainable use of Commonwealth fish resources. Activity is within a Commonwealth fishery area. AFMA expects petroleum operators to consult directly with fishing operators or via their fishing association body about all activities and projects which may affect day to day fishing activities.	1
Australian Hydrological Office (AHO)	Australian Government agency responsible for issuing notices to mariners.	2
AMSA Joint Rescue Coordination Centre (JRCC)	Australian Government agency responsible for maritime safety, adherence to advice, protocols, regulations. Issue radio-navigation warnings.	1
Parks Australia – Director of National Parks	Australian Government agency responsible for MNES and Australian Marine Parks	1

Stakeholder	Relevance	Information category
Department of Agriculture, Water and Environment-Biosecurity	Australian Government agency responsible for preventing, responding and recovering pests and diseases that threatened the economy and environment.	1
Each Department or agency of a State or the Northern Territory to which the activities to be carried out under the EP may be relevant		
DJPR – Marine Pollution	Regulatory body ensuring Victoria is adequately prepared for and effectively responds to a marine pollution incident in State coastal waters up to three nautical miles offshore.	2
Victorian Fishery Authority	Activity is within a Victorian fishery area or will impact or potentially impact a Victorian fishery area or resource.	1
The Department of the Responsible State or Northern Territory Minister		
Tasmanian DPIPWE EPA Tasmania	Regulatory body for oil and gas activities in Tasmanian waters. Required to be notified of reportable incidents. Commencement and cessation notifications are only required for drilling and seismic surveys.	2
DJPR - Earth Resources Regulation	Regulatory body for oil and gas activities in Victorian waters. Required to be notified of reportable incidents. Commencement and cessation notifications are only required for drilling and seismic surveys.	2
A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP		
Australian Southern Bluefin Tuna Industry (SBTF) Association	Peak body representing Southern Bluefin Tuna companies in Australia. The SBTF overlaps the operational area.	1
Blue Whale Study	Primary research into the ecology of endangered pygmy blue whales in south-east Australia. The operational area BIAs for the pygmy blue whale.	1
Commonwealth Fisheries Association (CFA)	Peak association representing commercial fishing in Commonwealth fisheries. Industry Association for the following Commonwealth fisheries that have catch effort within the operational area: SESSF (Commonwealth South East Trawl Sector, Scalefish Hook Sector and the Shark Hook and Shark Gillnet Sectors). Southern Squid Jig Fishery.	1
Department of Defence (DoD)	After reviewing the DoD's website it was noted that in the Bass Strait and Otway regions there could possibly be unexploded Ordnance (UXO) in the Otway region.	1
Port Campbell Professional Fisherman's Association	Association representing Port Campbell fishers, primarily rock lobster around Port Campbell and Peterborough. Engagement via SIV. s	1
Portland Professional Fishermen's Association	Association representing Portland fishermen.	1
South East Trawl Fishing Industry Association (SETFIA)	SETFIA represents businesses with a commercial interest in the SETF and the East Coast Deepwater Trawl Sector. SETFIA represent the following fisheries that have catch effort within the operational area:	1

Stakeholder	Relevance	Information category
	SESSF (Commonwealth South East Trawl Sector, Scalefish Hook Sector and the Shark Hook, Shark Gillnet Sectors and small pelagic fishery).	
Seafood Industries Victoria (SIV)	Peak body representing professional fishing, seafood processors and exporters in Victoria. SIV primary contact for State fishers.	1
Southern Rock Lobster Limited South Australian Rock Lobster Advisory Council Inc. South Eastern Professional Fishermen's Association Inc. Tasmanian Rock Lobster Fishermen's Association	Associations representing state-based commercial rock lobster fishers. Associations are represented by one consultancy and are therefore grouped.	1
Victorian Rock Lobster Association (VRLA)	VRLA represents Victorian rock lobster licence holders. Engagement via SIV.	1
Any other person or organisation that the titleholder considers relevant		
Abalone Victoria Central Zone	Represent the views and interests of its members and to ensure appropriate governance of member resources. No impact to stakeholders' functions, interests or activities due to the distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3
Alcatel Submarine Networks	They installed the sub-sea fibre optic cable south of Yolla Platform within the Bass Strait. No impact to stakeholders' functions, interests or activities. However, Beach maintain engagement in relation to activities within the Otway area.	3
Australian Petroleum Production and Exploration Association (APPEA)	APPEA is the voice of the oil and gas industry on the issues that matter, working collaboratively with industry and the community.	3
ConocoPhillips	Operator with current permit areas within the EMBA. No impact to stakeholders' functions, interests or activities. However, Beach maintain engagement in relation to activities within the Otway area.	3
Cooper Energy	Operator with current permit areas within the EMBA. No impact to stakeholders' functions, interests or activities However, Beach maintain engagement in relation to activities within the Otway area.	3
Corangamite Shire Council	The Otway Gas Plant is within the Corangamite Shire. The activity does not overlap shoreline receptors. However, Beach maintain engagement in relation to activities within the Otway area.	3
Crab and Shark Fisher	This stakeholder has acknowledged concern in the past during consultation. Beach maintain engagement in relation to activities within the Otway area.	3

Stakeholder	Relevance	Information category
Deakin University – School of Life and Environmental Sciences	Beach provide information as have ongoing engagement in relation to marine studies within their operating areas. No impact to stakeholders' functions, interests or activities.	3
Department of Agriculture and Water Resources	Ensuring Australia's agriculture, fisheries, food and forestry industries remain competitive, profitable and sustainable. No impact to stakeholders' functions, interests or activities. Beach maintain engagement in relation to activities within the Otway area.	3
Fishwell Consulting	Provide expert research advice and consulting services to encourage and promote sustainable fishing practices to the commercial fishing industry within Australia. Beach provide information as have ongoing engagement in relation to marine studies within their operating areas. No impact to stakeholders' functions, interests or activities.	3
Institute for Marine and Antarctic Studies (IMAS) - University of Tasmania	No impact to stakeholders' functions, interests or activities. Beach provide information as have ongoing engagement in relation to seismic survey impacts to commercial fisheries.	3
Lochard Energy	Owns and operates the Iona Gas Plant and the associated facilities located near Port Campbell in the state of Victoria. Offshore activities do not impact on the stakeholder's activities, interests or functions. Beach send information on offshore activities to stakeholder for their information only.	3
Ocean Racing Club of Victoria	Club which conducts regular offshore racing including the Melbourne to Hobart and the Melbourne to Launceston yacht races. However, no impact to stakeholders' functions, interests or activities due to distance offshore.	3
Otway Gas Plant Community Reference Group	Community Reference Group established for the Otway Gas Plant. No impact to stakeholders' functions, interests or activities due to distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3
Peterborough Residents Association Port Campbell Community Group Port Campbell Progress Group Port Campbell Visitor Centre	No impact to stakeholders' functions, interests or activities, because offshore activities do not have an impact. However, Beach maintain engagement in relation to activities within the Otway area.	3
Port Campbell Surf Life Saving Club Port Campbell Board Riders Association	No impact to stakeholders' functions, interests or activities, because of the distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3
Schlumberger	Schlumberger have no planned activities within the Otway region, therefore there will be no impact to stakeholders' functions, interests or	3

Stakeholder	Relevance	Information category
	activities. However, Beach maintain engagement in relation to activities within the Otway area.	
SCUBA Divers Federation of Victoria	No impact to stakeholders' functions, interests or activities, because of the distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3
Surf Rider Association	Registered not for profit sea-roots organisation dedicated to the protection of Australia's waves and beaches through conservation, activism, research and education. No impact to stakeholders' functions, interests or activities due to distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3
Tasmanian Abalone Council Limited	Peak industry body representing divers, processors and quota holders and represents the views and needs of all stakeholders and allied interests alike. No impact to stakeholders' functions, interests or activities due to distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3
Tasmanian Seafood Industry Council (TSIC)	The TSIC is the peak body representing the interests of wild capture fishers, marine farmers and seafood processors in Tasmania. The operational area does not overlap any Tasmanian fisheries where there is catch effort. However, Beach maintain engagement in relation to activities within the Otway area.	3
TGS	Proposing to undertake the Otway Deep three-dimensional (3D) marine seismic survey (MSS) in the Commonwealth waters of the Otway Basin, which is outside of the operational area. No impact to stakeholders' functions, interests or activities. However, Beach maintain engagement in relation to activities within the Otway area.	3
Timboon Action Group	No impact to stakeholders' functions, interests or activities, because offshore activities do not have an impact. However, Beach maintain engagement in relation to activities within the Otway area.	3
Tuna Australia - ETBF Industry Association	Represents statutory fishing right owners, holders, fish processors and sellers, and associate members of the Eastern and Western tuna and billfish fisheries of Australia. The operational area does not overlap any Eastern and Western tuna and billfish fishery areas. However, Beach maintain engagement in relation to activities within the Otway area.	3
Twelve Apostles Tourism and Business Group	No impact to stakeholders' functions, interests or activities, because offshore activities do not have an impact. However, Beach maintain engagement in relation to activities within the Otway area.	3
Victorian Scallop Fishermen's Association	Represents the interests of scallop fishermen operating within Australia's south east waters. No impact to stakeholders' functions, interests or activities due to distance offshore. However, Beach maintain engagement in relation to activities within the Otway area.	3

Table 9-2: Information category to determine information provided stakeholder

Information Category	Description	Information Type
1	Organisations or individuals whose functions, interests or activities may be impacted by the activity. Representative body for fishers who provide information to their members.	Information Sheet and/or provision of information as per organisations consultation guidance Provision of further information where required Meeting or phone call where required
2	Organisation who receive activity commencement and cessation notices.	Commencement and cessation notices.
3	Organisations or individuals whose functions, interests or activities will not be impacted by the activity but are kept up to date with Beach's activities in the Otway area.	Information Sheet

9.8 Ongoing stakeholder consultation

As the activity will be undertaken over a five-year period Beach will continue to consult with stakeholders to keep them informed as information becomes available. This will be done via ongoing consultation including updates in relation to the activity and broader Otway Offshore Gas Development project via one-on-one communications, mail outs and provision of information on the Beach website.

Any objections or claims raised from ongoing consultation will be managed as per Section 9.8.2.

Records of ongoing stakeholder engagement will be maintained as per Section 9.8.2 Records Management.

9.8.1 Ongoing Identification of Relevant Persons

New or changes to relevant persons will be identified through ongoing consultation with stakeholders including peak industry bodies and the environment plan review process detailed in Section 8.12.5. Should new relevant persons be identified they will be contacted and provided information about the activity relevant to their functions, interests or activities. Any objections or claims raised will be managed as per Section 9.8.2.

9.8.2 Management of objections and claims

If any objections or claims are raised during ongoing consultation these will be substantiated via evidence such as publicly available credible information and/or scientific or fishing data. Where the objection or claim is substantiated, it will be assessed as per the risk assessment process detail in Section 6 and controls applied where appropriate to manage impacts and risks to ALARP and an acceptable level. Stakeholders will be provided with feedback as to whether their objection or claim was substantiated, and if not why, and if it was substantiated how it was assessed and if any controls were put in place to manage the impact or risk to ALARP and an acceptable level. If the objection or claim triggers a revision of the EP this will be managed as per Section 8.12.5 and 8.12.6. This will also be communicated to the stakeholder.

Table 9-3: Ongoing stakeholder consultation requirements

Stakeholder	Ongoing stakeholder requirement	Timing
Relevant stakeholders	Ongoing engagement including: • stakeholder communication of information and addressing queries and concerns via email, phone or meeting; and • updates to Beach website.	As required
Relevant stakeholders who may be impacted by any activity outside of the PSZ for the Thylacine-A Platform.	Stakeholder notification of IMR activity commencement. Notification to include: • 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 details including call sign and contact; • any safety exclusion zones required; and • Beach contact details. Note: coordinates to be provided as degrees and decimal minutes referenced to the WGS 84 datum.	2 weeks prior to activity commencing
AHO	For IMR activities, vessel contractor to issue notification of activity for publication of notice to mariners (NTM). Information provided should detail: • type of activity; • geographical coordinates of the well location; • any exclusion zones required; • period that NTM will cover (start and finish date); • vessel details including name, Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), contact details and call signs; and • Beach and vessel contractor contact details. Update AHO of progress, changes to the intended operations including if activity start or finish date changes.	4 weeks prior to activity commencing
AMSA - JRCC	For IMR activities, vessel contractor to issue notification of activity for promulgation of radio navigation warnings. Information provided should detail: • type of activity; • area of operation: geographical coordinates of the well location; • any exclusion zones required; • period that warning will cover (start and finish date); • vessel details including name, call-sign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone numbers), contact details and calls signs; • any other information that may contribute to safety at sea; and • Beach and vessel contractor contact person.	48 – 24 hrs prior to activity commencing

Stakeholder	Ongoing stakeholder requirement	Timing
	Update AMSA JRCC of progress, changes to the intended operations including if activity start or finish date changes.	
NOPSEMA	Regulatory notification of start and completion of activity. This includes IMR activities.	10 days prior to activity commencing and completing
DJPR	Regulatory notification of start and completion of activity within 3nmls from shore.	Within 10 days of activity commencing and completion

Table 9-4: Summary of stakeholder consultation records and Beach assessment of objections and claims

Stakeholder name	Date	Record #	Description	Assessment of objection or claim
Australian Fisheries Management Authority (AFMA)	18/05/2021	AFMA_35	Beach followed up with AFMA to confirm if there is catch effort within the operational area from the following fisheries: Southern and Eastern Scalefish and Shark Fishery (SESSF) and the Southern Squid Jig Fishery.	
Australian Fisheries Management Authority (AFMA)	16/06/2021	AFMA_36	AFMA replied to Beach's follow-up email that AFMA are unable to comment on individual proposals due to limited resources within AFMA. AFMA provided links to fishery associations and Commonwealth Concession holders that may be relevant and need to be consulted. Beach acknowledged the email and informed AFMA that Beach are already consulting with all relevant fishers in the area and will continue ongoing engagement.	No concerns raised. Beach continue ongoing engagement with all relevant fishers in the area as shown in Table 9-1.
Australian Hydrographic Office (AHO)	02/06/2021	AHO_08	AHO responded to Beach's follow-up email. It was an acknowledgement that the AHO had received and registered Beach's correspondence.	No concerns raised.
Australian Maritime Safety Authority (AMSA)	18/05/2021	AMSA_05	AMSA replied to Beach's initial email with the following information: Maritime Safety Information– please ensure that timely and relevant Maritime Safety Information (MSI) is promulgated for the area and nature of your operations. To promulgate MSI, you should: 1. Contact the Australian Hydrographic Office at datacentre@hydro. gov.au no less than four weeks before operations, with details relevant to the operations. The AHO will promulgate the appropriate Notice to Mariners (NTM), which will ensure other vessels receive information of your activities. 2. Notify AMSA's Joint Rescue Coordination Centre (JRCC) by e-mail to rccaus@amsa.gov.au (Phone: 1800 641 792 or +61 2 6230 6811) for promulgation of radio-navigation warnings at least 24-48 hours before operations commence. AMSA's JRCC will require the vessel details (including name, callsign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone numbers), area of operation, requested clearance from other vessels and any other information that may contribute to safety at sea. JRCC will also need to be advised when operations start and end. 3. You should plan to provide updates to both the Australian Hydrographic Office and the JRCC on progress and, importantly, any changes to the intended operations. 4. Exhibit appropriate lights and shapes to reflect the nature of operations– we remind vessels of their obligation to comply with the International Rules for Preventing Collisions at Sea (COLREGs),in particular, the use of appropriate lights and shapes to reflect the nature of your operations(e.g. restricted in the ability to manoeuvre).Vessels should also ensure their navigation status is set correctly in the ship's AIS unit. 5. To obtain a vessel traffic plot showing Automatic Identification System (AIS) traffic data for your area of interest, please visit AMSA's spatial data gateway and Spatial@AMSA portal to download digital data sets and maps. A form for requesting customised information and data is also available via the portal (fees may apply). Beach responded to AMSA confirming Beach are aware of the advice given and Beach will inform the AHO and the JRCC prior to commencing operations and providing updates during the operations. All vessels used during operations will ensure and Beach will verify the ongoing display of appropriate lights and shapes to reflect the nature of the operations in line with the COLREGs.	The following has been updated in relation to AMSA's email: 1. Section 9.8 Ongoing Stakeholder Consultation Table 9-3: Ongoing stakeholder consultation requirements updated to include AHO notification requirements. Throughout EP updated Australian Hydrographic Service to Australian Hydrographic Office. 2. Section 9.8 Ongoing Stakeholder Consultation Table 9-3: Ongoing stakeholder consultation requirements updated to include AMSA JRCC notification requirements. Control Measure CM#8 updated to reflect that AMSA issue radio-navigation warning rather than AUSCOAST warning. 3. Section 9.8 Ongoing Stakeholder Consultation Table 9-3: Ongoing stakeholder consultation requirements updated to include AHO and AMSA JRCC update requirements. 4. Control Measure CM#27 updated to clarify that AMSA Marine Order 30: Prevention of collisions ensures compliance with the International Rules for Preventing Collisions at Sea (COLREGs). 5. Control Measure #29: Navigation and communication aids updated to include requirement to ensure navigation status is set correctly in vessel AIS unit. Added requirement as an environmental performance standard in Table 7-30: Environmental performance outcomes, standards and measurement criteria – IMR, Geophysical Surveys and Support Operations. 6. Data for vessel traffic figure in Section 5.7.4 Shipping was obtained from AMSA spatial data. The data obtained is the most current data to date.
Australian Southern Bluefin Tuna	04/06/2021	ASBT_20	Australian Southern Bluefin Tuna responded to Beach's follow-up email. No concerns were raised in relation to Beach's Otway operations.	No concerns raised.
Cooper Energy	12/05/2021	CE_22	Cooper Energy asked Beach what the Otway Offshore Operations impact will have on road traffic and truck movements. Beach phoned Cooper Energy regarding general matters in South-west Victoria. Advised the Offshore Operations EP revision has no impact on vehicles near Cooper's plant in Port Campbell. Some equipment will be installed at the Otway Gas Plant to enable new offshore wells to come online and that will mean additional contractors and equipment over a short period of time, to be determined.	The enquiry was regarding onshore matters, therefore no concerns raised for the offshore operations.

Stakeholder name	Date	Record #	Description	Assessment of objection or claim
Department of Agriculture, Water and Environment (DAWE) - Biosecurity	03/05/2021	DAWE-Bio_01	DAWE Biosecurity emailed Beach a receipt of confirmation they have received the email.	No concerns raised.
Department of Agriculture, Water and Environment (DAWE) - Biosecurity	03/05/2021	DAWE-Bio_02	DAWE biosecurity called Beach to gain further understanding of the Otway Offshore Operations and enquired about the already existing Thylacine-A platform. The questions raised by DAWE biosecurity were considered as administrative enquiries. DAWE biosecurity requested for the Thylacine-A consent to construct and install the platform application. Beach provided DAWE biosecurity a copy of the Consent to Construct and Install Thylacine-A Offshore Platform.	Administrative enquiry. No concerns raised.
Department of Defence (DoD)	03/06/2021	DoD_02	DoD responded to Beach's follow-up email. They provided advice on liaising with the AHO three weeks prior to the commencement of activities. Beach responded, thanking the DoD for the acknowledgement of receiving the follow-up email and notifying Beach of the advice.	Table 9-3 has been updated to include the AHO requirement.
Director of National Parks	5/7/2021	DNP_08	DNP responded to Beach's initial email. They noted that as the planned activities do not overlap AMPs there are no authorisation requirements. DNP provided guidance on the consideration of AMPs and their representativeness when preparing an EP for petroleum activities. They provided resources for identifying values in AMPs, including the South- east Management Plan and the Australian Marine Parks Science Atlas. DNP confirmed that they do not require further notification of progress made in relation to the activity unless details regarding the activity change and result in an overlap with or new impact to a marine park, or for emergency responses. DNP provided contact details for notification of oil/gas pollution incidences which occur within a marine park or are likely to impact on a marine park and outlined the details required in this notification. Beach responded, confirming that the EP will contain assessment of impacts and risks against AMPs as well as that the routine and incident reporting will be updated in the EP.	Table 8-6 updated to include DNP's contact for notification of oil/gas pollution incidences which occur within a marine park or are likely to impact on a marine park.
Institute for Marine and Antarctic Studies- University of Tasmania	02/06/2021	IMAS_19	Institute for Marine and Antarctic Studies- University of Tasmania responded to Beach's follow-up email, however no concerns were raised.	No concerns raised.
Seafood Industry Victoria (SIV)	09/06/2021	SIV_80	SIV replied to Beach's follow-up email. SIV has a new liaison person who wanted to clarify the role of SIV in distributing information to SIV members and how the information is distributed. SIV commented on the draft information sheet regarding rock lobster and giant crab fishing within the operational area along with the Fair Ocean Access Procedure for Compensation Claim Form asking if Beach would like SIV to comment on these two matters. They also commented that the map doesn't reflect the 4 new wells – just two. Beach replied that the previous SIV Executive Officer would apply discretion as to what EPs they could give representative feedback on, and what EPs should be distributed to members. From past engagements, they would not have distributed this information to members as it is a revised EP for an asset that has been in place since 2006. Also, SIV has previously communicated our drilling program to members, and the current Otway Offshore Operations EP is being reviewed to connect up new wells. Nevertheless, stakeholder consultation is an important part of our impact assessment process for new and revised EPs, thus our emails to SIV recently. We are currently working on an update to our overall Otway Offshore Project information sheet that we will issue next week. You may wish to distribute that to SIV members, as it covers the broad scope of all activities. But I will leave that to your discretion.	Beach provided SIV information regarding the distribution of information to SIV members. SIV asked are you suggesting that rock lobster and giant crab will not be affected? Beach addressed the comment based on data confirmed from VFA (stakeholder record VFA 01) and as there is a 500 m PSZ around the Thylacine-A platform and Geographe subsea well heads that is displayed on marine charts that fishing cannot occur within this area, this suggests that rock lobster and giant crab fishers will not be impacted as there is no change to the current areas where they can fish.

Stakeholder name	Date	Record #	Description	Assessment of objection or claim
			As to distribution channels, previously SIV has include our information sheets within the printed magazine, but I understand that the magazine is moving to online only. If you felt that 'snail mail' was better for your members, we are happy to facilitate printing of our content and placing in pre-paid envelopes for SIV to apply labels and post. We have also done that before with SIV where the project was deemed to have potentially disturbed fishing activity. From our assessments, that does not appear to be the case with the current activity. We also consult with Victorian Fisheries Authority and get an annual update of State licenced fishing activity, which is what I referenced in our information sheet for the EP review. In particular, the area around the Thylacine offshore platform has had a 500m radius Petroleum Safety Zone, along with other existing well heads. Therefore, fishers would be aware from marine charts that fishing cannot occur there. As such, we are suggesting that rock lobster and giant crab fishers will not be affected, but again if you wish to check with SIV members, we are happy to pay for costs of any mail outs. Regarding the map and reference to number of wells, the incorrect map label was used on the information sheet we sent you. Please see the map with the correct label, which we will replace on the information sheet on our website. The wells are not marked separately as they are very close together near the platform. Beach commented that they welcome any comments from SIV regarding the "Fair Ocean Access Procedure".	
Seafood Industry Victoria (SIV)	26/07/2021	SIV_81	SIV emailed a letter to Beach with feedback and questions regarding Beach's "Fair Ocean Access: Procedure for compensation claims from Commercial Fishers", seismic surveys, impact assessments and industry engagement. SIV stated that they would like to understand the outcomes of Department of Science, Energy and Resources (DISER) workshops in which Beach is participating, pursuing a national compensation framework for commercial fishers from offshore mining activities, and whether Beach would adapt its compensation procedure in relation to any national framework. They requested clarification on the defined area for compensation, expressed the need to consider the impact of COVID on fishers and provided advice on presenting information to SIV.	SIV requested clarification on compensation amount and the defined project area. They expressed concern regarding the impact of COVID on fishers.
Seafood Industry Victoria (SIV)	09/08/2021	SIV81	Beach emailed a letter in response to SIV's letter of 26/07/2021, addressing each question and feedback points.	Beach will continue its ongoing engagement with SIV and remains open to review of the Beach compensation procedure should relevant and broadly accepted approaches to compensation arise from the workshops being led by the Department of Science, Energy and Resources. Beach understands SIV's feedback regarding stakeholder fatigue, provided examples of Beach's adaptive communications to meet different stakeholder needs, remains open to further recommendations from SIV, such as their offer to place Beach information on their website.
TGS	02/06/2021	TGS_29	TGS responded to Beach's follow-up email, however no concerns were raised.	No concerns raised.
TGS	08/06/2021	TGS_30	Beach emailed TGS requesting further information on when they are going to undertake the Otway Deep Marine Seismic Survey. TGS confirmed they have nothing committed for the 2021 season so it's unlikely they will be acquiring this season. TGS are looking at the 2022/2023 season as the most likely start date utilising a new environment plan. TGS will be in touch in the near future regarding their 2022/2023 plans.	Table 5-19 has been updated with TGS planned timeline for the Otway Deep Marine Seismic Survey
Victorian Fisheries Association	18/03/2021	VFA_79	Beach emailed VFA notifying them that Beach are currently reviewing their exploration and development planning and therefore their stakeholder assessments. As such, Beach requested the latest fishing activity data in the area of their operations, given Beach's last data request was in 2019, for which Beach received data from 2014 – 2018. Beach requested for an up-to-date report of monthly catch by species from the last 5 years (Jan 2016- Nov 2020) for the following fishing blocks: • G10; G11; G12; G13 • H10; H11; H12; H13 • J10; J11; J12; J13 • K10; K11; K12; K13 • L10; L11; L12; L13 • M10; M11; M12; M13	Data was obtained for January 2016 - November 2020. Based on the updated fishery data Section 5.7.9 was updated

Stakeholder name	Date	Record #	Description	Assessment of objection or claim
Victorian Fisheries Association	05/08/2021	VFA 80	Beach shared its draft “Fair Ocean Access: Procedure for compensation claims from Commercial Fishers” with VFA for feedback and discussion, VFA replied with questions regarding resolving disagreements and industry wide compensation frameworks, and provided guidance on how VFA can support any compensation process with data verification.	Beach explained; that its compensation procedure includes a section for the independent appointment of an independent expert, paid for by Beach; that it is participating in an industry wide workshop with DISER and the seafood sector and should relevant and broadly accepted approaches to compensation arise from the workshops, Beach would consider review of its compensation procedure should relevant and broadly accepted approaches arise from that process. Beach is grateful of VFAs, support should it be required, in verify fishing data.

10 References

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

Adam P (1990). Saltmarsh Ecology. Cambridge University Press, Cambridge.

Advanced Geomechanics (2011). Technical Note Origin Doc No. S4200-RU-700699.

Andrew (1999). Under Southern Seas, University of New South Wales Press, Sydney, Australia pp. 238.

Andrew and O'Neill (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., Schmitt, N.T. & Double, M.C. (2018). Humpback whale migrations to Antarctic summer foraging grounds through the southwest Pacific Ocean. Scientific Reports. 8. 10.1038/s41598-018-30748-4.

Animal Diversity Web. (2020) *Pelecanoides urinatrix* common diving petrel. https://animaldiversity.org/accounts/Pelecanoides_urinatrix/#56244cb6e7a321c7c81115ff8e219dc5

Annala J.H (1991). Factors influencing fecundity and population egg production of Jasus species. In 'Crustacean Egg Production'. (Eds A Wenner and A. Kuris.) pp.301 -15 (A. A. Balkema: Rotterdam.)

Ansell, R., Gibson, R.N., and Barnes, M. (eds). (1999). Oceanography and Marine Biology: An Annual Review, Volume 37. The Dunstaffnage Marine Laboratory, Scotland.

AAD, 2020. Short-tailed shearwater. Australian Antarctic Division. http://www.antarctica.gov.au/about-antarctica/wildlife/animals/flying-birds/petrels-and-shearwaters/short-tailed-shearwater

Arnould J.P.Y. & Berlincourt M. (2014). At-Sea Associations in Foraging Little Penguins. School of Life and Environmental Sciences, Deakin University, Victoria, Australia.

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.

Attard, C. R. M., L. B. Beheregaray, J. Sandoval-Castillo, C. S. Jenner, P. C. Gill, M. N. M. Jenner, M. G. Morrice, and L. M. Moller. 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):170925.

Aulich, M. G., R. D McCauley, B. J. Saunders & M. J. G. Parsons. (2019) Fin whale (*Balaenoptera physalus*) migration in Australian waters using passive acoustic monitoring. Scientific Reports. 9: ARTN 8840.

Austin, M.E., Hannay, D.E. and Broker, K.C. (2018) Acoustic characterization of exploration drilling in the Chukchi and Beaufort seas. J. Acoust. Soc. Am. 144 (1), July 2018.

Australian Marine Parks (2019). Zeehan Marine Reserve. Available from: https://parksaustralia.gov.au/marine/parks/south-east/zeehan/

Australian Maritime Safety Authority (AMSA) (2015). Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities. Australian Government.

Australian Maritime Safety Authority (AMSA) (2018). Annual Report 2017-18. Australian Government.

Australian Museum. (2020). Orange-bellied Parrot. https://australianmuseum.net.au/learn/animals/birds/orange-bellied-parrot-neophema-chrysogaster/

Backhouse, G., Jackson, J. and O'Connor, J. 2008a. National Recovery Plan for the Australian Grayling *Prototroctes maraena*. Department of Sustainability and Environment, Melbourne.

Baker (1985). Pygmy right whale *Caperea marginata* (Gray, 1846). In: Ridgway, S H and R. Harrison, eds. Handbook of Marine Mammals Vol. 3: The Sirenians and Baleen Whales. Page(s) 345-354. Academic Press, London.

Baker, G.B., R. Gales, S. Hamilton and V. Wilkinson (2002). Albatrosses and petrels in Australia: a review of their conservation and management. Emu 102:71-97.

Baker, C., Potter, A., Tran, M., Heap, A.D. 2008. Sedimentology and geomorphology of the northwest marine region: a spatial analysis (Geoscience Australia Record No. 2008/07). Geoscience Australia, Canberra.

Ball, D. and 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 (2001). Status of southern right whales *(Eubalaena australis*) off southern Australia. Journal of Cetacean Research and Management Special Issue 2: 103-110.

Bannister, J.L., C.M. Kemper, and R.M. Warneke (1996). The Action Plan for Australian Cetaceans. Canberra: Australian Nature Conservation Agency. Available from: http://www.environment.gov.au/coasts/publications/cetaceans-action-plan/pubs/whaleplan.pdf.

Bannister, J.L., C.M. Kemper, and R.M. Warneke (1996). The Action Plan for Australian Cetaceans. Canberra: Australian Nature Conservation Agency. Available from: http://www.environment.gov.au/coasts/publications/cetaceans-action-plan/pubs/whaleplan.pdf.

Barton, J., Pope, A. and S. Howe (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.

Bilney, R.J., and W. B. Emison (1983). Breeding of the White-bellied Sea-eagle in the Gippsland Lakes Region of Victoria, Australia. Australian Bird Watcher 10:61-68.

BirdLife International (2019). Species factsheet: Pterodroma macroptera. Available from: http://www.birdlife.org.

Backhouse, G., Jackson, J. and O'Connor, J. 2008a. National Recovery Plan for the Australian Grayling *Prototroctes maraena*. Department of Sustainability and Environment, Melbourne. Available from: https://www.environment.gov.au/system/files/resources/184f9f43-1f10-441d-a918-5df406b2cd2c/files/australian-grayling.pdf

Blower D. C., J. M. Pandolfi, B. D. Bruce, M. Gomez-Cabrera & J. R. Ovenden. (2012). Population genetics of Australian white sharks reveals fine-scale spatial structure, trans - oceanic dispersal events and low effective population sizes. Mar Ecol Prog Ser 455: 229–244.

Beaman, Daniell and Harris (2005). Geology-benthos relationships on a temperate rocky bank, eastern Bass Strait, Australia. Marine and Freshwater Research, Vol 56 CSIRO publishing. Available from: https://www.deepreef.org/images/stories/publications/peer-reviewedliterature/GeologyBenthosRelations2005.pdf.

Best, P. B., Brandao, A. and Butterworth, D. S. (2001). Demographic parameters of southern right whales off South Africa. Journal of Cetacean Research and Management Special Issue 2: 161 -169.

BHP Petroleum (1999). Minerva Gas Field development: Environmental Impact Statement and Environment Effects Statement.

BirdLife Australia (2016a). Hooded Plover. *Thinornis rubricollis*. Available from: https://birdlife.org.au/bird-profile/hooded-plover

BirdLife Australia (2016b). Black-faced Cormorant. *Phalacrocorax fuscescens*. Available from: http://birdlife.org.au/bird-profile/black-faced-cormorant

BirdLife Australia (2016c). Australasian Gannet. *Morus serrator*. Available from: https://www.birdlife.org.au/bird-profile/australasian-gannet

BirdLife Australia (2017a). Gull-billed Tern. *Gelochelidon nilotica*. Available from: http://www.birdlife.org.au/bird-profile/gull-billed-tern

BirdLife Australia (2017b). Kelp Gull. *Larus dominicanus*. Available from: http://birdlife.org.au/bird-profile/kelp-gull

BirdLife Australia (2017c). Silver Gull. *Chroicocephalus novaehollandiae*. Available from: http://birdlife.org.au/bird-profile/Silver-Gull

BirdLife Australia (2017d). Pacific Gull. *Larus pacificus*. Available from: http://www.birdlife.org.au/bird-profile/pacific-gull

BirdLife Australia (2017e). Red-necked Avocet. *Recurvirostra novaehollandiae*. Available from: http://www.birdlife.org.au/bird-profile/red-necked-avocet

BMT WBM (2011). Ecological Character Description of the Corner Inlet Ramsar Site – Final Report. Prepared for the Australian Government Department of Sustainability, Environment, Water, Population and Communities. Canberra.

Boon, P., Allen, T., Brook, J., Carr, G., Frood, D., Harty, C., Hoye, J., McMahon, A., Mathews, S., Rosengren, N., Sinclair, S., White, M., and Yugovic, J. (2011). Mangroves and Coastal Saltmarsh of Victoria, Distribution, Condition, Threats and Management. Institute for Sustainability and Innovation, Victoria University.

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.

Booth, J. D. (1994). Jasus edwardsii larval recruitment off the east coast of New Zealand. Crustaceana 66(3), 295-317

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 (1993) 35-56.

BP. 2013. Shah Deniz 2 Project. Environmental and Socio-Economic Impact Assessment. BP Development Pty Ltd. https://www.bp.com/en_az/caspian/sustainability/environment/ESIA.html

Branch, T. A., Matsuoka, K. and Miyashita, T. (2004). Evidence for increases in Antarctic blue whales based on Bayesian modelling. Marine Mammal Science 20(4): 726-754.

Branch, T. A., Matsuoka, K. and 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.

Brown, K & Root, (2010), Western Port Ramsar Wetland Ecological Character Description. Report for Department of Sustainability, Environment, Water, Population and Communities, Canberra. Accessed at https://www.environment.gov.au/system/files/resources/95deb742-85da-4785-8206-7ec139bdfaa8/files/19-ecd.pdf [11 October 2019]

Brown, P.B. and Wilson, R.I. (1980). A survey of the Orange-bellied Parrot *Neophema chrysogaster* in Tasmania, Victoria & South Australia: a report prepared for World Wildlife Fund (Australia). National Parks & Wildlife Service, Tasmania.

Bruce, B. D., D. Harasti, K. Lee, C. Gallen & R. Bradford. (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.

Brusati, E.D. and Grosholz, E.D. (2006). Native and Introduced Ecosystem Engineers Produce Contrasting Effects on Estuarine Infaunal Communities. Biological Invasions 8: 683.

Buckley, R. W. (1993). Sites of Geological and Geomorphological Significance along the Victorian Coast, Geological Survey of Victoria.

Butcher, R, Hale, J and Cottingham, P. (2011a). Ecological character description for Piccaninnie Ponds Karst Wetlands. Prepared for the Department of Environment, Water and Natural Resources. Accessed at file:///C:/Users/bridg/Downloads/cons-gen-picanninieponds-characterdescription.pdf [11 October 2019]

Butcher, R.J., Cottingham, P., Hale, J., Philips, B., and Muller, K. (2011b). Ramsar Management Plan for Piccaninnie Ponds Karst Wetlands.

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). Page(s) 89-102.

Butler, A., Althaus, F., Furlani, D. and Ridgway, K. (2002). Assessment of the Conservation Values of the Bass Strait Sponge Beds Area: A component of the Commonwealth Marine Conservation Assessment Program 2002-2004. Report to Environment Australia, CSIRO Marine Research.

Cai, W. and 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. https://doi.org/10.1029/2006GL028037

Carlyon, K., Pemberton, D. and Rudman, T. (2011). Islands of the Hogan Group, Bass Strait: Biodiversity and Oil Spill Response Survey. Resource Management and Conservation Division, DPIPWE, Hobart, Nature Conservation Report Series 11/03

Carlyon, K., Visoiu, M., Hawkins, C., Richards, K. and Alderman, R. (2015). Rodondo Island, Bass Strait: Biodiversity & Oil Spill Response Survey, January 2015. Natural and Cultural Heritage Division, DPIPWE, Hobart. Nature Conservation Report Series 15/04.

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, A.G., Przeslawski, R., Duncan, A., Gunning, M. and Bruce B. 2017. A critical review of the potential impacts of marine seismic surveys on fish and invertebrates. Marine Pollution Bulletin 114: 9-24.

CEE Consultants Pty Ltd (2003). Otway Gas project Gas field and Subsea Pipeline Marine Biological Conditions, Existing Conditions and Impact Assessment.

Cefas. (2018) PLONOR List issued (23 August 2018). https://www.cefas.co.uk/cefas-data-hub/offshore-chemical-notification-scheme/ocns-bulletin-board/new-plonor-list-issued-23-august-2018/

Chapman, C.C., Lea, M.A., Meyer, A., Sallée, J.B. and Hindell, M., 2020. Defining Southern Ocean fronts and their influence on biological and physical processes in a changing climate. Nature Climate Change, 10(3), pp.209-219.

Chapp, E., D.R. Bohnenstiehl, and M. Tolstoy (2005). Sound-channel observations of ice generated tremor in the Indian Ocean. Geochemistry Geophysics Geosystems 6, Q06003, http://dx.doi.org/10.1029/2004GC000889.

Charlton, C.M., Guggenheimer, S.N. and Burnell, S.R (2014). Long term Southern Right Whale population monitoring at the Head of the Great Australian Bight, South Australia (1991 - 2013).

Report to the Department of Environment, Australian Antarctic Division, Australian Marine Mammal Centre. May 2014.

Charlton, C. M. (2017) Population demographics of southern right whales (Eubalaena australis) in Southern Australia. (PhD Thesis). Curtin University, Western Australia. Pp171.

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

Church, John.A., Hunter, John.R., Mcinnes, K., White, Neil.J., 2006. Sea-level rise around the Australian coastline and the changing frequency of extreme events. Australian Meteorological Magazine 55, 253–260. https://doi.org/10.1016/j.gloplachs.2006.04.001

Clancy, G.P. (2005). The diet of the Osprey (Pandion haliaetus) on the north coast of New South Wales. Emu 105:87-91.

Cogger, H.G. 1992, Reptiles and amphibians of Australia, Rev. 1992 [i.e. 4th rev.] ed, Reed, Frenchs Forest, N.S.W

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. (1993). The Action Plan for Australian Reptiles. Canberra, ACT: Australian Nature Conservation Agency. Available from: http://www.environment.gov.au/biodiversity/threatened/action/reptiles/index.html.

Commonwealth of Australia (2015b). Conservation Management Plan for the Blue Whale—A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 Commonwealth of Australia, 2015**.**

Commonwealth of Australia (2015c). South-east Marine Region Profile: A description of the ecosystems, conservation values and uses of the South-east Marine Region.

Commonwealth of Australia (2017a) National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna 2017.

Commonwealth of Australia (2017b). Recovery Plan for Marine Turtles in Australia. Available at http://www.environment.gov.au/system/files/resources/46eedcfc-204b-43de-99c5-4d6f6e72704f/files/recovery-plan-marine-turtles-2017.pdf.

Commonwealth of Australia. (2018) The Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Ocean.

Commonwealth of Australia (2019a). Draft National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2019.

Commonwealth of Australia (2019b). Draft National Recovery Plan for the Australian Fairy Tern (*Sternula nereis nereis*).

Commonwealth of Australia (2019c). Draft Wildlife Conservation Plan for Seabirds, Commonwealth of Australia 2019.

Commonwealth of Australia (2019d). Draft National Recovery Plan for the Swift Parrot (*Lathamus discolor*), Commonwealth of Australia 2019.

Commonwealth of Australia (2020a). National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds and migratory shorebirds, Commonwealth of Australia 2020

Commonwealth of Australia (2020) Australian Ballast Water Management Requirements. Rev 8.

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.

Connell, S. C, Koessler M.W. and McPherson C.R. 2021. Otway Offshore Project – Construction Program: Assessing Marine Fauna Sound Exposures. Document 02407, Version 1.0 DRAFT. Technical report by JASCO Applied Sciences for Beach Energy Limited

Cooke, J. G., Rowntree, V. J. and Payne, R. S. (2001). Estimates of demographic parameters for southern right whales (*Eubalaena australis*) observed off Peninsula Valdes, Argentina. Journal of Cetacean Research and Management 2: 125-132.

CSIRO (2005). Corner Inlet Environmental Audit. Report to the Gippsland Coastal Board. Prepared by Molloy R., Chidgey S., Webster I., Hancock G. and Fox D.

CSIRO (2015). Plankton 2015: State of Australia's Oceans. CSIRO Report.

CSIRO (2017). Cape Grim Greenhouse Gas Data. Available from: http://www.csiro.au/greenhousegases.

CSIRO (2017a). Climate Change in Australia [WWW Document]. URL https://www.climatechangeinaustralia.gov.au/en/

Currie, D.R. (1995). Impact of Exploratory Offshore Drilling on Benthic Communities in the Minerva Gas Field, Port Campbell, Victoria. In: Minerva Gas Field Development Technical Reports: Volume 2. BHP Petroleum, Victoria.

Currie, D.R. and Jenkins, G.P. (1994). Marine Growth of Submarine Structures in the Minerva Field. In: Minerva Gas Field Development Technical Reports: Volume 2. BHP Petroleum, Victoria.

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.

Dai, A., 2013. Increasing drought under global warming in observations and models. Nature climate change 3, 52.

Dann, P. (2013). Book Chapter-17. Little Penguins (*Eudyptula minor*). In Penguins: Natural History and Conservation (Garcia-Borboroglue, P. & Boersma, D. eds.). Pp. 305-319. University of Washington Press, Seattle, USA.

Day, R., D., R.D. McCauley, Q.P. Fitzgibbon, K. Hartmann, J.M. Semmens, and Institute for Marine and Antarctic Studies. 2016. 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 Research & Development Corporation, University of Tasmania, Hobart. 159 pp.

Debus, S.J.S., G. Baker, D. Owner, and B. Nottidge (2014). Response of White-bellied Sea-Eagles *Haliaeetus leucogaster* to encroaching human activities at nest sites. Corella (38) 3:53-62.

De Campos, LF., Paiva, PM., Rodrigues, PPGW., Ferreira, MIP. And Lugon Jnr, P. (2017). Disposal of waste from cementing operations from offshore oil and gas wells building. Ciencia natura. V.39 n.2, 2017, Mai -Ago, p. 413 -422.

Department of Agriculture (DoA) (2015). Anit-Fouling and In-Water Cleaning Guidelines. Department of the Environment, Australian Government.

Department of Agriculture (2019). Map of marine pests in Australia. Australian Government.

Department of Agriculture, Water and Environment (DAWE) (2015). Species Profile and Threats Database - Bonney coast upwelling. Department of Agriculture Water and the Environment. Accessed June 2020 at: < https://www.environment.gov.au/sprat-public/action/kef/view/89;jsessionid=01AD87551D0DE1B0248C8722BE137004

Department of Agriculture, Water and Environment (DAWE) (2021). National Conservation Values Atlas. Commonwealth of Australia, Canberra, viewed 1 August 2017, http://www.environment.gov.au/topics/marine/marine-bioregional-plans/conservation-values-atlas

Department of Agriculture, Water and Environment (DAWE) (2021a). Guidance on key terms within the Blue Whale Conservation Management Plan. September 2021

Department of Agriculture, Water and Environment (DAWE) 2022. Australian biofouling management requirements (Version 1), Department of Agriculture, Water and the Environment, Canberra, May. CC BY 4.0

Department of the Environment (DoE) (2005). *Eubalaena australis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2015a). South-east Marine Region Profile: A description of the ecosystems, conservation values and uses of the South-east Marine Region. Australian Government

Department of the Environment (DoE) (2015b). Wildlife Conservation Plan for Migratory Shorebirds. Commonwealth of Australia.

Department of the Environment (DoE) (2015c). *Carcharodon carcharias* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2015d). *Balaenoptera musculus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2015e). Conservation Advice for *Numenius madagascariensis* (Eastern Curlew). Available from: http://environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice.pdf

Department of the Environment (DoE) (2015f). Conservation Advice *Calidris ferruginea* curlew sandpiper. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/856-conservation-advice.pdf.

Department of the Environment (DoE) (2016a). *Neophema chrysogaster* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016b). *Ardenna carneipes* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016c). *Sternula nereis nereis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016d). *Sternula albifrons* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016e). *Pachyptila turtur* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016f). *Haliaeetus leucogaster* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016g). *Tringa brevipes* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016h). *Orcinus orca* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016i). *Balaenoptera bonaerensis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016j). *Globicephala melas* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016k). *Hyperoodon planifrons* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016l). *Physeter macrocephalus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016m*). Tasmacetus shepherdi* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016n). *Lissodelphis peronii* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016o). *Tursiops truncatus* s. str. in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2016q). Australian National Shipwreck Database. A WWW database. Available from: https://dmzapp17p.ris.environment.gov.au/shipwreck/public/wreck/search.do;jsessionid=624517E77FC8FA606AA179083E0882B1. Department of the Environment. Canberra.

Department of the Environment (DoE) (2016r). Historic Shipwreck Protected Zones. A WWW database. Available from: http://www.environment.gov.au/topics/heritage/historic-shipwrecks/historicshipwreck-protected-zones. Department of the Environment. Canberra

Department of the Environment (DoE) (2017a). *Arctocephalus pusillus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017b). *Pluvialis fulva* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017c). *Pluvialis squatarola* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017d). *Gallinago stenura* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017e). *Limosa limosa* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017f). *Numenius minutus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017g). *Numenius phaeopus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017h). *Xenus cinereus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017i). *Actitis hypoleucos* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017j). *Tringa stagnatilis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017k). *Tringa glareola* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017l). *Calidris alba* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017n). *Calidris melanotos* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017o). *Philomachus pugnax* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017p). *Anous stolidus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017q). *Apus pacificus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017r). *Calidris acuminata* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017t). *Ardea modesta* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017u). *Morus capensis* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017v). *Rhipidura rufifrons* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017w). *Rhincodon typus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment (DoE) (2017x). *Balaenoptera edeni* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment and Conservation (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

Department of the Environment and Energy (DoEE 2019). Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases [WWW Document]. URL https://www.environment.gov.au/climate-change/climate-solutions-package

Department of Environment, Land, Water and Planning. (2016). National Recovery Plan for the Orange-bellied Parrot *Neophema chrysogaster*. Australian Government, Canberra. Available from: https://www.environment.gov.au/system/files/resources/f6680c43-4b28-4a4a-86c1-04adaad26f28/files/national-recovery-plan-orange-bellied-parrot.pdf

Department of Environment, Land, Water and Planning (2017a), Ecological Character Description for Glenelg Estuary and Discovery Bay Ramsar Site. Department of Environment, Land, Water and Planning, East Melbourne, Victoria. Accessed at https://www.water.vic.gov.au/__data/assets/pdf_file/0029/214796/Glenelg-MP-Full-Draft_Final.pdf [11 October 2019]

Department of Environment, Land, Water and Planning (2017b). Department of Environment, Land, Water and Planning Flora and Fauna Guarantee Act 1988 Threatened List, DELWP, Melbourne. Available from: https://www.environment.vic.gov.au/__data/assets/pdf_file/0019/50239/201703-FFGThreatened-List.pdf

Department of Environment, Land, Water and Planning (2017c). Glenelg Estuary and Discovery Bay Ramsar Site Management Plan. Department of Environment, Land, Water and Planning, East Melbourne, Victoria.

Department of Environment, Land, Water and Planning (2017d). Western Port Ramsar Site Management Plan. Department of Environment, Land, Water and Planning, East Melbourne.

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2008). Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1768-conservation-advice.pdf.

Department of Environment, Water and Natural Resource (DEWNR). (2012). Lower South East Marine Park Management Plan 2012.

Department of Natural Resources and Environment (DNRE) (2002). Corner Inlet Ramsar Site Strategic Management Plan, May 2002. Department of Natural Resources and Environment, Victoria.

Department of Primary Industries (DPI) (2012). A Review of Rebuilding Options for the Victorian Abalone Fishery. State Government Victoria. Available from: https://www.environment.gov.au/system/files/pages/fb3d8568-f6d1-4fd4-bd78-180ea31d12eb/files/abalone-review.pdf

Department of Primary Industries, Water and Environment (DPIPWE) (2013). King Island Biodiversity Management Plan. Department of Primary Industries, Parks, Water and Environment, 2012

Department of Primary Industries, Water and Environment (DPIPWE) (2015). Australian fisheries and aquaculture statistics 2014-15 (ABARES 2016), Department of the Environment and Energy (DotEE 2017), Fish Research and Development Corporation (FRDC, 2017)

Department of Primary Industries, Water and Environment (DPIPWE) (2016). Marine Life and Their Habitats. Available from: http://dpipwe.tas.gov.au/conservation/the-marine-environment/fisheries-habitats

Department of Sustainability and Environment (2008a). Background and Implementation Information for the Australian *Prototroctes maraena* National Recovery Plan. State of Victoria Department of Sustainability and Environment. East Melbourne.

Department of Sustainability and Environment (DSE) (2008b). National Recovery Plan for the Australian Grayling *Prototroctes maraena*. State of Victoria Department of Sustainability and Environment. East Melbourne.

Department of Sustainability and Environment (DSE) (2009). Action Statement, Leathery Turtle Dermochelys coriacea. prepared under Flora and Fauna Guarantee Act 1988. Australian Government. Accessed at https://www.environment.vic.gov.au/__data/assets/pdf_file/0025/32398/Leathery_Turtle_Dermochelys_coriacea.pdf.Department of Sustainability and Environment (DSE) (2003). Port Phillip Bay (Western Shoreline) & Bellarine Peninsula Ramsar Site Strategic Management Plan

Department of Sustainability and Environment (DSE) (2013). Advisory List of Threatened Vertebrate Fauna in Victoria. State Government of Victoria.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2011a). National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016. Department of Sustainability, Environment, Water, Population and Communities. Australian Antarctic Division. Canberra.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2011b). Background Paper, Population Status and Threats to Albatrosses and Giant Petrels Listed as Threatened under the Environment Protection and Biodiversity Conservation Act 1999. Commonwealth of Australia, Hobart.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2011c). 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.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2012a). Conservation Management Plan for the Southern Right Whale .2011 – 2021. Department of Sustainability, Environment, Water, Population and Communities. Australian Antarctic Division. Canberra. https://www.environment.gov.au/system/files/resources/4b8c7f35-e132-401c-85be-6a34c61471dc/files/e-australis-2011-2021.pdf. Accessed on 26 September 2019.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2012b). Species group report card – seabirds; Supporting the marine bioregional plan for the South-west Marine Region, Australian Government. Available from: https://www.environment.gov.au/system/files/pages/a73fb726-8572-4d64-9e33-1d320dd6109c/files/south-west-report-card-seabirds.pdf [10 October 2019]

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2013a). Recovery Plan for the White Shark *(Carcharodon carcharias)*. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: https://www.environment.gov.au/system/files/resources/ce979f1b-dcaf-4f16-9e13-010d1f62a4a3/files/white-shark.pdf.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2013b). Recovery Plan for the Australian Sea Lion (Neophoca cinerea). Department of Sustainability, Environment, Water, Population and Communities. Commonwealth of Australia.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2013c). Approved Conservation Advice for Rostratula australis (Australian Painted Snipe). Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/77037-conservation-advice.pdf.

Department of the Environment and Energy (DotEE) (2004a). Australian Heritage Database; HMAS Cerberus Marine and Coastal Area, Sandy Point Rd, HMAS Cerberus, VIC, Australia. Australian Government.

Department of the Environment and Energy (DotEE) (2004b). Australian Heritage Database; Swan Island and Naval Waters, Queenscliff, VIC, Australia. Australian Government.

Department of the Environment and Energy (DotEE) (2014). SPRAT Profile (*Ardenna carneipes* — Flesh-footed Shearwater, Fleshy-footed Shearwater). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82404

Department of the Environment and Energy (DotEE) (2015). Victorian Managed Fisheries. Australian Government. Available from: https://www.environment.gov.au/marine/fisheries/vic-managed-fisheries

Department of the Environment and Energy (DotEE) (2015b). South-east marine region profile. Available from: http://www.environment.gov.au/system/files/resources/7a110303-f9c7-44e4-b337-00cb2e4b9fbf/files/south-east-marine-region-profile.pdf

Department of the Environment and Energy (DotEE). (2017a). Glenelg Estuary - VIC028, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC028.

Department of the Environment and Energy (DotEE) (2017b). Piccaninnie Ponds Karst Wetlands, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=66.

Department of the Environment and Energy (DotEE) (2017c). Tasmanian Managed Fisheries. Australian Government. Available from: https://www.environment.gov.au/marine/fisheries/tas-managed-fisheries

Department of the Environment and Energy (DotEE) (2019a). SPRAT Profile (Neophema chrysogaster — Orange-bellied Parrot). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=747

Department of the Environment and Energy (DotEE) (2019b). SPRAT Profile (*Balaenoptera musculus* — Blue Whale). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=36

Department of the Environment and Energy (DotEE) (2019c). SPRAT Profile (*Eubalaena australis* — Southern Right Whale). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=40

Department of the Environment and Energy (DotEE) (2019d). SPRAT Database (*Orcinus orca* — Killer Whale, Orca). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=46

Department of the Environment and Energy (DotEE) (2019e). SPRAT Database (*Balaenoptera bonaerensis* — Antarctic Minke Whale, Dark-shoulder Minke Whale). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=67812

Department of the Environment and Energy (DotEE) (2019f). SPRAT Database (*Globicephala melas* — Long-finned Pilot Whale). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59282

Department of the Environment and Energy (DotEE) (2019g). SPRAT Profile (*Physeter macrocephalus* — Sperm Whale). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59

Department of the Environment and Energy (DotEE) (2019h). SPRAT Profile (*Lissodelphis peronii* — Southern Right Whale Dolphin). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=44

Department of the Environment and Energy (DotEE) (2019i). SPRAT Profile (*Lagenorhynchus obscurus* — Dusky Dolphin). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=43

Department of the Environment and Energy (DotEE) (2019j). SPRAT Database (*Tursiops truncatus* s. str. — Bottlenose Dolphin). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68417

Department of the Environment and Energy (DotEE) (2019k). SPRAT Profile (*Delphinus delphis* — Common Dolphin, Short-beaked Common Dolphin). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=60

Department of the Environment and Energy (DotEE) (2019m). SPRAT Profile (*Chelonia mydas* — Green Turtle). Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1765

Department of the Environment and Energy (DotEE) (2019n). SPRAT Profile (*Adrenna pacifica* — Wedge-tailed Shearwater). Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=84292

Department of the Environment and Energy (DotEE) (2020a). SPRAT Profile (*Caperea marginata* – Pygmy Right Whale). http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=39

Department of the Environment and Energy (DotEE) (2020b). SPRAT Profile (*Balaenoptera physalus* – Fin Whale). http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=37

Department of the Environment and Energy (DotEE) (2020c). SPRAT Profile (Sternula nereis nereis — Australian Fairy Tern. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82950

Department of the Environment and Energy (DotEE) (2020d). SPRAT Profile (*Ardenna pacifica* — Wedge-tailed Shearwater). http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=84292

Department of the Environment and Heritage. (2003). Douglas Point Conservation Park Management Plan.

Department of the Environment, Land, Water and Planning (DELWP) (2015). Marine Assets – Victorian Spatial Data Directory, DEWLP, Melbourne.

Department of the Environment, Land, Water and Planning (DELWP) (2016a). National Recovery Plan for the Orange-bellied Parrot *Neophema chrysogaster*. Australian Government, Canberra.

Department of the Environment, Land, Water and Planning (DELWP) (2016b). Shipwreck Protection Zones. A WWW publication. Available from: http://www.dtpli.vic.gov.au/heritage/shipwrecks-andmaritime/shipwreck-protected-zones. Department of Transport, Planning and Local Infrastructure. Melbourne

Department of the Environment, Land, Water and Planning (DELWP) (2017a). Western Port Ramsar Site Management Plan. Department of Environment, Land, Water and Planning, East Melbourne.

Department of the Environment, Land, Water and Planning (DELWP) (2017b). Department of Environment, Land, Water & Planning Flora and Fauna Guarantee Act 1988 Threatened List, DELWP, Melbourne. Available from: https://www.environment.vic.gov.au/__data/assets/pdf_file/0019/50239/201703-FFGThreatened-List.pdf

Director of National Parks (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-networkmanagement-plan2013-23.pdf.

DTPLI (2015). Shipwreck Protection Zones. A WWW publication. Available from: http://www.dtpli.vic.gov.au/heritage/shipwrecks-and-maritime/shipwreck-protected-zones. Department of Transport, Planning and Local Infrastructure. Melbourne.

Duncan, A.J., Gavrilov, A.N., McCauley, R.D., Parnum, I.M. and Collis, J.M (2013). Characteristics of sound propagation in shallow water over an elastic seabed with a thin cap-rock layer. J. Acoust. Soc. Am:134, pp. 207-215.

Duke NC, Kovacs JM, Griffiths AD, Preece L, Hill DJE, van Oosterzee P, Mackenzie J, Morning HS and Burrowa D (2017) Large-scale dieback of mangroves in Australia's Gulf of Carpentaria: a severe ecosystem response, coincidental with an unusually extreme weather event. Marine and Freshwater Research http://dx.doi.org/10.1071/MF16322

Dunlop, M., Hilbert, D., Ferrier, S., House, A., Liedloff, A., Prober, S., Smyth, A., Martin, T., Harwood, T., Williams, K., Fletcher, C., Murphy, H., 2012. The Implications of Climate Change for Biodiversity, Conservation and the National Reserve System: Final Synthesis. CSIRO Climate Adaptation Flagship. https://doi.org/10.4225/08/5850384d796c6

Dziak, R.P., M.J. Fowler, H. Matsumoto, D.R. Bohnenstiehl, M. Park, K. Warren, and W.S. Lee (2013). Life and death sounds of Iceberg A53a. Oceanography 26(2):10–12, http://dx.doi.org/10.5670/oceanog.2013.20.

EA (2002). Blue whale migration and recognised aggregation areas mapping. Environment Australia. Canberra.

ECC (2000). Marine, Coastal and Estuarine Investigation Final Report, Environment Conservation Council, East Melbourne.

Edmunds et al., (2006). cited in Hutchinson et al (2010). Seagrass and Reef Program for Port Phillip Bay: Temperate Reefs Literature Review. Fisheries Victoria Technical Report No.11. Department of Primary Industries. Victoria.

Edmonds, N.J., Firmin, C.J., Goldsmith, D., Faulkner, R.C. and Wood, D.T. (2016). A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species. Mar Pollut Bull. 15;108(1-2):5-11

EMSA 2016. The Management of Ship-Generated Waste On-board Ships. Report by Delft., C.E. for the European Maritime Safety Agency. EMSA/OP/02/2016 Accessed on 28 May 2019 at <http://www.emsa.europa.eu/news-a-press-centre/external-news/item/2925-the-management-of-ship-generated-waste-on-board-ships.html>

Environment Protection Authority (EPA) Victoria, 2010, A Snapshot of the Environmental Condition of Victorian Lakes, Publication 1303, EPA Victoria, Melbourne. Accessed at https://www.epa.vic.gov.au/~/media/Publications/1303.pdf [11 October 2019]

Erbe, C., Ainslie, M.A., de Jong, C.A.F., Racca, R., Stocker, M.: 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, vol. 875, pp. 1265–1271. Springer, New York (2016)

Erbe, C., McCauley, R., McPherson. C, Gavrilov, A. (2013) Underwater noise from offshore production vessels. Journal of Acoustic Society America. 133(6) June 2013.

Esso. (2009). Bass Strait Environment Plan (BSEP) Geophysical and Geotechnical Supplement Summary Environment Plan. Esso Australia Pty Lrd. Available from: https://industry.gov.au/resource/Documents/upstream-petroleum/summary-environment-plans/vic/Esso%20Australia%20Pty%20Ltd_2009%20Bass%20Strait%20Environment%20Plan.pdf.

Evans K, Bax NJ, Smith DC (2016). Marine environment: State and trends of marine biodiversity: Species Groups. In: Australia state of the environment 2016, Australian Government Department of the Environment and Energy, Canberra, https://soe.environment.gov.au/theme/marine-environment/topic/2016/state-and-trends-marinebiodiversity-species-groups, DOI 10.4226/94/58b657ea7c296

Fandry, C. B (1983). Model for the three-dimensional structure of winddriven and tidal circulation in Bass Strait, Aust. J. Mar. Freshwater Res., 34, 121 –141.Fandry 1983.

Field, C.D., 1995. Impact of expected climate change on mangroves. Hydrobiologia 295, 75–81. https://doi.org/10.1007/BF00029113

Finneran, JJ. 2015. Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015. Journal of the Acoustical Society of America 138(3): 1702-1726. https://doi.org/10.1121/1.4927418.

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. A WWW document. Available from: www.flagstaffhill.com/media/uploads/ShipwreckTrail.pdf

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.

Gannier, A, Drouot, V. and Gould, J. C. (2002). Distribution and the relative abundance of Sperm Whales in the Mediterranean Sea. Mar Ecol. Prog. Ser. 243: 281 -293.

Garcia-Rojas, Maria I., K. Curt S. Jenner, Peter C. Gill, Micheline-Nicole M. Jenner, Alicia L. Sutton, and Robert D. McCauley. 2018. 'Environmental evidence for a pygmy blue whale aggregation area in the Subtropical Convergence Zone south of Australia', Marine Mammal Science, 34: 901-23.

Gardner, N. C. (1998). The Larval and Reproductive Biology of the giant crab. Phd Thesis, University of Tasmania

Gavine, F. M., Ingram, B. A., Hardy-Smith, P., and Doroudi, M. (2009). Biosecurity Control Measures for Abalone Viral Ganglioneuritis: A Code of Practice. Prepared as part of FRDC Project No. 2006/243.

Gavrilov, A. (2012). Seismic 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.

Geoscience Australia (2020). All Upwelling percentage data (as supplied 22 June 2020 (Data on file). (As detailed in: 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.) Geoscience Australia, Canberra.

Georgeson, L., Stobutzki, I. & Curtotti, R. (eds) 2014, Fishery status reports 2013–14, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

Geraci, J.R. and 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. (2020) Blue Whale Literature Review - Offshore Victoria (Otway Basin/Bass Strait. Report to Beach Energy Limited. Blue Whale Study Inc.

Gill, P. and M. Morrice (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., G.J.B Ross, W.H. Dawbin, and H. Wapstra (2000). Confirmed sightings of dusky dolphins (*Lagenorhynchus obscurus*) in southern Australian waters. Marine Mammal Science, 16(2): 452-459.

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., C.M. Kemper, M. Talbot and S.A. Lyons. (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., M.G. Morrice, B. Page, R. Pirzl, A.H. Levings and M. Coyne (2011). Blue whale habitat selection and within-season distribution in a regional upwelling system off southern Australia. Marine Ecology Progress Series, 421: 243–263. Available from: http://www.intres.com/articles/meps_oa/m421p243.pdf.

Gill, P.C., R. Pirzl, M.G. Morrice and K. Lawton (2015). Cetacean diversity of the continental shelf and slope off southern Australia. The Journal of Wildlife Management.

Gillanders, B.M., Doubleday, Z., Cassey, P., Clarke, S., Connell, S.D., 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, B.D., van Ruth, P., Tanner, J.E., Ward, T., Woodcock, S.H. 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.

Gilmour, J., Speed, C.W., Babcock, R., 2016. Coral reproduction in Western Australia. PeerJ 4, e2010. https://doi.org/10.7717/peerj.2010

Glenelg Hopkins CMA, 2006. Glenelg Estuary Management Plan, Glenelg Hopkins CMA, Hamilton. Accessed at https://info.ghcma.vic.gov.au/wp-content/uploads/2017/05/glenelg_estuary_managment_plan.pdf [11 October 2019]

Goldsworthy, S.D. (2008). The Mammals of Australia. Third Edition. New Holland. Sydney.

Green, R.H. (1969). The birds of Flinders Island. Records of the Queen Victoria Museum, 34:1 -32.

Griffin, Thompson, Bax, Hallegraeff (1997). The 1995 mass mortality of pilchards: No role found for physical or biological oceanographic factors in Australia. Aust J Mar Freshwater Res, 48, 27-58"

Hannay, D., MacGillivray, A., Laurinolli, M. and Racca, R. 2004. Source Level Measurements from 2004 Acoustics Programme, Sakhalin Energy, pp. 66.

Hastie, G.D, Swift, R.J, Gordon, J.C.D., Slesser, G. and Turrell, W.R. (2003). Sperm Whale Distribution and Seasonal Density in the Faroe Shetland Channel. J Cetacean Res. Manage 5(3): 247-252.

Hayes, K., C. Sliwa, S. Mugus, F. McEnnulty, and P. Dunstan (2005). National priority pests: Pt 2 Ranking of Australian marine pests, CSIRO marine Research. Available from: www.marine.csiro.au/crimp/Reports/publications.html

Heap, A.D. and Harris, P.T (2008). Geomorphology of the Australian margin and adjacent seafloor, Australian Journal of Earth Sciences 55(4): 555-585.

Heisler, S. and 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. A WWW publication. Available from: http://parkweb.vic.gov.au/__data/assets/pdf_file/0015/314520/19_2096.pdf Parks Victoria, Melbourne

Heritage Victoria (2004). Victorian Heritage Register On-line, www.doi.vic.gov.au/doi/hvolr.nsf, Department of Infrastructure, Melbourne.

Higgins, P.J. and Davies, S.J.J.F. (1996). Handbook of Australian, New Zealand and Antarctic Birds. Volume Three - Snipe to Pigeons. Melbourne, Victoria: Oxford University Press.

Hinwood JB, Poots AE, Dennis LR, Carey JM, Houridis H, Bell RJ, Thomson JR, Boudreau P, Ayling AM (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., 1999. Climate change, coral bleaching and the future of the world's coral reefs. Marine and freshwater research 50, 839–866.

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.I., Thomas, A., Warren, R., Zhou, G., 2018. Impacts of 1.5oC Global Warming on Natural and Human Systems, 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.

Hofmeyr, G. and Gales, N. (2008). *Arctocephalus pusillus*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2.

Hook, S.E. and Lee, K. (2015). A review of the ecotoxicological implications of oil dispersant use in Australian waters. CSIRO Oceans and Atmosphere Report, Lucas Heights, NSW, Australia.

Horwood, J. (1987). The sei whale: Population biology, ecology, and management. Croom Helm, Sydney.

Hosack, GR & Dambacher, JM, (2012). Ecological indicators for the Exclusive Economic Zone of Australia's South-east Marine Region., A report prepared for the Australian Government Department of Sustainability, Environment, Water, Population and Communities, CSIRO Wealth from Oceans Flagship, Hobart.

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.

Huertas, I.E., Rouco, M, Lopez-Roda, V. and Costas, E. (2001) Warming will affect phytoplankton differently: evidence through a mechanistic approach. Proceedings of the Royal Society B. Published:20 April 2011 https://doi.org/10.1098/rspb.2011.0160

Hughes, L., 2003. Climate change and Australia: Trends, projections and impacts. Austral Ecology 28, 423–443. https://doi.org/10.1111/j.1442-9993.2003.tb00266.x

Hughes, L. 2011 Climate change and Australia: key vulnerable regions. Reg Environ Change 11, 189–195 (2011). https://doi.org/10.1007/s10113-010-0158-9

Hughes TP, Kerry JT, Álvarez-Noriega M, Álvarez-Romero JG, Anderson KD, Baird AH, Babcock RC, Beger M, Bellwood DR, Berkelmans R, Bridge TC, Butler IR, Byrne M, Cantin NE, Comeau S, Connolly SR, Cumming GS, Dalton SJ, Diaz-Pulido G, Eakin CM, Figueira WF, Gilmour JP, Harrison HB, Heron SF, Hoey AS, Hobbs J-PA, Hoogenboom MO, Kennedy EV, C-y Kuo, Lough JM, Lowe RJ, Liu G, McCulloch MT, Malcolm HA, McWilliam MJ, Pandolfi JM, Pears RJ, Pratchett MS, Schoepf V, Simpson T, Skirving WJ, Sommer B, Torda G, Wachenfeld DR, Willis BL, Wilson SK (2017) Global warming and recurrent mass bleaching of corals. Nature 543:373–377

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. Vol. 144, no. 3, pp. 407-415.

Hutchinson, N., Hunt, T. and Morris, L. (2010). Seagrass and Reef Program for Port Phillip Bay: Temperate Reefs Literature Review. Fisheries Victoria Technical Report No.11. Department of Primary Industries. Victoria.

Hyland, J., Hardin, D., Steinhauer, M., Coats, D., Green, R. and 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. 2013. IALA Recommendation R0139 The Marking of Man-Made Offshore Structures. International Association of Marine Aids to Navigation and Lighthouse Authorities. Edition 2.1. December 2013.

IEA. 2021. World Energy Outlook 2021. International Energy Agency. https://www.iea.org/reports/world-energy-outlook-2021/executive-summary

IFC (2015). Environmental, Health, And Safety Guidelines for Offshore Oil and Gas Development. International Finance Corporation.

IPCC. 2021. Climate Change 2021: The Physical Science Basis. International Panel on Climate Change. https://www.ipcc.ch/report/ar6/wg1/

Irvine, L.M., D.M. Palacios, B.A. Lagerquist, and B.R. Mate. 2019. Scales of Blue and Fin Whale Feeding Behaviour off California, USA, With Implications for Prey Patchiness. Frontiers in Ecology and Evolution 7(338).

Irving, P. and Lee, K. (2015). Improving Australia's dispersant response strategy. Proceedings of the 38th AMOP Technical Seminar on Environmental Contamination and Response. 973-987.

ITOPF. 2011a. Effects of Oil Pollution on the Marine Environment. Technical Information Paper 13. The International Tanker Owners Pollution Federation Ltd. London.

ITOPF. 2011b. The Use of Chemical Dispersants to Treat Oil Spills. Technical Information Paper 4. The International Tanker Owners Pollution Federation Ltd. London.

IOGP. Risk assessment data directory – Blowout frequencies – IOGP Report 434-02 Version 3, September 2019.

JASCO Applied Sciences .2015. Acoustic Characterisation of Subsea Choke Valve. Results from North West Shelf Measurements. In Woodside, 2020.

Jenkins, G., and McKinnon, L. (2006). Port Phillip Bay Channel Deepening Project: supplemental environmental effects statement – aquaculture and fisheries.

Jones, I.S.F. and Padman, L. (1983). Semidiurnal internal tides in eastern Bass Strait. Australian Journal of Marine and Freshwater Research 34, 159–171.

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, R.L., Ward, T.M., 2004. Evidence of a large seasonal coastal upwelling system along thesouthern shelf of Australia. Geophys. Res. Lett. 31, L09310.

Kasamatsu, F., Ensor, P. and Joyce, G. (1998). Clustering and aggregations of minke whales in the Antarctic feeding grounds. Marine Ecology Progress Series 168: 1 -1 1.

Kato, H. J. Bannister, C. Burton, D. Ljungblad, K. Matsuoka & H. Shimada (1996). Report on the Japan/IWC Blue Whale Cruise 1995-96 off the Southern Coast of Australia. Paper SC/48/SH9 presented to the IWC Scientific Committee. Unpublished.

Kellogg Brown & Root. (2010). Western Port Ramsar Wetland Ecological Character Description. Report for Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Kemper, C.M. (2004). Osteological variation and taxonomic affinities of bottlenose dolphins, Tursiops spp., from South Australia. Australian Journal of Zoology. 52:29-48.

Kjeilen-Eilertsen G., H. Trannum, R.G. Jak, M.G.D. Smit, J. Neff & G. Durell, (2004). Literature report on burial: derivation of PNEC as component in the MEMW model tool. Report AM 2004/024. ERMS report 9B.

Kimmerer W.J. & McKinnon A.D. (1984). Zooplankton Abundances in Bass Strait and WesteEnsco 102 Tasmanian Shelf Waters, March 1983.

Kirkman, 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. Marine Mammal Science 25(2): 441 –449.

Kirkwood, R., Pemberton, D., Gales, R., Hoskins, A.J., Mitchell, T., Shaughnessy, P.D., and Arnould, J.P.Y. (2010). Continued population recovery by Australian fur seals. Marine and Freshwater Research, Vol.61, pp.695–701.

Klimey, A.P. and Anderson, S.D. (1996). Residency patterns of White Sharks at the South Farrallone Islands, California. In: Great White Sharks: The biology of *Carcharodon carcharias*. Edited by A.P. Klimley & D.G. Ainley. Academic Press, New York USA.

Koopman, M., Knuckey, I., Harris, A. and Hudson, R. (2018). Eastern Victorian Ocean Scallop Fishery 2017-18 Abundance Survey. Report to the Victorian Fisheries Authority. Fishwell Consulting. 42pp.

Koessler, M, Matthews M-N R, and C. McPherson. (2020). 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.

Koessler, M. and C. McPherson. (2021). Beach Otway Project: Additional and Revised Modelling Study. Technical Addendum by JASCO Applied Sciences for Beach Energy Limited.

Land Conservation Council (1993). Marine and Coastal Descriptive Report (special investigation) June 1993.

Larcombe P., Peter R., Prytz A and Wilson B. (1995). Factors Controlling Suspended Sediment on the Inner-Shelf Coral Reefs. Coral Reefs. 14. 163-171. 10.1007/BF00367235.

Lesser, J.H.R. (1974). Identification of early larvae of New Zealand spiny and shovel-nosed lobsters (Decapoda, Palinuridae and Scyllaridae). Crustaceana 27: 259-277

Levings, A.H. and Gill, P.C. (2010). 'Seasonal winds drive water temperature cycle and migration patterns of southern Australian giant crab *Pseudocarcinus gigas*.' In: Biology and Management of Exploited Crab Populations under Climate Change. Edited by G.H. Kruse, G.L. Eckert, R.J. Foy, R.N. Lipcius, B. Sainte-Marie, D.L. Stram and D. Woodby. Alaska Sea Grant, University of Alaska Fairbanks.

Lewis, R.K., 1981. Seasonal upwelling along the south-eastern coastline of South Australia. Mar. Freshw. Res. 32, 843–854.

Lewis, M. and Pryor, R. 2013. Toxicities of oils, dispersants and dispersed oils to algae and aquatic plants: Review and database value to resource sustainability. Env. Poll. 180: 345–367.

Limpus, C.J. (2008). A biological review of Australian Marine Turtles. 1. Loggerhead Turtle *Caretta caretta* (Linneaus). Queensland Environment Protection Agency. Available 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, McGarvey R, McLeay L, Feenstra J & Reilly D. (2015). Victorian rock lobster and giant crab fisheries status report—2013/2014 fishing year, fishery status report to Fisheries Victoria, SARDI publication F2012/000434-4, SARDI Research Report Series, no. 863, South Australian Research and Development Institute (Aquatic Sciences), Adelaide

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.

Marchant, S. and P. J. Higgins. (1990). Handbook of Australian, New Zealand and Antarctic Birds. Vol. 1. Oxford University Press, Australia.

Marchant, S. and P. J. Higgins. eds. (1993). Handbook of Australian, New Zealand and Antarctic Birds. Vol. 2. Raptors to Lapwings. Melbourne, Victoria: Oxford University Press.

Matsumoto, H., D.W. R. Bohnenstiehl, J. Tournadre, R. P. Dziak, J. H. Haxel, T.-K. A. Lau, M. Fowler, & S. A. Salo (2014). Antarctic icebergs: A significant natural ocean sound source in the Southern Hemisphere. Geochemistry Geophysics Geosystems, 15(8), 3448–3458.

Matsuoka, K. and Hakamada, T (nd). Estimates of abundance and abundance trend of the blue, fin and southern right whales in the Antarctic Areas IIIE-VIW, south of 60oS, based on JARPA and JARPAII sighting data (1989/90-2008/09). The Institute of Cetacean Research.

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.

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 Duncan, A. 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.

McCauley, R.D. and 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., 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: Topical Studies in Oceanography 157-158: 154-168.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., McCabe, K., 2000. Marine seismic surveys - a study of environmental implications. APPEA J. 40, 692–706.

McClatchie, S., Middleton, J., Pattiaratchi, C., Currie, D., and Kendrick, G. 2006. The South-west Marine Region: Ecosystems and Key Species Groups. Department of the Environment and Water Resources. Australian Government.

McInnes, K., 2015. Wet Tropics Cluster Report, in: Ekström, M., Whetton, P., Gerbing, C., Grose, M., Webb, L., Risbey, J. (Eds.), Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports. CSIRO and Bureau of Meteorology, Australia.

McInnes, K. L. and Hubbert, G. D. 2003. A numerical modelling study of storm surges in Bass Strait. Australian Meteorological Magazine 52(3).

McIntyre, A.D. and Johnson, R. 1975. Effects of nutrient enrichment from sewage in the sea. In: ALH Gameson, ed. Discharge of sewage from sea outfalls. New York, Pergamon Press. pp. 131–141.

McLeay, L.J., Sorokin, S.J., Rogers, P.J. and 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.

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.

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.

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., Arthur, C., Van Ruth, P, Ward, T.M., McClean, J.L, Maltrud, M.E., Gill, P, Levings, A. and Middleton, S. 2007. El Nino Effects and Upwelling off South Australia. Journal of Physical Oceanography 37: 2,458–2,477.

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.

Miller, B.S., N. Kelly, M.C. Double, S.J. Childerhouse, S. Laverick & N. Gales 2012. Cruise report on SORP 2012 blue whale voyages: development of acoustic methods. Paper SC/64/SH1 1 presented to the IWC Scientific Committee.

Minton, C., & J. Deleyev 2001. Analysis of recoveries of VWSG banded Caspian Terns. Victorian Wader Study Group Bulletin. 24:71-75.

Möller, L.M., S.J. Allen & R.G. Harcourt 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.

Möller, L.M. Double, D. Paton, C. Attard and K. Bilgmann. 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, L.M. Attard, C.R.M, Bilgmann, K., Andrews-Goff, V. Jonsen, I., Paton, D. and Double, M.C. 2020. Movements and behaviour of blue whales satellite tagged in an Australia upwelling system. Nature Scientific Reports. 10:21165. https://doi.org/10.1038/s41598-020-78143-2.

Mollet, H.F., Cliff, G., Pratt Jr, H.L. and Stevens, J.D. 2000. Reproductive Biology of the female shortfin mako, Isurus oxyrinchus Rafinesque, 1820, with comments on the embryonic development of lamnoids. Fish. Bull. 98: 299-318.

Morrice, M.G, P.C. Gill, J. Hughes & A.H. Levings 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.

Mustoe & Ross 2004. Search Australian Whales & Dolphins, Interactive CD ROM Identification Guide Version 1.0, Australian Petroleum Production and Exploration Association.

Mustoe, S.H. 2008. Killer Whale (*Orchinus orca*) sightings in Victoria. Victorian Naturalist 125 (3): 76-81.

NCVA. (2021). National Conservation Values Atlas. http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf

National Marine Fisheries Service. (2013). Marine Mammals: Interim Sound Threshold Guidance. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

National Marine Fisheries Service. (2018). Marine Mammal Acoustic Thresholds. Available from: https://www.westcoast.fisheries.noaa.gov/ protected_species/marine_mammals/threshold_guidance.html.

National Oceanic and Atmospheric Administration. (2002). Environmental Sensitivity Index Guidelines. Version 3. March 2002. National Oceanic and Atmospheric Administration. Washington.

National Oceanic and Atmospheric Administration. (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.

Native National Title Tribual (NNTT) (2016). Search National Native Title Register. Available from: http://www.nntt.gov.au/searchRegApps/NativeTitleRegisters/Pages/Search-National-Native-Title-Register.aspx

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.

NERA (2017). Environment Plan Reference Case, Planned discharge of sewage, putrescible waste and grey water. National Energy Resources Australia (NERA), Kensington, WA. Accessed on 28 May 2019 at https://referencecases.nopsema.gov.au/assets/reference-case-project/2017-1001-Sewage-grey-water-and-putrescible-waste-discharges.pdf

Newall, P.R. and Lloyd, L.N. 2012. Lavinia Ramsar Site Ecological Character Description. Lloyd Environmental report to NRM North. Lloyd Environmental, Syndal, Victoria. 2 March 2012.

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 (2013). Marine Mammals: Interim Sound Threshold Guidance. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS (2014). 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 (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. National Marine Fisheries Service (U.S.) NMFS-OPR-59. 167 p. https://www.fisheries.noaa.gov/webdam/download/75962998.

NSF (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.

Noad, M.J, Dunlop, R.A., Paton, D. Cato, D.H. et al. (2011). Absolute and relative abundance estimates of Australian east coast humpback whales. Journal of Cetacean Research and Management, Special issue 3: 243-252.

NOO (2001). South East Regional Marine Plan. Impacts on the Natural System. Prepared by Ecos Consulting Pty Ltd for the National Oceans Office.

NOO (2002). Ecosystems – Nature's diversity: The South-east Regional Marine Plan Assessment Reports. National Oceans Office. Hobart.

NOO (2004). South-east Regional Marine Plan; Implementing Australia's Oceans Policy in the Southeast Marine Region. National Oceans Office. Hobart.

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).

NOPSEMA (2015). ALARP Guidance Note. National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Guidance-notes/A138249.pdf

NOPSEMA (2018). Environment plan decision making guideline. National Offshore Petroleum Safety and Environmental Management Authority. Available from: https://www.nopsema.gov.au/assets/Guidelines/A524696.pdf

NOPSEMA (2019) Otway Deep Marine Seismic Survey Key Matter Report. July 2019.

NSW National Parks and Wildlife Service (NPWS) (1995). Montague Island Nature Reserve Plan of Management. Available from: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Parks-plans-of-management/montague-island-nature-reserve-plan-of-management-950096.pdf

NSW National Parks and Wildlife Service (NPWS) (2000). Eurobodalla National Park Plan of Management. Available from: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Parks-plans-of-management/eurobodalla-national-park-plan-of-management-000092.pdf

OGUK (2014). The UK offshore oil and gas industry guidance on risk-related decision making. Oil and Gas UK.

O'Hara, T., McShane, P. E., and Norman, M. (1999) cited in Andrew (1999).

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. 2014. Establishment of a list of Predicted No Effect Concentrations (PNECs) for naturally occurring substances in produced water. OSPAR Commission. OSPAR Agreement: 2014–05

OSPAR (2009). Assessment of impacts of offshore oil and gas activities in the North-East Atlantic. OSPAR Commission, 40pp

Owen. K., Jenner CS., Jenner. M-NM. And Andrews. RD. 2016. A week in the life of a pygmy blue whale: migratory dive depths overlaps with large vessels draft. Animal Biotelemetry. 4:17. DOI 10.1186/s40317-016-0109-4.

Pade, N.G., N. Queiroza, N.E. Humphries, M.J. Witt, C.S. Jones, L.R. Noble, and D.W. Sims (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.

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.

Parks and Wildlife Service Tasmania (PWST) (2005). Kent Group National Park (Terrestrial Portion) Management Plan 2005. Department of Tourism, Parks, Heritage and the Arts. Tasmania.

Parks Victoria (1998). The Port Campbell National Park and Bay of Islands Coastal Park Management Plan. Parks Victoria, Melbourne. Available from: http://parkweb.vic.gov.au/explore/parks/port-campbell-national-park

Parks Victoria (2002). Wilsons Promontory National Park Management Plan. Parks Victoria, Melbourne. Available from: https://parkweb.vic.gov.au/__data/assets/pdf_file/0006/313458/Wilsons-Promontory-National-Park-Managemetn-Plan.pdf

Parks Victoria (2003). Cape Liptrap Coastal Park Management, Parks Victoria, Melbourne. Available from: http://parkweb.vic.gov.au/explore/parks/cape-liptrap-coastal-park

Parks Victoria (2005a). Corner Inlet Marine National Park Management Plan, Parks Victoria, Melbourne

Parks Victoria (2005b). Point Addis National Park Point Danger Marine Sanctuary and Eagle Rock Marine Sanctuary Management Plan, Parks Victoria, Melbourne. Available from: http://parkweb.vic.gov.au/__data/assets/pdf_file/0019/313426/Point-Addis-Marine-National-Park-Management-Plan.pdf

Parks Victoria (2006a). Bunurong Marine National Park. Bunurong Marine Park, Bunurong Coastal Reserve and Kilcunda-Harmers Haven Coastal Reserve: Management Plan July 2006. Victoria.

Parks Victoria (2006b). Twelve Apostles Marine National Park and The Arches Marine Sanctuary Management Plan. Parks Victoria, Melbourne. Available from: http://parkweb.vic.gov.au/__data/assets/pdf_file/0020/313445/Twelve-Apostles-Marine-National-Park-and-The-Arches-MS-Management-Plan.pdf

Parks Victoria (2007a). Marengo Reefs Marine Sanctuary Management Plan, Parks Victoria, Melbourne. Available 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. Available 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. Available from: http://parkweb.vic.gov.au/explore/parks/merri-marine-sanctuary

Parks Victoria (2013). Mornington Peninsula National Park and Arthurs Seat State Park Management Plan. Parks Victoria, Melbourne. Available 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. Available from: http://parkweb.vic.gov.au/explore/parks/discoverybay-coastal-park

Parks Victoria (2016a). Park Management – Environment – Ecosystems – Marine – Sandy Plains. Available from: http://parkweb.vic.gov.au/park-management/environment/ecosystems/marine.

Parks Victoria (2016b). Enviroactive. Available from: http://www.enviroactive.com.au/wetlands/shorebirds.

Parks Victoria (2017). Lake Connewarre Wildlife Reserve. Parks Victoria, Melbourne. Available from: http://parkweb.vic.gov.au/explore/parks/lake-connewarre-w.r

Parks Victoria (2019a). French Island Marine National Park. Parks Victoria, Melbourne. Available from: https://www.visitvictoria.com/regions/mornington-peninsula/things-to-do/nature-and-wildlife/national-parks-and-reserves/french-island-marine-national-park

Parks Victoria (2019b). 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. Available from: http://parkweb.vic.gov.au/explore/parks/great-otway-national-park

Parliament of South Australia. (2011). Little Penguins Report "Away with the fairies". 59th Report for the Natural Resources Committee. Available from: https://www.parliament.sa.gov.au/.../TabledPapersandPetitions.aspx?...NRC%2BLittle

Parry, G.D., Campbell, S.J., and Hobday, D.K. (1990). Marine resources off East Gippsland, Southeastern Australia. Technical Report No. 72, Marine Science Laboratories. Queenscliff, Victoria.

Patterson, H., Georgeson, L., Stobutzki, I. & Curtotti, R. (ed) 2015, Fishery status reports 2015, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 3.0.

Patterson, H., Noriega, R., Georgeson, L., Stobutzki, I. & Curtotti, R. (2016). Fishery status reports 2016, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 3.0.

Patterson, H., Noriega R., Georgeson, L., Larcombe, J. and Curtotti, R. (2017). Fishery status reports 2017, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

Patterson, H., Larcombe, J., Nicol, S. and Curtotti, R. 2018, Fishery status reports 2018, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

Patterson, H., Willliams, A., Woodhams, J. and Curtotti, R. 2019, Fishery status reports 2019, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

Patterson, H., Larcombe, J., Woodhams, J. and Curtotti, R. 2020, Fishery status reports 2020, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

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.

Pegler, J.M. (1983). A brief survey of the water birds in the Shoalhaven-Crookhaven estuary. Australian Birds. 17:38-42.

Phalan, B., Phillips, R., Silk, J., Afanasyev, V., Fukuda, A., Fox, J., Catry, P., Higuchi, H. and Croxall, J. 2007. Foraging behavior of four albatross species by night and day. Marine Ecology-Progress Series. 340. 271-286. 10.3354/meps340271.

Pirzl, R., N. J. Patenaude, S. Burnell & J. Bannister. 2009. Movements of southern right whales (*Eubalaena australis*) between Australian and subantarctic New Zealand populations. Marine Mammal Science 25: 455-461.

Pizzey G. and F. Knight (1999). The Graham Pizzey and Frank Knight Field Guide to the Birds of Australia. Pymble, Sydney: Angus and Robertson.

Plotkin P.T., M.K. Wicksten, and A.F. Amos (1993). Feeding ecology of the loggerhead sea turtle Caretta caretta in the northwestern Gulf of Mexico. Marine Biology, 115(1):1.

Plummer A., Morris L., Blake S. and Ball, D. (2003). Marine Natural Values Study, Victorian Marine National Parks and Sanctuaries, Parks Victoria Technical Series No. 1, Parks Victoria, Melbourne.

Poore G.C.B., Wilson R.S., Gomon M., and Lu C.C. (1985). Museum of Victoria Bass Strait Survey, 1979-1984.Museum of Victoria: Melbourne.

Popper A.N., Hawkins A.D., Fay R.R., Mann D.A., Bartol S., Carlson T.J., Coombs S., Ellison W.T., Gentry R.L., Halvorsen M.B. and Løkkeborg S. (2014). Sound exposure guidelines for fishes and sea turtles. Springer Briefs in Oceanography. DOI, 10(1007), pp.978-3.

Ports Australia (2020) Trade Statistics Financial Year 2018 – 2019. https://www.portsaustralia.com.au/resources/trade-statistics

Protected Planet. (2019). Yambuk Wetlands Natural Conservation Reserve in Australia. Protected Planet. Available from: https://www.protectedplanet.net/357690

Przeslawski R., Bruce B., Carroll A., Anderson J., Bradford R., Durrant A., Edmunds M., Foster S., Huang Z., Hurt L., Lansdell M., Lee K., Lees C., Nichols P., 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

Pulham G. and Wilson D. (2013). 'Fairy tern.' In New Zealand Birds Online. Edited by Miskelly, C.M.

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. Accessed at 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.

Reilly S.B., Bannister J.L., Best P.B., Brown M., Brownell Jr. R.L., Butterworth D.S., Clapham P.J., Cooke J., Donovan G.P., Urbán J. and Zerbini A.N. (2008). *Balaenoptera acutorostrata*. In: IUCN 2008. 2008 IUCN Red List of Threatened Species.

Research Data Australia (2013). Marine Key Ecological Features. Australian Ocean Data Network. Research Data Australia, Canberra. Accessed June 2020 at: <https://researchdata.ands.org.au/marine-key-ecological-features/952075>

Richardson A.J., Matear R.J. and Lenton A (2017) Potential impacts on zooplankton of seismic surveys. CSIRO, Australia. 34 pp.

Richardson, W.J., Greene, C.R., Malme, C.I. and Thomson, D.H. (1995) Marine Mammals and Noise. Academic Press, San Diego, 576 pp.

Roberts J.M., Wheeler A., Freiwald A., and Carins S. (2009). Cold-Water Corals: The Biology and Geology of Deep-Sea Coral Habitats. Cambridge University Press, United States of America.

Robinson S., Gales R., Terauds A. & Greenwood M. (2008). Movements of fur seals following relocation from fish farms. Aquatic Conservation: Marine and Freshwater Ecosystems. Vol. 18, no. 7, pp. 1189-1199.

Rodríguez 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. https://doi.org/10.1371/journal.pone.0110114

Rogers P. (2011). Habitat use, movement and dietary dynamics of pelagic sharks in coastal and shelf ecosystems off southern Australia. Doctorate of Philosophy Thesis, Flinders University, Adelaide, Australia. pp 148-205.

Rosenbaum, H. C., Razafindrakoto, Y., Vahoavy, J. and Pomilla, C. (2001). A note on recent sightings of southern right whales (*Eubalaena australis*) along the east coast of Madagascar. Journal of Cetacean Research and Management 2: 177-179.

Roughan, M., Middleton, J.H., 2004. On the East Australian Current: variability, encroachment, and upwelling. J. Geophys. Res. 109, C07003.

Ross R 2000, Mangroves and Salt Marshes in Westernport Bay, Victoria, Arthur Rylah Institute for Environmental Research, Department of Natural Resources and the Environment, Victoria

Ross P, Minchinton T and Ponder W (2009). The ecology of molluscs in Australian saltmarshes. In: Australian Saltmarsh Ecology. (ed.. N Saintilan). CSIRO Publishing, Victoria.

Ross G.J.B (2006). Review of the Conservation Status of Australia's Smaller Whales and Dolphins. Page(s) 124. [Online]. Report to the Australian Department of the Environment and Heritage, Canberra. Available from: http://www.environment.gov.au/coasts/publications/pubs/conservation-smaller-whalesdolphins.pdf.

RPS (2013). Marine Fauna Observer’s Report during Enterprise 3D Marine Seismic survey 30th October to 9th November 2014. Report prepared by RPS for Origin Energy Resources Ltd, Perth.

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 (2017). Otway Basin Operations: Geographe and Thylacine Quantitative Oil Spill Modelling. Rev 5/31 July 2017.

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.

Santos (2004). Casino Gas Field Development Environment Report. Prepared by Enesar Consulting Pty Ltd. Hawthorn East, Victoria.

Santos (2016). Casino, Henry, Netherby. A WWW resource. Available from: https://www.santos.com/what-we-do/activities/victoria/otway-basin/casino-henry-netherby/. Santos. Adelaide.

Saunders D.L. and Tzaros C.L (2011). National Recovery Plan for the Swift Parrot (*Lathamus discolor*). Birds Australia, Melbourne. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/recovery/lathamusdiscolor.html. In effect under the EPBC Act from 10-Feb-2012.

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.

Shapiro M.A. (1975). Westernport Bay Environmental Study, 1973 -1974. Ministry for Conservation, Victoria.

Shaughnessy P.D. (1999). The Action Plan for Australian Seals. CSIRO Wildlife and Ecology, Natural Heritage Trust, Environment Australia.

Shell (2009). Prelude Floating LNG Project Draft Environmental Impact Statement. EPBC 2008/4146.

Shell (2018) Crux Offshore Project Proposal. Rev 3. 20/12/2018. Shell Australia Pty Ltd.

Shepard F.P. (1954) Nomenclature based on sand-silt-clay ratios: Journal of Sedimentary Petrology, v. 24, p. 151-158.

Shigenaka G. (2001). Toxicity of oil to reef-building corals: A spill response perspective.

Skira I.J., Brothers N.P. and Pemberton D. (1996). Distribution, abundance and conservation status of Short-tailed Shearwaters *Puffinus tenuirostris* in Tasmania, Australia. Marine Ornithology 24:1–14.

Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M., Miller, H.L., 2007. Contribution of working group I to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Spalding, M.D., Brown, B.E., 2015. Warm-water coral reefs and climate change. Science 350, 769–771.

Stamation, K., Watson, M., Moloney, P., Charlton, C. & 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., Burbidge, A.A., Hughes, L., Kitching, R., Lindenmayer, D., Musgrave, W., Staford Smith, M., Werner, P., 2009. Australia´s biodiversity and climate change: A strategic assessment of vulnerability of Australia´s biodiversity to climate change. A report to the Natural resource Management Ministerial Council commissioned by Australian Government. CSIRO Publishing.

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.

Stephenson L.H. (1991). Orange-bellied Parrot Recovery Plan: Management Phase. Tas. Dept Parks, Wildlife & Heritage.

Taylor I.R. and 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.

Taylor B.L., Chivers S.J., Larese J. and Perrin W.F. (2007). Generation length and percent mature estimates for IUCN assessments of Cetaceans. Southwest Fisheries Science Centre.

Thiele K. (1977). Sightings from Land of the Sooty Albatross, South Australian Ornithologist (27)7:259.

Threatened Species Scientific Committee (TSSC) (2010). Commonwealth Listing Advice on *Neophoca cinerea* (Australian Sea-lion). Department of Sustainability, Environment, Water, Population and Communities. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/22-listing-advice.pdf. In effect under the EPBC Act from 26-Aug-2010.

Threatened Species Scientific Committee (TSSC) (2013). Commonwealth Conservation Advice for Subtropical and Temperate Coastal Saltmarsh. Canberra: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/118-conservationadvice.pdf.

Threatened Species Scientific Committee (TSSC) (2022). *Megaptera novaeangliae* (humpback whale) Listing Advice.

Threatened Species Scientific Committee (TSSC) (2015b). Approved Conservation Advice for the Whale Shark (*Rhicodon typus*). Department of the Environment. Available from:

www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf.

Threatened Species Scientific Committee (TSSC) (2015c). Approved Conservation Advice for *Pterodroma mollis* (soft-plumaged petrel). Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1036-conservation-advice-01102015.pdf.

Threatened Species Scientific Committee (TSSC) (2015d). Approved Conservation Advice for *Pachyptila subantarctica* (Fairy prion (Southern)). Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/64445-conservation-advice-01102015.pdf.

Threatened Species Scientific Committee (TSSC) (2015e). Approved Conservation Advice for the Blue Petrel (*Halobaena caerulea*). Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1059-conservation-advice-01102015.pdf.

Threatened Species Scientific Committee (TSSC) (2015f). Approved Conservation Advice for *Balaenoptera physalus* (fin whale). Threatened Species Scientific Committee. Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservationadvice-01102015.pdf.

Threatened Species Scientific Committee (TSSC) (2015g). Conservation Advice *Balaenoptera borealis* sei whale. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/34-conservation-advice-01102015.pdf..

Threatened Species Scientific Committee (TSSC) (2016a). Conservation Advice *Limosa lapponica baueri* Bar-tailed godwit (western Alaskan). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/86380-conservation-advice-05052016.pdf

Threatened Species Scientific Committee (TSSC) (2016b). Conservation Advice *Charadrius leschenaultii* Greater sand plover. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/877-conservation-advice-05052016.pdf.

Threatened Species Scientific Committee (TSSC) (2016d). Conservation Advice *Calidris canutus* Red knot. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/855-conservation-advice-05052016.pdf.

Threatened Species Scientific Committee (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. Available from: www.environment.gov.au/biodiversity/threatened/communities/pubs/132-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC). (2019). Conservation Advice *Botaurus poiciloptilus* Australasian Bittern. Canberra, ACT: Department of the Environment and Energy. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1001-conservation-advice-18012019.pdf.

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.

Tzioumis V. and Keable S. (eds). (2007). Description of Key Species Groups in the East Marine Region, Final Report – September 2007. Australian Museum.

Underwood K.A. (1991). Patterns in shallow subtidal marine assemblages along the coast of New South Wales. Australian Journal of Ecology 6. 231 -249.

Underwood K.A. (1991). Patterns in shallow subtidal marine assemblages along the coast of New South Wales. Australian Journal of Ecology 6. 231 -249.

UNFCCC. 2020. The Paris Agreement. United Nations Framework Convention on Climate Change. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

UNEP (1985). GESAMP: Thermal discharges in the marine environment. UNEP Regional Seas Reports and Studies No. 45. Victoria, Rev 2 (Project No: Q0036).

Van de Kam J., Ens B., Piersma T. and Zwarts.L. (2004). Shorebirds: An illustrated behavioural ecology. Utrecht, Holland: KNNV Publishers.

Victorian Government Department of Sustainability and Environment. 2009. Action Statement Flora and Fauna Guarantee Act 1988 No. 242 - Blue Whale *Balaenoptera musculus*

Victoria State Government (2016). Marine Pests and Disease, Abalone Disease, Background and Impact. Available from: http://agriculture.vic.gov.au/fisheries/policy-and-planning/marinepests-and-diseases/abalone-disease/background-and-impact

Visit Victoria. (2019a). Churchill Island Marine National Park. Available from: https://www.visitmelbourne.com/regions/Phillip-Island/Things-to-do/Nature-and-wildlife/National-parks-and-reserves/Churchill-Island-Marine-National-Park

Visit Victoria. (2019b). Port Phillip Heads Marine National Park. Available from: https://www.visitmelbourne.com/regions/Mornington-Peninsula/Things-to-do/Nature-and-wildlife/National-parks-and-reserves/Port-Phillip-Heads-Marine-National-Park

Watson C.F. and Chaloupka M.Y. (1982). Zooplankton of Bass Strait: Species Composition, Systematics and Artificial key to Species. Tasmanian Institute of Marine Science Technical Report No. 1.

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.

Wiese, F.K., Montevecchi, W.A., Davoren, G.K., Huettmann, F., Diamond, A.W. and Linke, J. (2001) Seabirds at risk around offshore oil platforms in the North-west Atlantic. Marine Pollution Bulletin 42: 1285 - 1290.

WGCMA (2003). West Gippsland Native Vegetation Plan. West Gippsland Catchment Management Authority, Traralgon, Victoria.

WGCMA (2014). Corner Inlet Ramsar Site Management Plan. West Gippsland CMA, Traralgon. Available from: http://www.wgcma.vic.gov.au/wpcontent/uploads/2015/01/WaterStrategy2014-2022-web-pt4.pdf

Whinney J.C. (2007). Physical conditions on marginal coral reefs. PhD, James Cook University, Thesis (unpublished).

Williams et al., (2009) in DotEE, (2017e).

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 R.S. and Poore G.C.B. (1987). The Bass Strait Survey: Biological Sampling Stations, 1979- 1984.

Woodside (2003). Environmental Impact Statement/Environmental Effects Statement: Otway Gas Project. Woodside Energy Ltd., Perth.

Woodside (2008). Torosa South - 1 (TS-1) Pilot Appraisal well, Environmental Monitoring Program - Development of Methodologies Part 1 (p51). Report produced by Environmental Resources Management and SKM.

Woodside (2014). Browse FLNG Development, Draft Environmental Impact Statement. EPBC 2013/7079. November 2014. Woodside Energy, Perth WA.

Woodside (2019) Propose Browse to NWS Project. Draft EIS/ERD. EPA Assessment No. 2191. EBPC 2018/8319.

Woodside (2020) Scarborough Gas Project Offshore Project Proposal [Accepted by NOPSEMA April 2020]. https://www.nopsema.gov.au/environmental-management/assessment-process/offshore-project-proposals/public-comment/scarborough/

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.

Zieman J.C., Iverson R.L. and Ogden, J. (1984). Herbivory effects on *Thalassia testudinum* leaf growth and nitrogen content. Marine Ecology-progress Series (15), 151-158.

11 Document information and history

Document custodian group

Title	Name/s
DocCust-OPS-Otway	Kevin Galea, David Ross

Process maintainer

Position	Name
Senior Environmental Advisor	Adrian Cukovski

Document history

Rev	Date	Changes made in document	Reviewer/s	Consolidator	Approver
OEUP-V9000-PLN-ENV-001					
0	21/06/10	Woodside Document revised for Origin and submitted to Tasmanian Department	TN	-	-
1	24/10/10	Updated to include DIER and Department of Primary Industries (DPI) comments, revised for Offshore facilities only and for Origin operation	RT	-	-
2	28/06/13	Revision request from NOPSEMA.	John Brewster	-	-
3	06/12/13	Updated in line with a request for modification from NOPSEMA	John Brewster	Robert Meagher	Mark Sanford
4	04/03/2014	Updated in line with a request for modification from NOPSEMA	Robert Meagher	Scott Cornish	Mark Sanford
5	22/09/2014	Updated in line with a request for modification from NOPSEMA	Tom Hatfield	Scott Cornish John Massey James Boorman	Gary Rooks
CDN/ID 3977021 : VIC-9000-ENV-PLN-00003					
6	15/05/2017	Final – Issued to NOPSEMA and DEDJTR for acceptance	Kristy Presley	Shane Reynolds Kelly Hunt Scott Cornish	Mark Sanford
7	14/08/2017	Revisions made to address NOPSEMA and DEDJTR comments	Kristy Presley	Shane Reynolds Kelly Hunt Scott Cornish	Mark Sanford
8	13/03/2018	Revisions made to reflect DEDJTR and NOPSEMA acceptance and Lattice response dated 3/11/2017 to NOPSEMA RFFI dated 13/09/2017.	Kristy Presley	Shane Reynolds Amanda Keely Kelly Hunt	Mark Sanford

Rev	Date	Changes made in document	Reviewer/s	Consolidator	Approver
8A	21/05/2019	Converted to new Beach Template and updated Section 2.0 with current ownership and contact details and an additional objective outlining the reason for the minor revision. Section 8.14 has been updated with the latest corporate IMS strategies as per NOPSEMA recommendation 2064-07.	Adrian Cukovski Phil Wemyss Tim Flowers	Adrian Cukovski	-
8B	21/09/2020	Corrected cross-references, updated information regarding introduced marine species, added pre-amble regarding ownership, all references to Origin replaced with Beach.	Phil Wemyss	Adrian Cukovski	-
9	31/10/2020	Approved for use	-	-	Frank Groen
9A	27/11/2020	Changes limited to: • OEMS updates • Name changes from Origin to Beach • Operating address updated.	Naz Butler, Adrian Cukovski, Tim Flowers	Naz Butler	-
10	17/12/2020	Approved for use	-	-	Frank Groen
10A	14/06/2021	Updated Project Description to include the current operations; Update of Project Description to include two new wells drilled at Geographe	Kamran Khalfay, Mika Porter, Patrick Flynn, Samantha Nunan, Brad Muir, Frank Groen, Phil Wemyss	Phil Wemyss	-
10B	05/08/2021	Update of the HSEMS section to now reflect Beach's OEMS	Frank Groen, Kevin Galea, Linda French, Phil Wemyss, Adrian Cukovski	Phil Wemyss	-
10C	13/08/2021	Updated environmental description to include information from recent studies undertaken as part of the Otway Drilling Campaign	Frank Groen, Kevin Galea, Linda French, Phil Wemyss	Phil Wemyss	-
11	03/09/2021	Approved for use	-	-	Kevin Galea
12	10/03/2022	Updated as per NOPSEMA OMR	PW	Xodus	Kevin Galea

Appendix A EPBC Act Protected Matters Search Reports

A. 1. Spill EMBA

Australian Government
Department of Agriculture, Water and the Environment

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.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 18/05/21 12:12:04

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates
Buffer: 0.0Km

Summary

Matters of National Environmental 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:	6
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	9
Listed Threatened Species:	111
Listed Migratory Species:	80

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 http://www.environment.gov.au/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 Land:	9
Commonwealth Heritage Places:	8
Listed Marine Species:	131
Whales and Other Cetaceans:	32
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	6

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	48
Regional Forest Agreements:	3
Invasive Species:	57
Nationally Important Wetlands:	10
Key Ecological Features (Marine)	3

Details

Matters of National Environmental Significance

National Heritage Properties		[Resource Information]
Name	State	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)	[Resource Information]
Name	Proximity
Corner inlet	Within 10km of Ramsar
Glenelg estuary and discovery bay wetlands	Within Ramsar site
Lavinia	Within Ramsar site
Piccaninnie ponds karst wetlands	Within Ramsar site
Port phillip bay (western shoreline) and bellarine peninsula	Within Ramsar site
Western port	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 the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

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.

Name	Status	Type of Presence
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
Karst springs and associated alkaline fens of the Naracoorte Coastal Plain Bioregion	Endangered	Community likely to 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
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
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]
Name	Status	Type of Presence
Birds		
Acanthiza pusilla archibaldi King Island Brown Thornbill, Brown Thornbill (King Island) [59430]	Endangered	Species or species habitat likely to occur within area
Acanthornis magna greeniana King Island Scrubtit, Scrubtit (King Island) [82329]	Critically Endangered	Species or species habitat likely to occur within area
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area
Aquila audax fleayi Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian) [64435]	Endangered	Species or species habitat likely to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	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]	Critically Endangered	Roosting known to occur within area
Calyptorhynchus banksii graptogyne South-eastern Red-tailed Black-Cockatoo [25982]	Endangered	Species or species habitat known to occur within area
Ceyx azureus diemenensis Tasmanian Azure Kingfisher [25977]	Endangered	Species or species habitat may occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to 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

Name	Status	Type of Presence
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
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]	Vulnerable	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	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route 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 likely to 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 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	Foraging, feeding or related behaviour likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	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

Name	Status	Type of Presence
		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 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 eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to 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 likely to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Crustaceans		
Euastacus bispinosus Glenelg Spiny Freshwater Crayfish, Pricklyback [81552]	Endangered	Species or species habitat known to occur within area
Fish		
Galaxiella pusilla Eastern Dwarf Galaxias, Dwarf Galaxias [56790]	Vulnerable	Species or species habitat known to occur within area
Nannoperca obscura Yarra Pygmy Perch [26177]	Vulnerable	Species or species habitat likely to occur within area
Nannoperca variegata Variegated Pygmy Perch, Ewens Pygmy Perch, Golden Pygmy Perch [26178]	Vulnerable	Species or species habitat known to occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Frogs		
Litoria raniformis Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat known to occur within area
Insects		
Synemon plana Golden Sun Moth [25234]	Critically Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Mammals		
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
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	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 known to occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat may occur within area
Potorous tridactylus tridactylus Long-nosed Potoroo (SE Mainland) [66645]	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 known 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
Plants		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Caladenia colorata Coloured Spider-orchid, Small Western Spider-orchid, Painted Spider-orchid [54999]	Endangered	Species or species habitat known to occur within area
Caladenia hastata Melblom's Spider-orchid [16118]	Endangered	Species or species habitat likely to occur within area
Caladenia insularis French Island Spider-orchid [24372]	Vulnerable	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 tensa Greencomb Spider-orchid, Rigid Spider-orchid [24390]	Endangered	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
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 likely to occur within area
Euphrasia collina subsp. muelleri Purple Eyebright, Mueller's Eyebright [16151]	Endangered	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
Grevillea infecunda Anglesea Grevillea [22026]	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
Hypolepis distans Scrambling Ground-fern [2148]	Endangered	Species or species habitat likely 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 likely to occur within area
Lepidium aschersonii Spiny Pepper-cress [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 likely to occur within area

Name	Status	Type of Presence
Leucochrysum albicans subsp. tricolor Hoary Sunray, Grassland Paper-daisy [89104]	Endangered	Species or species habitat may 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 frenchii Maroon Leek-orchid, Slaty Leek-orchid, Stout Leek-orchid, French's Leek-orchid, Swamp Leek-orchid [9704]	Endangered	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
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat likely 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
Pterostylis ziegeleri Grassland Greenhood, Cape Portland Greenhood [64971]	Vulnerable	Species or species habitat may 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
Taraxacum cygnorum Coast Dandelion [2508]	Vulnerable	Species or species habitat likely to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat likely to occur within area
Thelymitra matthewsii Spiral Sun-orchid [4168]	Vulnerable	Species or species habitat known to occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to 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	Foraging, feeding or related behaviour known to occur within area

Name	Status	Type of Presence
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Breeding known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
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
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat known to occur within area
Ardenna grisea Sooty Shearwater [82651]		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	Species or species habitat may occur within area
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

Name	Threatened	Type of Presence
		related behaviour 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 eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to 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 likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Breeding known to 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 edeni Bryde's Whale [35]		Species or species habitat may 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
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Breeding 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	Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely 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]	Vulnerable	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
Rhincodon typus Whale Shark [66680]	Vulnerable	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 known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to 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
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur

Name	Threatened	Type of Presence
		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]	Critically Endangered	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	Roosting 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]		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 known to occur within area
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]		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]		Species or species habitat known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area

Name	Threatened	Type of Presence
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 incana Wandering Tattler [831]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [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.

Name
Commonwealth Land -
Commonwealth Land - Australian Maritime Safety Authority
Defence - CROWS NEST CAMP - QUEENSCLIFF
Defence - HMAS CERBERUS
Defence - STAFF COLLEGE-FORT QUEENSCLIFF
Defence - SWAN ISLAND TRAINING AREA
Defence - TRAINING CENTRE (Norris Barracks) - Portsea
Defence - WARRNAMBOOL TRAINING DEPOT
Defence - WEST HEAD GUNNERY RANGE

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
HMAS Cerberus Marine and Coastal Area	VIC	Listed place
Swan Island and Naval Waters	VIC	Listed place
Historic		
Cape Northumberland Lighthouse	SA	Listed place
Cape Wickham Lighthouse	TAS	Listed place
Fort Queenscliff	VIC	Listed place
Sorrento Post Office	VIC	Listed place
Swan Island Defence Precinct	VIC	Listed place
Wilsons Promontory Lighthouse	VIC	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
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

Name	Threatened	Type of Presence
		area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	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]	Critically Endangered	Roosting known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may 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	Roosting 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
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat 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 gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
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]		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 known to occur within 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
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Heteroscelus incanus Wandering Tattler [59547]		Roosting known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Larus dominicanus Kelp Gull [809]		Breeding known to occur within area
Larus novaehollandiae Silver Gull [810]		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
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]		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	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Morus capensis Cape Gannet [59569]		Breeding known to occur within area
Morus serrator Australasian Gannet [1020]		Breeding known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route 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
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
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Pelecanoides urinatrix Common Diving-Petrel [1018]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Species or species habitat known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Species or species habitat 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]		Roosting known to occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Foraging, feeding or related behaviour known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat known to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Puffinus tenuirostris Short-tailed Shearwater [1029]		Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area
Sterna albifrons Little Tern [813]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		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 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 eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to 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 sp. nov. Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable*	Species or species habitat known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys tryoni Tryon's Pipefish [66193]		Species or species habitat may occur within area
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
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		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
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
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		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

Name	Threatened	Type of Presence
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Vanacampus vercoi Verco's Pipefish [66286]		Species or species habitat may occur within area
Mammals		
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 known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
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 edeni Bryde's Whale [35]		Species or species habitat may 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

Name	Status	Type of Presence
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
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 simus Dwarf Sperm Whale [58]		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]	Vulnerable	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

Name	Status	Type of Presence
		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]

Name	Label
Apollo	Multiple Use Zone (IUCN VI)
Beagle	Multiple Use Zone (IUCN VI)
Murray	Multiple Use Zone (IUCN VI)
Nelson	Special Purpose Zone (IUCN VI)
Zeehan	Multiple Use Zone (IUCN VI)
Zeehan	Special Purpose Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Aire River	VIC
Anser Island	VIC
Bay of Islands Coastal Park	VIC
Cape Liptrap Coastal Park	VIC
Cape Nelson	VIC
Cape Wickham	TAS
Cape Wickham	TAS
Christmas Island	TAS
Cone Islet	TAS
Councillor Island	TAS
Curtis Island	TAS
Deen Maar	VIC
Devils Tower	TAS
Disappointment Bay	TAS
Discovery Bay Coastal Park	VIC
Douglas Point	SA
East Moncoeur Island	TAS
French Island	VIC
Glenelg River	VIC
Great Otway	VIC
Hogan Group	TAS
Lady Julia Percy Island W.R.	VIC
Lake Connewarre W.R	VIC
Lake Flannigan	TAS
Lavinia	TAS
Lawrence Rocks W.R.	VIC
Mornington Peninsula	VIC
Nene Valley	SA
New Year Island	TAS

Name	State
North East Islet	TAS
Phillip Island Nature Park	VIC
Piccaninnie Ponds	SA
Point Nepean	VIC
Port Campbell	VIC
Queenscliff N.F.R	VIC
Reef Island and Bass River Mouth N.C.R	VIC
Rodondo Island	TAS
Seal Islands W.R.	VIC
Southern Wilsons Promontory	VIC
Sugarloaf Rock	TAS
Swan Bay - Edwards Point W.R	VIC
Unnamed C0293	VIC
Ventnor B.R.	VIC
West Moncoeur Island	TAS
Wilsons Promontory	VIC
Wilsons Promontory Islands	VIC
Wonthaggi Heathlands N.C.R	VIC
Yambuk F.F.R.	VIC

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
Gippsland RFA	Victoria
Tasmania RFA	Tasmania
West Victoria RFA	Victoria

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Callipepla californica California Quail [59451]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Carduelis chloris European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Gallus gallus Red Junglefowl, Feral Chicken, Domestic Fowl [917]		Species or species habitat likely to occur within area
Meleagris gallopavo Wild Turkey [64380]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pavo cristatus Indian Peafowl, Peacock [919]		Species or species habitat likely to occur within area
Phasianus colchicus Common Pheasant [920]		Species or species habitat likely to occur within area
Pycnonotus jocosus Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Turdus philomelos Song Thrush [597]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Austrocylindropuntia spp. Prickly Pears [85132]		Species or species habitat likely to occur within area
Carrichtera annua Ward's Weed [9511]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. rotundata Bitou Bush [16332]		Species or species habitat likely to occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom,		Species or species

Name	Status	Type of Presence
Common Broom, French Broom, Soft Broom [20126]		habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Anderson Inlet	VIC
Glenelg Estuary	VIC
Lake Connewarre State Wildlife Reserve	VIC
Lake Flannigan	TAS
Long Swamp	VIC
Lower Aire River Wetlands	VIC
Mud Islands	VIC
Swan Bay & Swan Island	VIC
Western Port	VIC
Yambuk Wetlands	VIC

Key Ecological Features (Marine) [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

Name	Region
Upwelling East of Eden	South-east
West Tasmania Canyons	South-east

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-36.795 138.132,-36.817 138.639,-37.004 139.328,-37.745 140.241,-37.912 140.375,-37.939 140.452,-38.057 140.66,-38.044 140.793,-38.058 140.998,-38.098 141.097,-38.203 141.276,-38.323 141.397,-38.379 141.365,-38.359 141.461,-38.391 141.52,-38.399 141.651,-38.309 141.597,-38.26 141.7,-38.253 141.774,-38.273 141.91,-38.299 141.996,-38.394 142.151,-38.368 142.26,-38.352 142.374,-38.383 142.441,-38.392 142.482,-38.412 142.537,-38.492 142.674,-38.575 142.793,-38.626 142.933,-38.626 143.01,-38.675 143.119,-38.76 143.213,-38.772 143.261,-38.752 143.301,-38.756 143.36,-38.811 143.473,-38.859 143.507,-38.853 143.557,-38.792 143.621,-38.782 143.666,-38.741 143.672,-38.696 143.798,-38.666 143.868,-38.594 143.921,-38.548 143.99,-38.539 143.976,-38.517 143.993,-38.478 144.035,-38.472 144.059,-38.469 144.103,-38.426 144.145,-38.397 144.241,-38.325 144.332,-38.283 144.431,-38.291 144.501,-38.273 144.495,-38.27 144.546,-38.292 144.615,-38.232 144.64,-38.188 144.703,-38.136 144.738,-38.105 144.816,-38.217 144.909,-38.351 144.925,-38.371 144.832,-38.392 144.785,-38.474 144.882,-38.494 144.893,-38.481 145.015,-38.429 145.054,-38.386 145.124,-38.409 145.223,-38.301 145.194,-38.278 145.274,-38.297 145.289,-38.397 145.278,-38.407 145.373,-38.495 145.444,-38.535 145.375,-38.544 145.437,-38.564 145.491,-38.68 145.613,-38.639 145.729,-38.691 145.796,-38.785 145.877,-38.88 145.916,-38.897 145.936,-38.882 146.006,-38.837 145.997,-38.81 146.027,-38.809 146.082,-38.896 146.22,-38.98 146.272,-39.049 146.333,-39.125 146.345,-39.116 146.432,-39.081 146.423,-39.024 146.472,-38.94 146.507,-38.867 146.572,-38.825 146.581,-38.758 146.675,-38.713 147.066,-38.481 147.273,-38.096 147.788,-37.922 148.581,-37.919 148.817,-37.976 148.921,-38.176 148.977,-38.343 148.958,-38.386 148.523,-38.916 147.889,-39.242 147.643,-39.786 146.918,-39.84 146.566,-39.699 145.171,-39.749 144.884,-40.068 144.812,-40.289 144.388,-40.239 144.272,-40.137 144.17,-40.021 144.141,-39.811 144.152,-39.601 144.071,-39.707 143.817,-39.865 143.815,-41.272 143.989,-41.453 143.942,-41.391 143.435,-41.145 143.264,-40.971 143.242,-40.641 143.228,-40.489 143.032,-40.597 142.568,-40.601 142.209,-40.844 141.434,-40.648 141.071,-40.329 141.021,-39.76 140.941,-39.626 140.727,-39.394 140.615,-38.84 139.27,-38.506 139.078,-37.912 139.041,-37.781 139.07,-37.498 138.411,-37.223 138.153,-36.795 138.132

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.

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A. 2. Operational Area – 500 m

Australian Government
Department of Agriculture, Water and the Environment

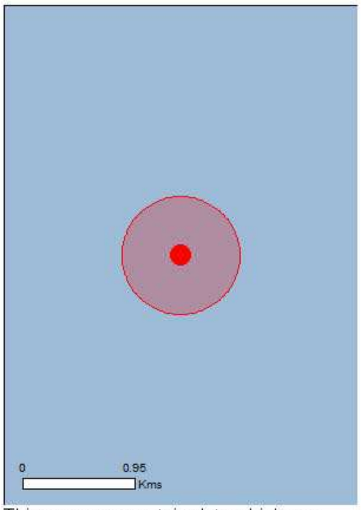
EPBC Act Protected Matters Report

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.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 29/06/21 21:59:41



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates
Buffer: 0.5Km

Summary

Matters of National Environmental 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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	32
Listed Migratory Species:	36

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 http://www.environment.gov.au/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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	58
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	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 the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	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
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	Species or species habitat may occur within

Name	Status	Type of Presence
		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
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 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	Species or species habitat may 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 likely to occur within area
Mammals		
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

Name	Status	Type of Presence within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
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
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		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
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	Species or species habitat may 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 cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
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	Species or species habitat may 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 likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	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
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat 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
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 may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	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]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	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
Catharacta skua Great Skua [59472]		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

Name	Threatened	Type of Presence
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	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
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
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		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 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	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely 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
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
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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
Mammals		
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
Reptiles		
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]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may 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

Name	Status	Type of Presence
		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
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
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to 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

Extra Information

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-38.89139 142.8825

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.

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A. 3. Light EMBA – 20 km

Australian Government
Department of Agriculture, Water and the Environment

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.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 05/08/21 19:23:55

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates
Buffer: 20.0Km

Summary

Matters of National Environmental 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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	35
Listed Migratory Species:	38

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 http://www.environment.gov.au/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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	62
Whales and Other Cetaceans:	14
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	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 the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	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
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	Species or species habitat may occur within

Name	Status	Type of Presence
		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
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 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 likely to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat may occur within area
Fish		
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Status	Type of Presence
		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
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
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
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
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]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		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
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may 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 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 likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	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
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat 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

Name	Threatened	Type of Presence
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 may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	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
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
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
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calidris canutus Red Knot, Knot [855]	Endangered	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
Catharacta skua Great Skua [59472]		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
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	Species or species habitat may 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 Fairy Prion [1066]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		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
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species

Name	Threatened	Type of Presence
		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 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 sp. nov. Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable*	Species or species habitat may 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
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		Species or species

Name	Threatened	Type of Presence
[66249]		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
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
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Reptiles		
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]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may 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
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
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to 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		Species or species

Name	Status	Type of Presence
Bottlenose Dolphin [68418]		habitat likely to occur within area
Tursiops truncatus s. str.		
Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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.

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- marine

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- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-38.89139 142.8825

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
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-Natural history museums of Australia
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-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
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-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
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-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.

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A. 4. Sound 24 hr EMBA – 1.5 km

Australian Government
Department of Agriculture, Water and the Environment

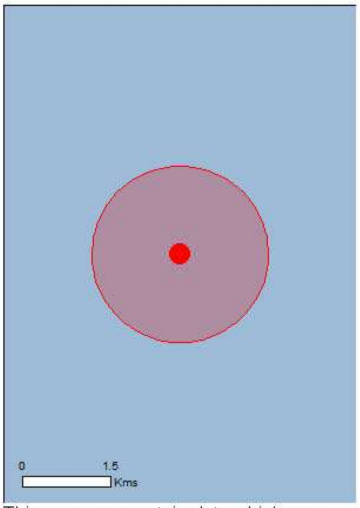
EPBC Act Protected Matters Report

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.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 06/08/21 15:48:12



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates
Buffer: 1.5Km

Summary

Matters of National Environmental 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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	32
Listed Migratory Species:	36

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 http://www.environment.gov.au/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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	58
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	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 the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	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
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	Species or species habitat may occur within

Name	Status	Type of Presence
		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
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 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	Species or species habitat may 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 likely to occur within area
Mammals		
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

Name	Status	Type of Presence within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
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
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		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
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	Species or species habitat may 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 cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
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	Species or species habitat may 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 likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	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
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat 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
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 may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	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]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	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
Catharacta skua Great Skua [59472]		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

Name	Threatened	Type of Presence
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	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
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
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		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 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	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely 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
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
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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
Mammals		
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
Reptiles		
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]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may 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

Name	Status	Type of Presence
		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
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
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to 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

Extra Information

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-38.89139 142.8825

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
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-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.

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A. 5. Sound Behaviour EMBA – 7.5 km

Australian Government
Department of Agriculture, Water and the Environment

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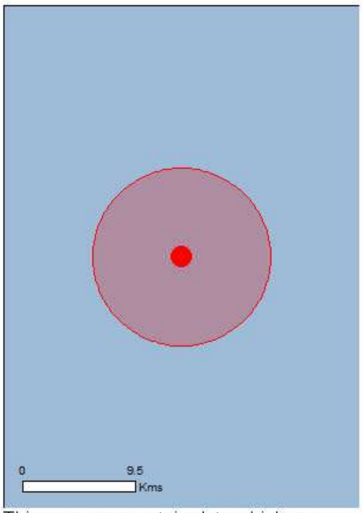
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 05/08/21 19:25:55



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates
Buffer: 7.5Km

Summary

Matters of National Environmental 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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	33
Listed Migratory Species:	37

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 http://www.environment.gov.au/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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	59
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	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 the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	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
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	Species or species habitat may occur within

Name	Status	Type of Presence
		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
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 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	Species or species habitat may 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 likely to occur within area
Fish		
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area
Mammals		
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

Name	Status	Type of Presence
		related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
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
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		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
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	Species or species habitat may 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

Name	Threatened	Type of Presence
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	Species or species habitat may 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 likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	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
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat 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
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 may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	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
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	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
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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	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
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		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
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		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 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

Name	Threatened	Type of Presence
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely 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
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

Name	Threatened	Type of Presence
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
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
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
Reptiles		
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]

Name	Status	Type of Presence

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may 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
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
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to 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

Extra Information

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-38.89139 142.8825

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.

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Appendix B RPS APASA Artisan-1 Spill Model Report

Report

RPS

13 JUNE 2019

Beach Energy Artisan-1 Exploration Well

Oil Spill Modelling

RPS

Document status

Version	Purpose of document	Authored by	Reviewed by	Review date
Draft	Draft issued for internal review	Jeremie Bernard	Nathan Benfer	27 May 2019
Rev0	Draft issued for client review	Jeremie Bernard	Dr. Sasha Zigic	31 May 2019
Rev 1	Issued to client		Dr. Sasha Zigic	13 June 2019

Approval for issue

Name	Signature	Date
Dr. Sasha Zigic	S. Zigic	13 June 2019

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Version: Rev0
Date: 13 June 2019

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RPS

Contents

RPS

Tables

RPS

Figures

RPS

Terms and Abbreviations

°	Degrees
‘	Minutes
“	Seconds
Actionable oil	Oil which is thick enough for effective use of mitigation strategies, such as mechanical clean up (e.g. skimmers), booms, dispersed, or burned
AMP	Australian marine parks
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 in comparison to water)
ASTM	American Society for Testing and Materials
Bonn Agreement Oil Appearance Code	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
°C	Degree Celsius (unit of temperature)
cP	Centipoise (unit of viscosity)
CFSR	Climate Forecast System Reanalysis
cm	Centimetre (unit of length)
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
Dissolved hydrocarbons	Dissolved hydrocarbons within the water column with alternating double and single bonds between carbon atoms forming rings, containing at least one six-membered benzene ring
g/m^2	Grams per square meter (unit of surface or area density)
EIA	Environmental impact assessment
Entrained oil	Droplets or globules of oil that are physically mixed (but not dissolved) into the water column. Physical entrainment can occur either during pressurised release from a subsurface location, or through the action of breaking waves (>12 knots)
EP	Environmental plan
EEZ	Exclusive Economic Zone
Evaporation	The process whereby components of the oil mixture are transferred from the sea-surface to the atmosphere
GODAE	Global Ocean Data Assimilation Experiment
HYCOM	Hybrid Coordinate Ocean Model is a data-assimilative, three-dimensional ocean model
HYDROMAP	Advanced ocean/coastal tidal model used to predict tidal water levels, current speed and current direction
IOA	Index of Agreement gives a non-dimensional measure of model accuracy or performance
IBRA	Interim Biogeographic Regionalisation for Australia

IMCRA	Integrated Marine and Coastal Regionalisation of Australia
Isopycnal layers	Water column layers with corresponding water densities
ITOPF	The International Tanker Owners Pollution Federation
KEF	Key Ecological Feature
km	Kilometre (unit of length)
km^2	Square Kilometres (unit of area)
KEF	Key ecological feature
Knot	unit of wind speed (1 knot = 0.514 m/s)
LGA	Local Government Area
LOWC	Loss of Well Control
m	Metres (unit of length)
m^2	Metres squared (unit of area)
m^3	Metres cubed (unit of volume)
m/s	Metres per Second (unit of speed)
MAE	Mean Absolute Error is the average of the absolute values of the difference between model predicted and observed data (e.g. surface elevations)
MB	Marine boundary
MNP	Marine National Park
RSB	Reefs, Shoals and Banks
MS	Marine Sanctuary
NASA	National Aeronautics and Space Administration
NCEP	National Centres for Environmental Prediction
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
nm	nautical mile (unit of distance; 1 nm = 1.852 km)
NP	National Parks
Ocean current	Large scale and continuous movement of seawater generated by forces such as breaking waves, wind, the Coriolis effect, and temperature and salinity gradients. It is the main flow of ocean waters
OECD	Organisation for Economic Co-operation and Development
ppb	Parts per billion (concentration)
ppb.hrs	ppb multiplied for hours (concentration x time)
PSU	Practical salinity units
Ramsar site	A wetland site designated of international importance under the Ramsar Convention
Ramsar Convention	The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
Sea surface exposure	Floating oil on the sea surface equal to or above reporting threshold (e.g. 0.5 g/m^2)
Shoreline contact	Stranded oil on the shoreline equal to or above reporting threshold (e.g. 10 g/m^2)

SIMAP	Spill Impact Mapping Analysis Program
US EPA	United States Environmental Protection Agency
Visible oil	Floating oil on the sea surface equal to or above reporting threshold (e.g. 0.5 g/m^2)

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EXECUTIVE SUMMARY

Background

Beach Energy is intending to undertake further development of the Otway offshore natural gas reserves. The proposed development will include the drilling of offshore exploration wells situated in the Otway Basin, starting with the Artisan-1 gas well. In order to support the development of environmental approvals for the drilling program, a comprehensive oil spill modelling study was commissioned which considered the following two hypothetical spill scenarios:

- 300 m^3 surface release of marine diesel over 6 hours in the event of a containment loss from a vessel at the Artisan-1 well location; and
- 222,224 bbl subsea release of condensate over 86 days to represent an unrestricted open-hole loss of well control (LOWC) event from the Artisan-1.

SIMAP's (Spill Impact Mapping Analysis Program) stochastic model was used to quantify the probability of exposure from a spill to the sea (surface and in-water), and the probability of shoreline contact from hypothetical spill scenarios. The SIMAP system and the methods and analysis presented herein, use modelling algorithms which have been 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*".

Methodology

The modelling study was carried out in several stages. Firstly, a five-year current dataset (2008–2012) that includes the combined influence of three-dimensional ocean and tidal currents was developed. Secondly, the currents, spatial winds and then detailed hydrocarbon properties were used as inputs in the oil spill model to simulate the drift, spread, weathering, entrainment and fate of the spilled hydrocarbons.

As spills can occur during any set of wind and current conditions, a total of 100 spill trajectories per hypothetical spill scenario per season (e.g. summer and winter) were initiated at random times within a 5-year period (2008–2012) to enable a robust statistical analysis.

Each simulation was configurated with the same spill information (i.e. spill volume, duration and oil type) except for the start time and date which in turns, ensures that the predicted transport and weathering of an oil slick is subject to a wide range of current and wind conditions.

Oil Properties

The marine diesel oil (MDO) used for Scenario 1, is a light-persistent fuel oil used in the maritime industry. It has a density of 829.1 kg/m^3 (API of 37.6), a low pour point (-14ºC) and low viscosity (4cP). According to the International Tankers Owners Pollution Federation (ITOPF, 2014) and AMSA (2015a) guidelines, this oil is categorised as a group II oil (light-persistent).

Thylacine condensate was used for the loss of well control scenario (Scenario 2). The condensate has an API of 44.3, density of 804.6 kg/m^3 at 15ºC) with low viscosity (0.875 cP), classifying it as a Group I oil according to the International Tankers Owners Pollution Federation (ITOPF, 2014) and USEPA/USCG classifications. The condensate comprises a significant portion of volatiles and semi to low volatiles (99% total) with very little residual components (<1%).

Key Findings

Scenario: 300 m^3 surface release of marine diesel oil

Sea surface exposure

- No shoreline contact above the minimum threshold (>10 g/m^2) was predicted for any of the seasons modelled.
- During summer conditions, low (0.5 g/m^2) and moderate (10 g/m^2) exposure to surface hydrocarbons were predicted to travel a maximum distance of 68 km and 12 km from the release location, respectively. During winter, low and moderate exposure of surface hydrocarbons extended to a maximum distance of 93 km and 10 km from the release location, respectively.
- The modelling results demonstrated a 1% probability of oil exposure on the sea surface for the Central Victoria Integrated Marine and Coastal Regionalisation of Australia (IMCRA) receptor, during the summer season.
- During winter conditions, there was a 1% probability of oil exposure on the sea surface for several receptors including the Central Victoria and Central Bass Strait IMCRA, Apollo Australian Marine Park (AMP) and within Victorian State Waters.
- None of the receptors were exposed at or above the moderate or high (>25 g/m^2) thresholds with the exception of the Otway IMCRA. This receptor registered low, moderate and high exposure to sea surface hydrocarbons due to the release location being situated within the boundaries of this receptor.

Dissolved hydrocarbon exposure

- There was no dissolved hydrocarbon exposure (over the 48-hour window) in the 0-10 m depth layer to receptors at or above the low threshold (6 ppb), with the exception of the Otway IMCRA which registered 8 ppb and 9 ppb during summer and winter conditions, respectively. None of the receptors recorded exposure (over 48 hours) at or above the moderate (50 ppb) or high (400 ppb) thresholds.
- At the depths of 0-10 m, the dissolved hydrocarbon exposure over 1 hour was predicted for the Otway IMCRA, with the maximum concentration of 76 ppb during summer and 59 ppb during winter. No moderate or high dissolved hydrocarbons exposure (over 1 hour) was predicted for any receptors, except for the Otway IMCRA.

Entrained hydrocarbon exposure

- At the depths of 0-10 m, the maximum entrained hydrocarbon exposure (over a 48-hour window) during summer and winter conditions was 2,182 ppb and 792 ppb, respectively. None of the receptors were exposed at or above the moderate (10-100 ppb) or high (>1,000 ppb) thresholds, excluding the Otway IMCRA.
- Within the 0-10 m depth layer, the maximum entrained hydrocarbon exposure (over 1 hour) for the Otway IMCRA was 5,933 ppb and 5,046 ppb, during summer and winter conditions, respectively. For receptors other than the Otway IMCRA (83% summer and 93% winter), the probability of exposure to entrained hydrocarbons at or above the moderate threshold (100-1,000 ppb) ranged from 1% (Cape Patton sub-Local Government Area (sub-LGA)) to 8% (within Victorian State Waters) during summer conditions and 1% (Twelve Apostles Marine National Park (MNP)) to 16% (Apollo AMP) during winter conditions. No other receptors were exposed at or above the high threshold (>1,000 ppb), except for the Otway IMCRA.

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Scenario: 222,224 bbl subsea release of condensate over 86 days

Sea surface exposure

- During summer conditions, low (0.5 -10 g/m^2) and moderate (10 - 25 g/m^2) exposure to surface hydrocarbons were predicted to travel a maximum distance of 52 km and 4 km from the release location, respectively. Under winter conditions, low and moderate exposure from surface hydrocarbons extended to a maximum distance of 53 km and 3 km from the release location, respectively. Note, no high exposure was predicted on the sea surface for any of the seasons assessed.
- During summer conditions, the probability of hydrocarbon exposure on the sea surface at or above the low threshold was predicted to range from 6% (Otway Ranges Interim Biogeographic Regionalisation for Australia (IBRA) sub-region) to 16% (Colac Otway and Cape Otway West sub-LGAs and within Victorian State Waters). The exception is the Otway IMCRA (100% during both seasons). The winter modelling results demonstrated a larger number of receptors exposed to surface hydrocarbons at or above the low threshold. The probability ranged from 3% (Twelve Apostles MNP and Otway Ranges IBRA) to 40% (Otway Plain IBRA; Cape Otway West sub-LGA and Colac Otway LGA). No other receptors except the Otway IMCRA were exposed to moderate or high levels for any seasons assessed.

Shoreline contact

- The probability of contact to any shoreline was 16% and 57% for the summer and winter season, respectively. While the minimum time for visible surface hydrocarbons to reach a shoreline was 3 days for 5 days, respectively.
- The maximum volume of hydrocarbons predicted to come ashore was 15 m^3 and 33 m^3, during summer and winter conditions, respectively, while the maximum length of shoreline contacted above the low threshold (10 – 100 g/m^2) was 7.0 km and 11.0 km, respectively. Note, no shoreline loading was predicted for the high threshold (above 1,000 g/m^2).
- Cape Otway West LGA was the receptor predicted with the greatest probability of contact above the low and moderate thresholds during summer (16% and 15%, respectively) and winter (40% for both thresholds) conditions. The modelling results during winter conditions demonstrated additional shoreline contact to Moyne, Corangamite, Moonlight head and Childers Cove.

In-water exposure

- At the depth of 0-10 m, the maximum concentration of dissolved hydrocarbons over the 48-hour window was 30 ppb in summer and 34 ppb in winter, and hence no moderate or high exposure was predicted during either season. For summer conditions, the probability of low exposure to dissolved hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF, Moyne LGA, Bay of Islands and Childers Cove sub-LGAs) to 17% (Otway Plain IBRA, Colac Otway LGA, Cape Otway West sub-LGA and within Victoria State Waters)The Otway IMCRA recorded a probability of 50% during summer. During winter conditions, the probability of low exposure to dissolved hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF, Bay of Islands and Lorne sub-LGA) to 16% (within Victoria State Waters). The Otway IMCRA registered a probability of 42% for winter. None of the receptors were exposed to moderate (50 – 400 ppb) or high (>400 ppb) dissolved hydrocarbons (over a 48-hour basis) during the summer or winter season.
- At the depths of 0-10 m, the maximum dissolved hydrocarbon concentrations predicted over the 1-hour period was 309 ppb during summer and 289 ppb for winter, which occurred within the Otway IMCRA and the Victoria State Waters. During summer conditions, the probability of moderate exposure to

dissolved hydrocarbons ranged from 1% (Glenelg Plain and Bridgewater IBRA's; Glenelg, Moyne and Surf Coast LGAs; Lorne, Bay of Islands, Childers Cove and Cape Nelson sub-LGAs) to 43% (Otway Plain IBRA, Colac Otway LGA, Cape Otway West sub-LGA and within Victoria State Waters). The probability for Otway IMCRA was 58%. Under winter conditions, the probability of moderate exposure (over 1 hour) to dissolved hydrocarbons ranged from 1% (Gippsland Plain IBRA; Flinders IMCRA; Point Addis and Wilsons Promontory MNP; Mornington Peninsula LGA; Lorne, Mornington Peninsula and Childers Cove sub-LGAs) to 57% for the Victorian State Waters. The probability of exposure to the Otway IMCRA was 68%. None of the receptors were exposed high concentrations during the summer or winter season.

- The maximum entrained hydrocarbon concentrations time-averaged over 48 hours for the summer and winter season was 559 ppb and 569 ppb, respectively. No moderate or high exposure was predicted for any of the receptors predicted for any of the seasons. During summer conditions, the probability of low exposure to entrained hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF; Moyne LGA; Bay of Islands and Childers Cove sub-LGAs) to 17% (Otway Plain IBRA; Colac Otway LGA; Cape Otway West sub-LGA and within Victorian State Waters), with the exception of IMCRA – Otway (50%). During winter conditions, the probability of low exposure to entrained hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF; Bay of Islands and Lorne sub-LGAs) to 16% (Victoria State Waters), with the exception of Otway IMCRA (42%).
- Within the 0-10 m depth layer, the maximum concentration of entrained hydrocarbons over 1 hour was 948 ppb during summer and 932 ppb during winter, occurring within the Otway IMCRA. During summer conditions, the probability of moderate entrained hydrocarbon exposure ranged from 7% (Cape Patton sub-LGA) to 73% (Victorian State Waters). The probability of exposure to the Otway IMCRA receptor was 100% during both seasons. For other receptors during winter conditions, the probability of moderate entrained hydrocarbon exposure ranged from 8% (along the shoreline of Childers Cove sub-LGA; Moyne and Warrnambool LGA) to 73% (within Victorian State Waters).

1 INTRODUCTION

Beach Energy[1] is seeking approval to undertake further development of the Otway offshore natural gas reserves. The proposed development will include the drilling of offshore exploration wells situated in the Otway Basin starting with the Artisan-1 gas exploration well. In order to obtain environmental approvals for the drilling program, Beach Energy commissioned RPS to undertake a comprehensive oil spill modelling based on the following two hypothetical spill scenarios:

- 300 m^3 surface release of marine diesel over 6 hours in the event of a containment loss from a vessel at the Artisan-1 well location; and
- 222,224 bbl subsea release of condensate over 86 days to represent an unrestricted open-hole loss of well control (LOWC) event from the Artisan-1 well location.

Figure 1 and Table 1 present the location and coordinates of Artisan-1 which was used as the release location for the two scenarios.

The potential risk of exposure to the surrounding waters and contact to shorelines was assessed for summer (October to March) and winter (April to September) conditions. This approach assists with identifying the environmental values and sensitivities that would be at risk of exposure on a seasonal basis.

The purpose of the modelling is to further improve understanding of a conservative 'outer envelope' of the potential area that may be affected in the unlikely event of hydrocarbon release. The modelling does not take into consideration any of the spill prevention, mitigation and response capabilities that would be implemented in response to the 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 Mapping Analysis 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.

The hydrocarbon spill model, the method and analysis applied herein uses modelling algorithms which have been peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the American Society for Testing and Materials (ASTM) Standard F2067-13 "*Standard Practice for Development and Use of Oil Spill Models*".

Table 1 Location of the Artisan-1 well location used for the oil spill modelling study.

Well location	Latitude	Longitude	Water Depth (m)
Artisan-1	38° 53" 29.4' S	142° 52" 55.7' E	60

[1] It should be noted that Beach Energy is the 100% owner of Lattice Energy. Lattice Energy are the permit titleholder.

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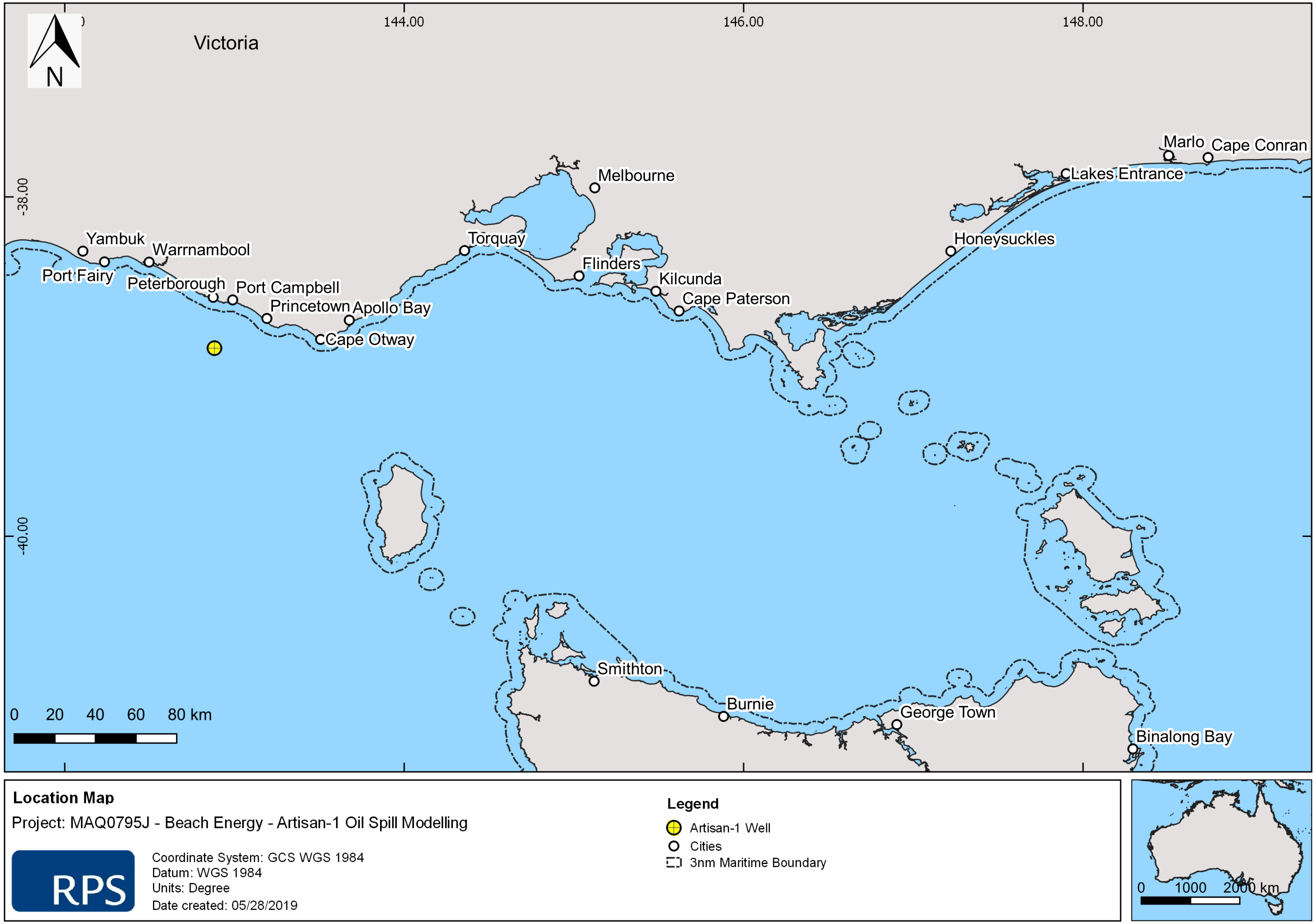

Figure 1 Locality map of the Artisan-1 exploration well.

2 SCOPE OF WORK

The scope of work included the following components:

1. Generate tidal current patterns of the region using the ocean/coastal model, HYDROMAP;
2. Use HYCOM (Hybrid Coordinate Ocean Model) ocean currents combined with HYDROMAP tidal currents over a 5-year period (2008 to 2012) to account for large scale flows offshore and tidal flows nearshore;
3. Use 5 years of high-resolution wind, aggregated current data and oil characteristics as input into the 3-dimensional oil spill model SIMAP to represent the movement, spreading, entrainment, weathering of the oil over time; and
4. Use SIMAP's stochastic model (also known as a probability model) to calculate exposure to surrounding waters (sea surface and water column) and shorelines; and
5. Undertake a high-level deterministic analysis of the "worst case" LOWC scenario.

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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 Otway Basin is part of the western field of the Bass Strait and lies along a north-west to south-east axis. It is approximately 500 km long and extends from Cape Jaffa in South Australia to north-west Tasmania and forms part of the Australian Southern Rift System.

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 2 displays seasonal surface 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 & Kampf 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward in offshore waters.

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 2-dimensional tidal currents developed by RPS. The following sections provide a summary of the hybrid regional data set.

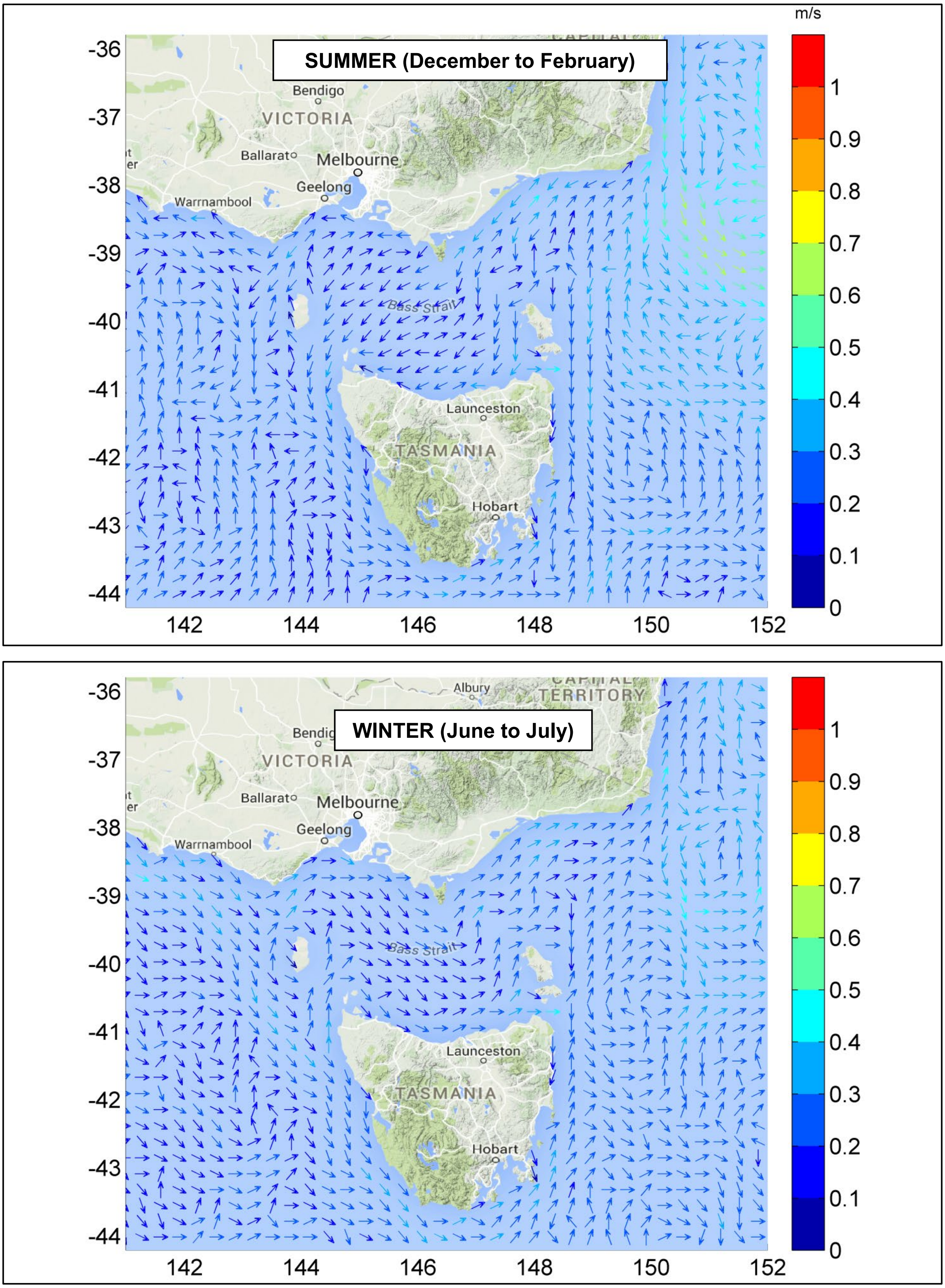

Figure 2 HYCOM averaged seasonal surface drift currents during summer and winter.

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 32 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 and Spaulding (1984) and Isaji et al. (2001).

3.1.1 Grid Setup

The tidal model domain has been 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 were 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 shows the tidal model grid covering the study domain.

A combination of datasets were used and merged to describe the shape of the seabed within the grid domain (Figure 4). 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).

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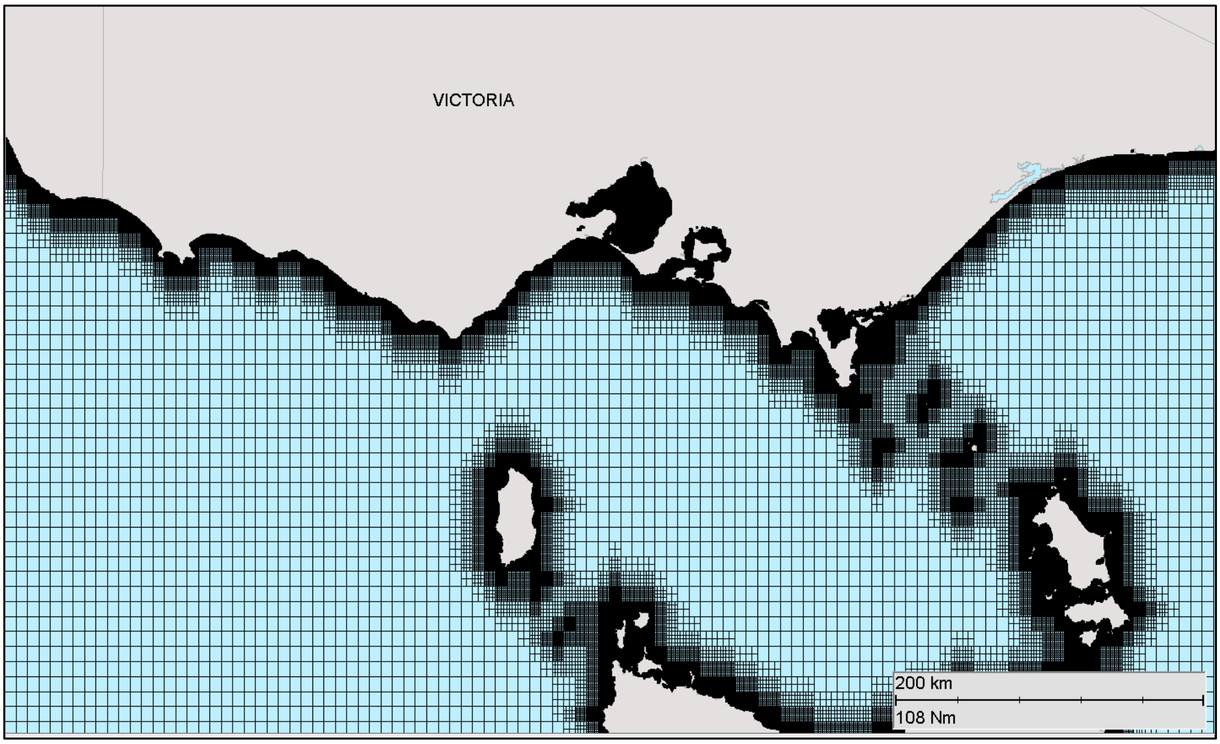

Figure 3 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

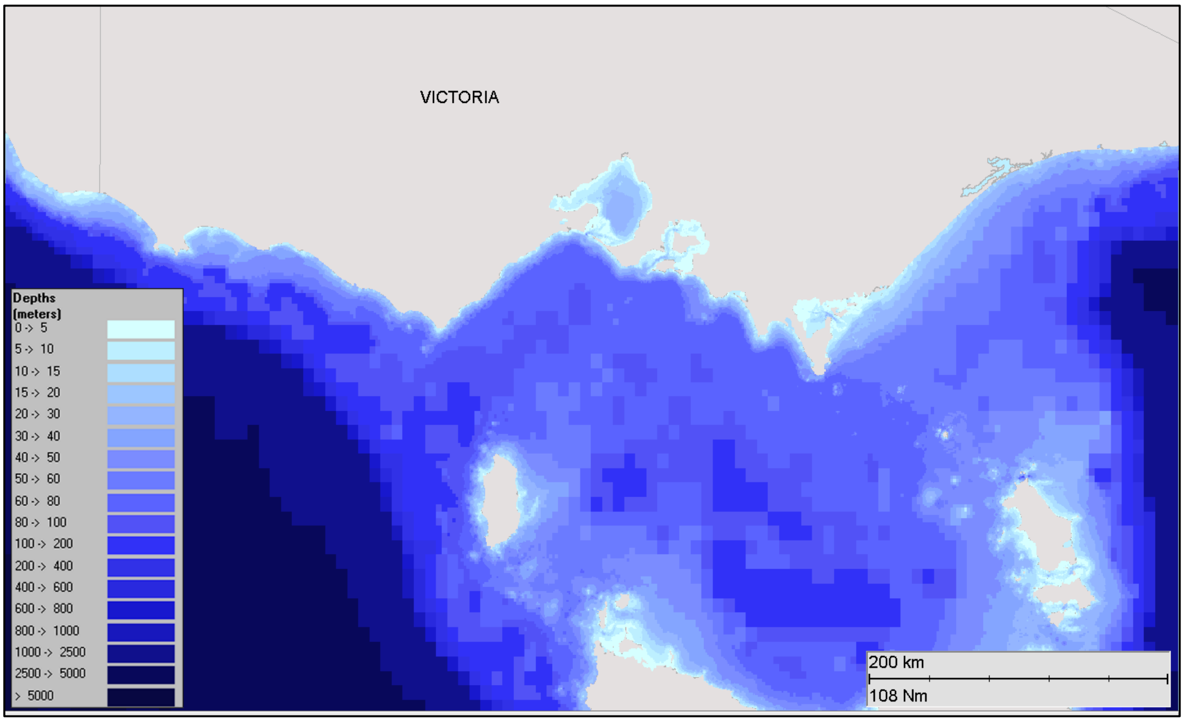

Figure 4 Bathymetry defined throughout the tidal model domain.

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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 and Tangdong, 2004; Qiu and Chen 2010). As such 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 five locations (see Figure 5).

To provide a statistical measure of the model performance, the Index of Agreement (IOA - Willmott (1981)) and the Mean Absolute Error (MAE - Willmott (1982) and Willmott and 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:

$$MAE = N^{-1} \sum_{i=1}^{N} |P_i - O_i| \quad \text{Eq.1}$$

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:

$$IOA = 1 - \frac{\sum |X_{model} - X_{obs}|^2}{\sum (|X_{model} - \overline{X_{obs}}| + |X_{obs} - \overline{X_{obs}}|)^2} \quad \text{Eq.2}$$

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 6 and Figure 7 illustrate a comparison of the predicted and observed surface elevations for each location for January 2014. As shown on the graph, the model accurately reproduced the phase and amplitudes throughout the spring and neap tidal cycles. Table 2 shows the statistical comparison between the observed and predicted surface elevations. For all of the stations, the IOA is well within the limits highlighting a good model performance. Hence, the tidal model predictions are considered accurate for this study.

Table 2 Statistical comparison between the observed and 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
Gabo Island	0.96	0.22

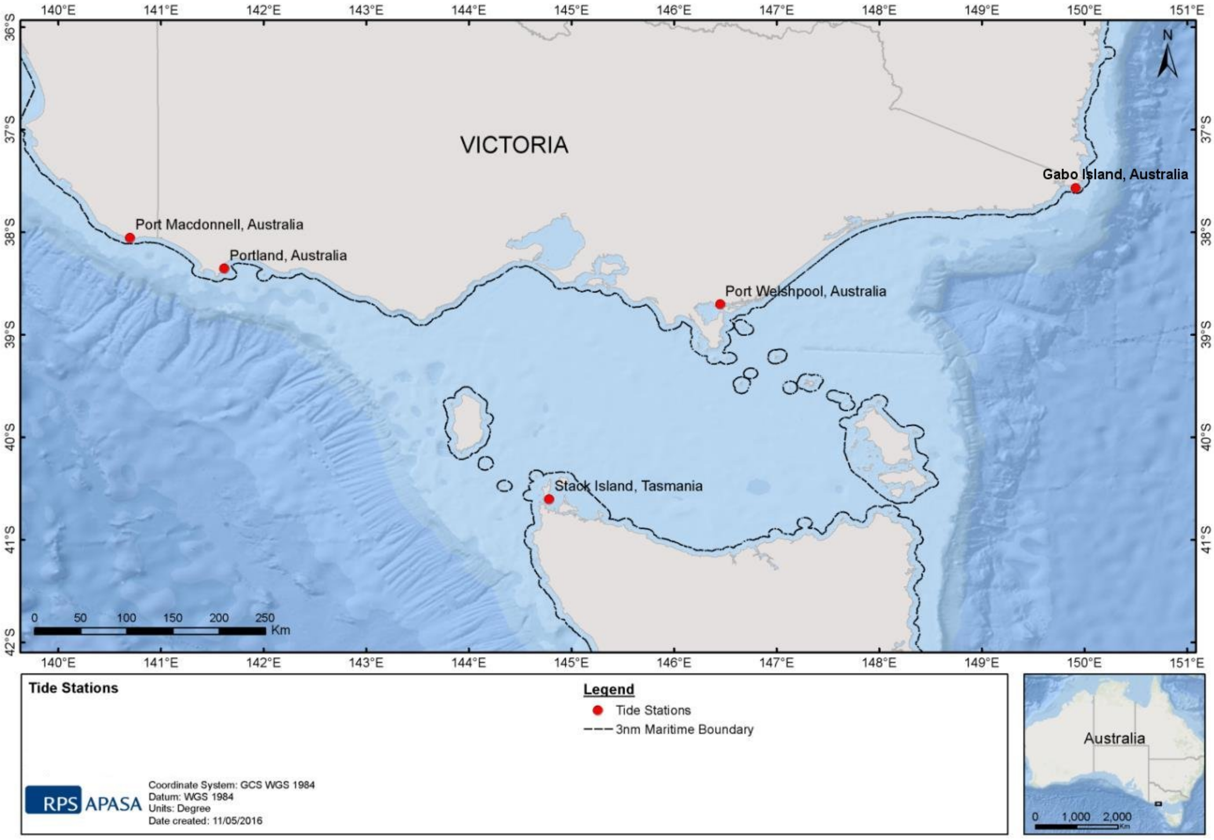

Figure 5 Tide stations used to calibrate surface elevation within the model.

Figure 8 is a snapshot of the predicted tidal current vectors.

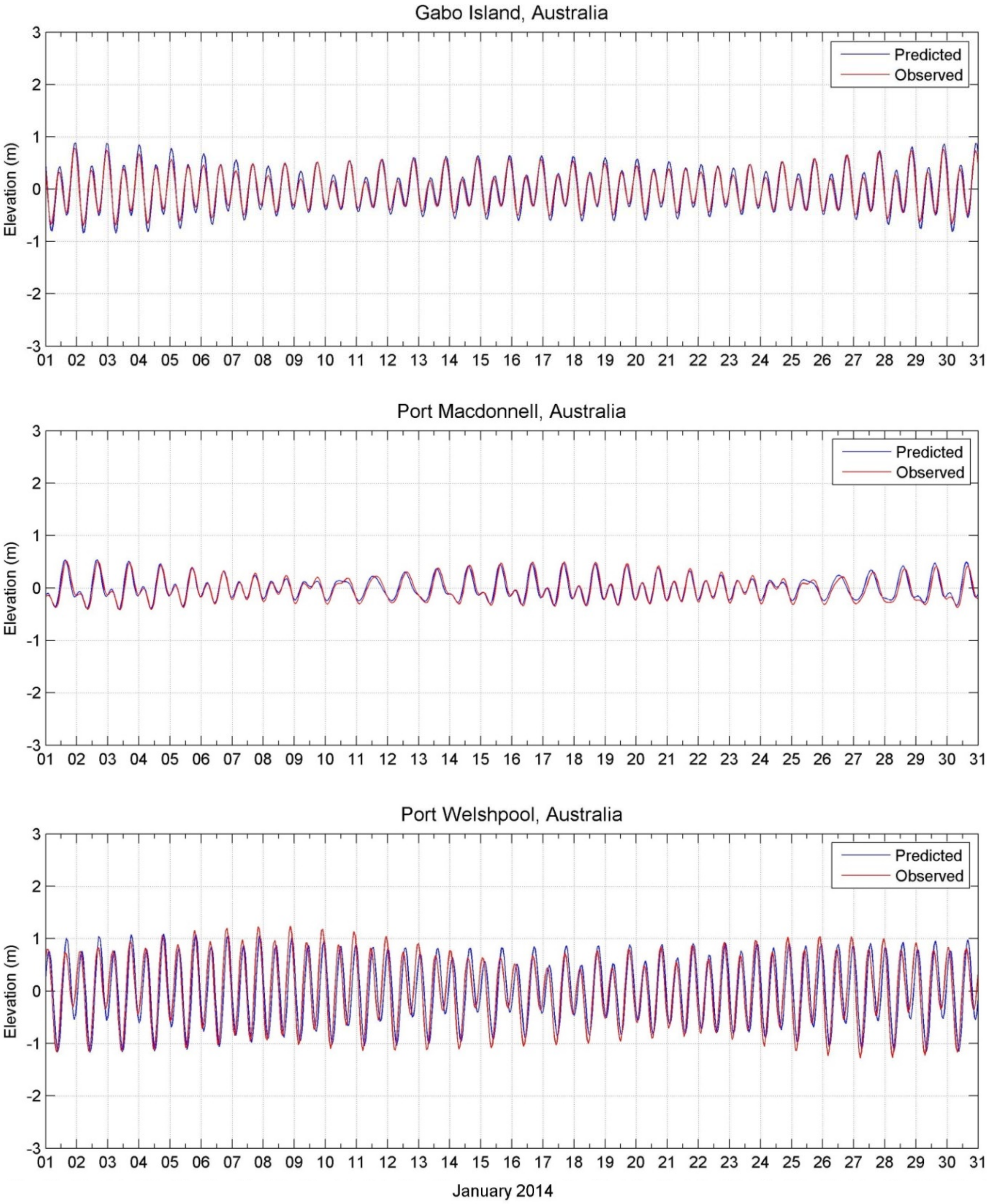

Figure 6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Gabo Island (upper image), Port MacDonnell (middle image) and Port Welshpool (lower image).

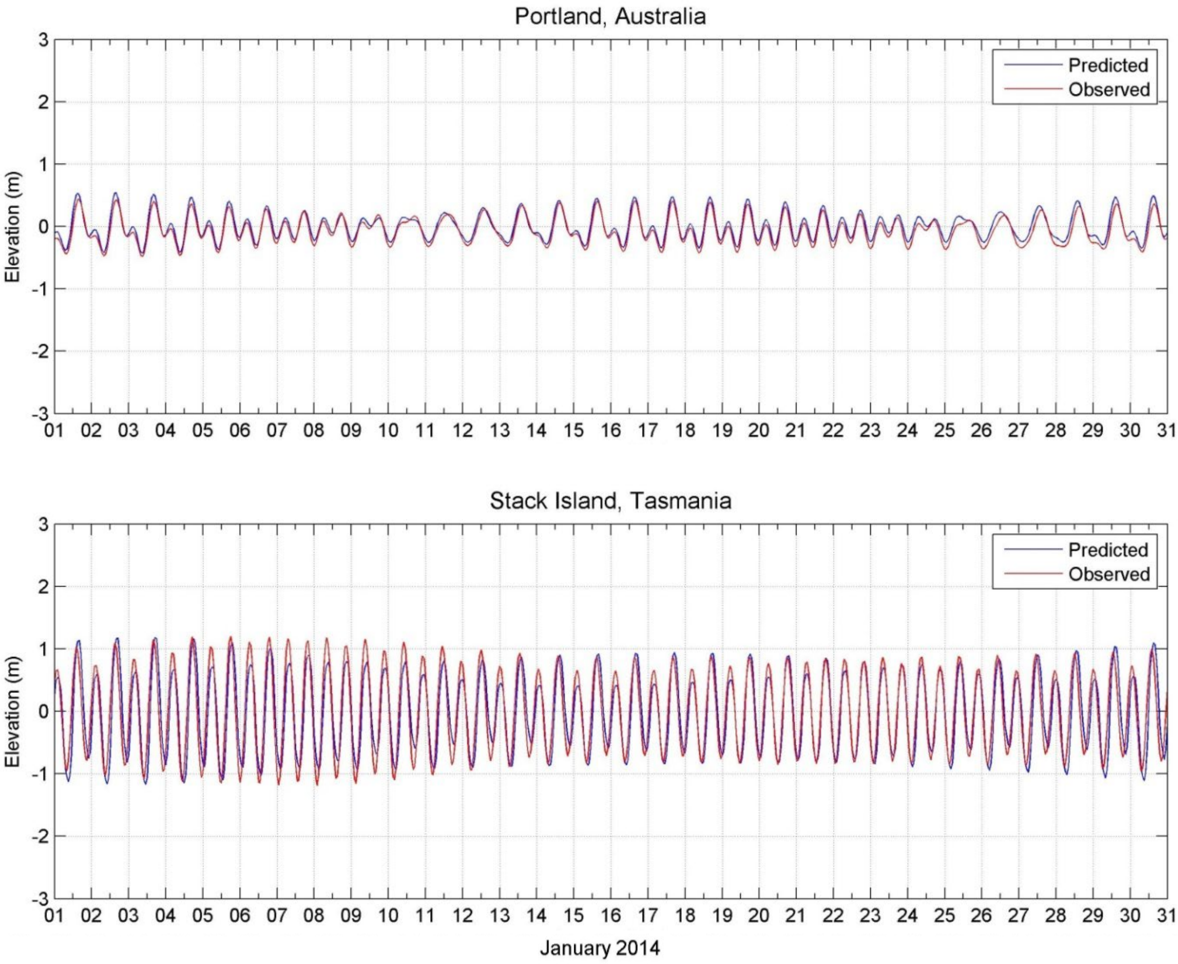

Figure 7 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation at tidal stations Portland (upper image) and Stack Island (lower image).

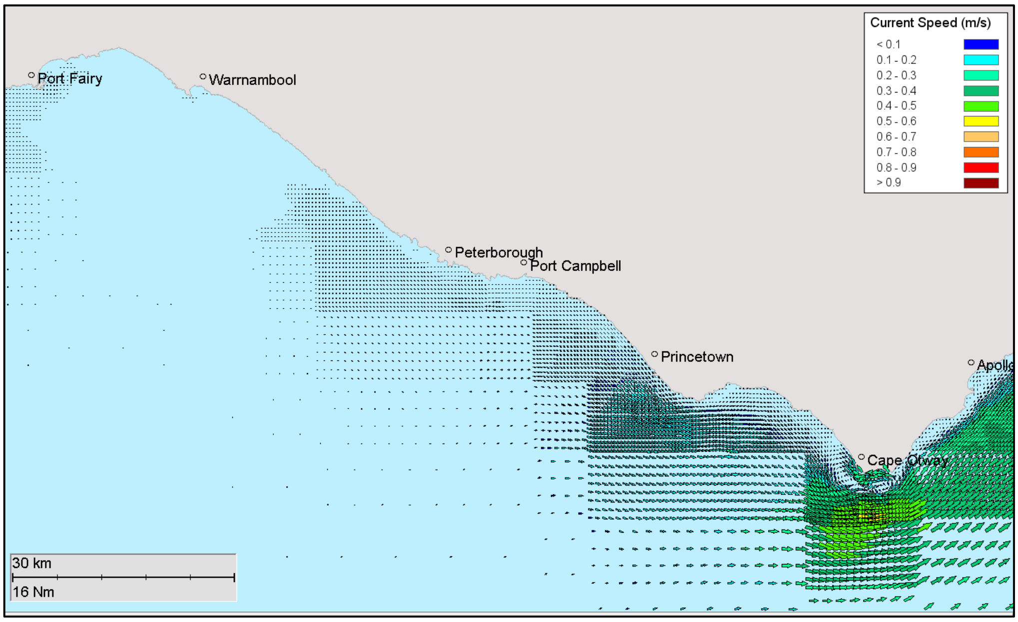

Figure 8 Snapshot of the predicted tidal current vectors. Note the density of the tidal vectors vary with the grid resolution, particularly along the coastline and around the islands and sholas.

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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 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 once per day. 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 reanalysis hindcast currents were obtained for the years 2008 to 2012 (inclusive). Five years of data has been found to be suitably sufficient to account for the inter-annual variations and conditions with Bass Strait.

3.3 Surface Currents at the release site

Table 3 displays the predicted average and maximum surface current speed near the release location. Figure 9 and Figure 10 illustrate the monthly and seasonal current rose distributions (2008-2012 inclusive) derived from combining HYCOM ocean current data and HYDROMAP tidal data, respectively.

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 0.1 m/s are predominantly 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 combined current data (ocean plus tides) indicated that during April to December the currents predominately flowed east and west during January to March. Monthly average surface current speed was similar throughout the year (0.16 to 0.25 m/s), while the maximum surface current speed ranged between 0.60 m/s (November and January) and 1.22 m/s (July).

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Table 3 Predicted monthly average and maximum surface current speeds adjacent to the release location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2008-2012 (inclusive).

Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction (towards)
January	0.17	0.60	WNW and ENE
February	0.18	0.69	WNW
March	0.16	0.85	WNW and ENE
April	0.16	1.20	E
May	0.16	0.78	E
June	0.22	0.99	E
July	0.22	1.22	E
August	0.25	1.01	ESE
September	0.22	0.90	E
October	0.18	0.68	E
November	0.17	0.60	E
December	0.19	0.68	E
Minimum	**0.16**	**0.60**	
Maximum	**0.25**	**1.22**	

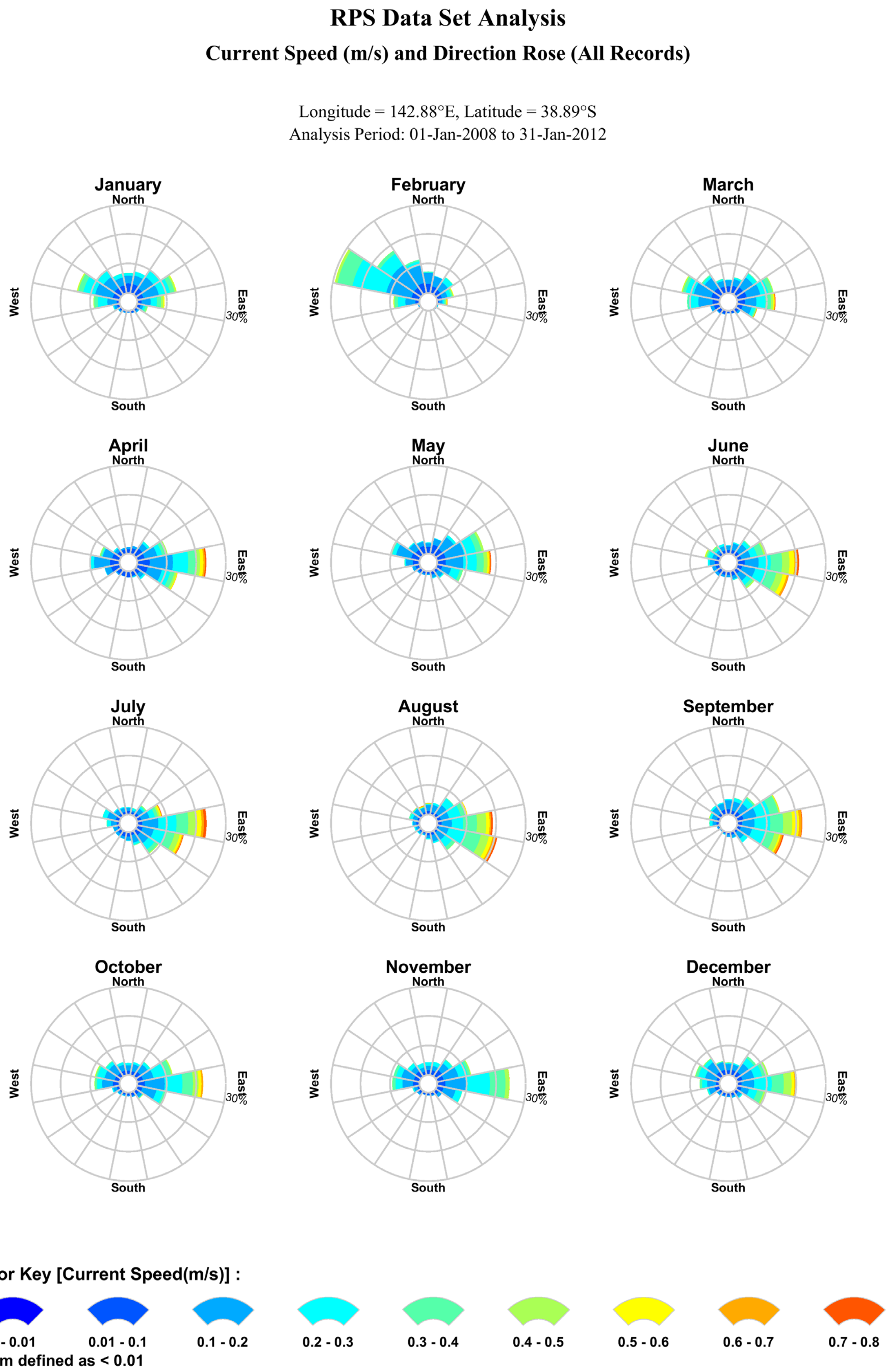

Figure 9 Monthly surface current rose plots near the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008 – 2012 inclusive).

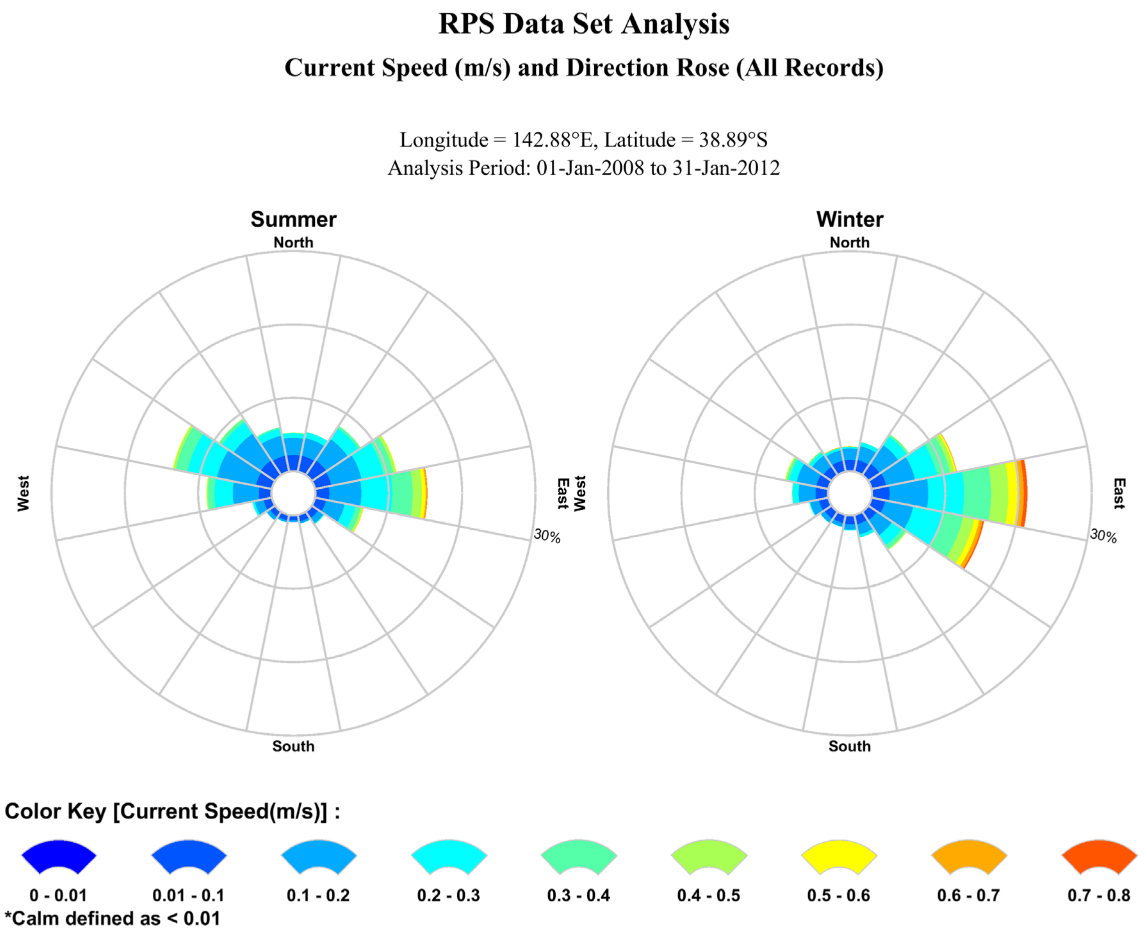

Figure 10 Seasonal surface current rose plots near the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008 – 2012 inclusive).

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4 WIND DATA

High resolution wind data was sourced from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR; see Saha et al., 2010) from 2008 to 2012 (inclusive).The CFSR wind model includes observations from many data sources; surface observations, upper-atmosphere air balloon observations, aircraft observations and satellite observations and is capable of accurately 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 11 shows the spatial resolution of the wind field used as input into the oil spill model. Table 4 shows the monthly average and maximum winds derived from the CFSR node located adjacent to the release site. Figure 12 and Figure 13 show the monthly and seasonal wind rose distributions, respectively.

Note the convention for defining wind direction throughout this report is the direction the wind blows from. Each branch of the wind rose distribution represents wind coming from that direction, with north to the top of the diagram. The branches are divided into segments of different colour, which represent wind speed ranges from that direction. Speed ranges of 3 knot intervals, excluding the calm and near calm conditions are used in these wind roses. The length of each coloured segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction.

The wind data analysis indicated that winds in the region are generally moderate to strong throughout the year, with a monthly average oscillating between ~13 knots (March) to ~18 knots (August). A maximum wind speed of 49 knots was recorded during September, while the lowest maximum speed of 34 knots occurred in December.

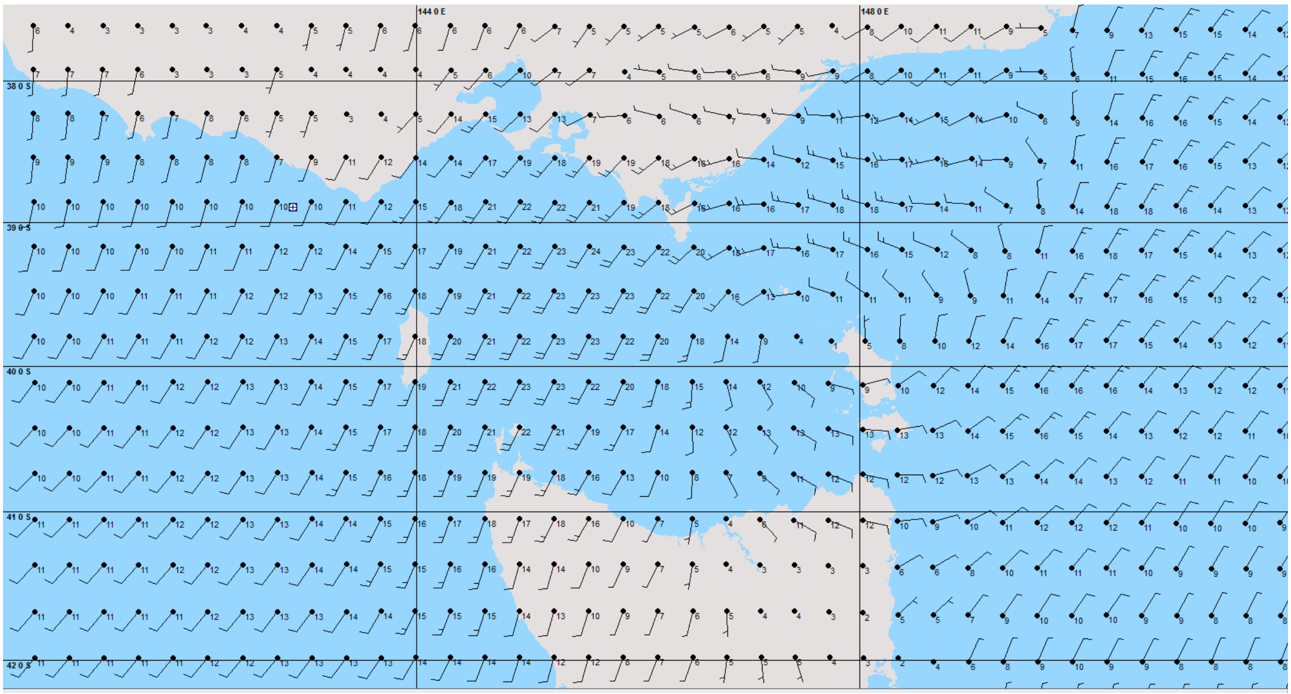

Figure 11 Image showing the CFSR modelled wind nodes.

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Table 4 Predicted monthly average and maximum winds for the wind node adjacent to the release location. Data derived from CFSR hindcast model from 2008-2012 (inclusive).

Month	Average wind (knots)	Maximum wind (knots)	General direction (from)
January	13	37	Variable SW to SE
February	14	37	SE
March	13	38	Variable
April	14	44	W
May	13	36	W
June	16	46	SW to NW
July	18	44	SW to NW
August	18	46	SW to NW
September	17	49	SW
October	14	35	SW to S
November	14	38	W to SE
December	14	34	W to E
Minimum	**13**	**34**	
Maximum	**18**	**49**	

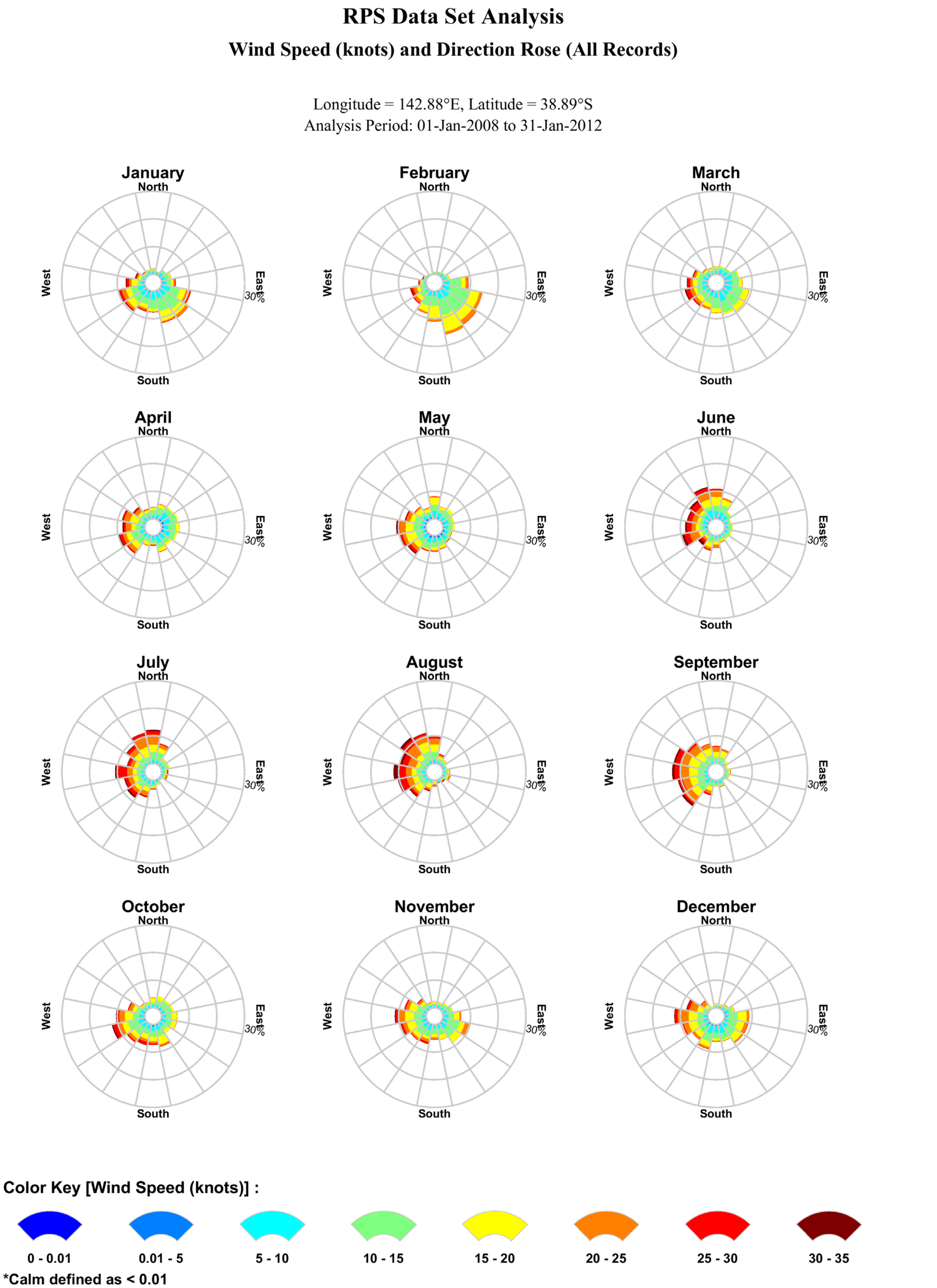

Figure 12 Monthly wind rose distributions derived from the CFSR hindcast model from 2008–2012 (inclusive), for the nearest wind node to the release location.

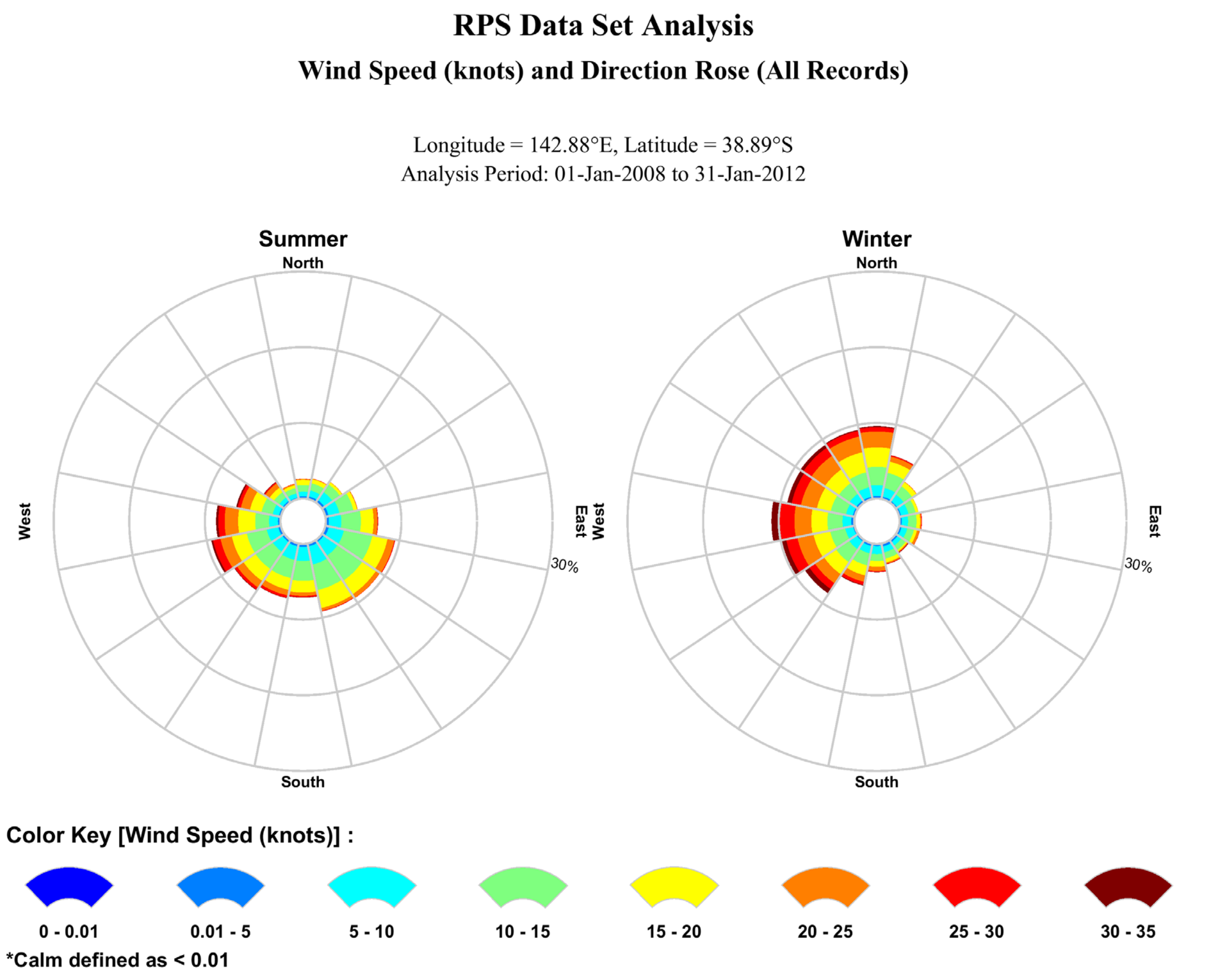

Figure 13 Seasonal wind rose distributions derived from the CFSR hindcast model from 2008–2012 (inclusive), for the nearest wind node to the release location.

5 WATER TEMPERATURE AND SALINITY

The monthly depth-varying water temperature and salinity profiles at 5 m intervals through the water column adjacent to the release location (refer to Figure 14) was obtained from the World Ocean Atlas 2013 (WOA13) produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration) (see Levitus et al., 2013). The data is to inform the weathering, movement and evaporative loss of hydrocarbon spills in the surface and subsurface layers.

Table 5 summarises the monthly average sea surface temperatures and salinity (0-5 m depth layer). The sea surface temperatures were shown to range from 13.3°C (September) and 18.0°C (January). Salinity remained consistent throughout the year ranging from 35.1 to 35.6 psu.

Table 5 Monthly average sea surface temperature and salinity in the 0–5 m depth layer near the Artisan-1 well location.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	18.0	17.2	17.9	16.4	16.3	16.0	14.9	13.6	13.3	14.6	14.4	16.1
Salinity (psu)	35.4	35.1	35.4	35.4	35.4	35.4	35.6	35.3	35.3	35.4	35.4	35.4

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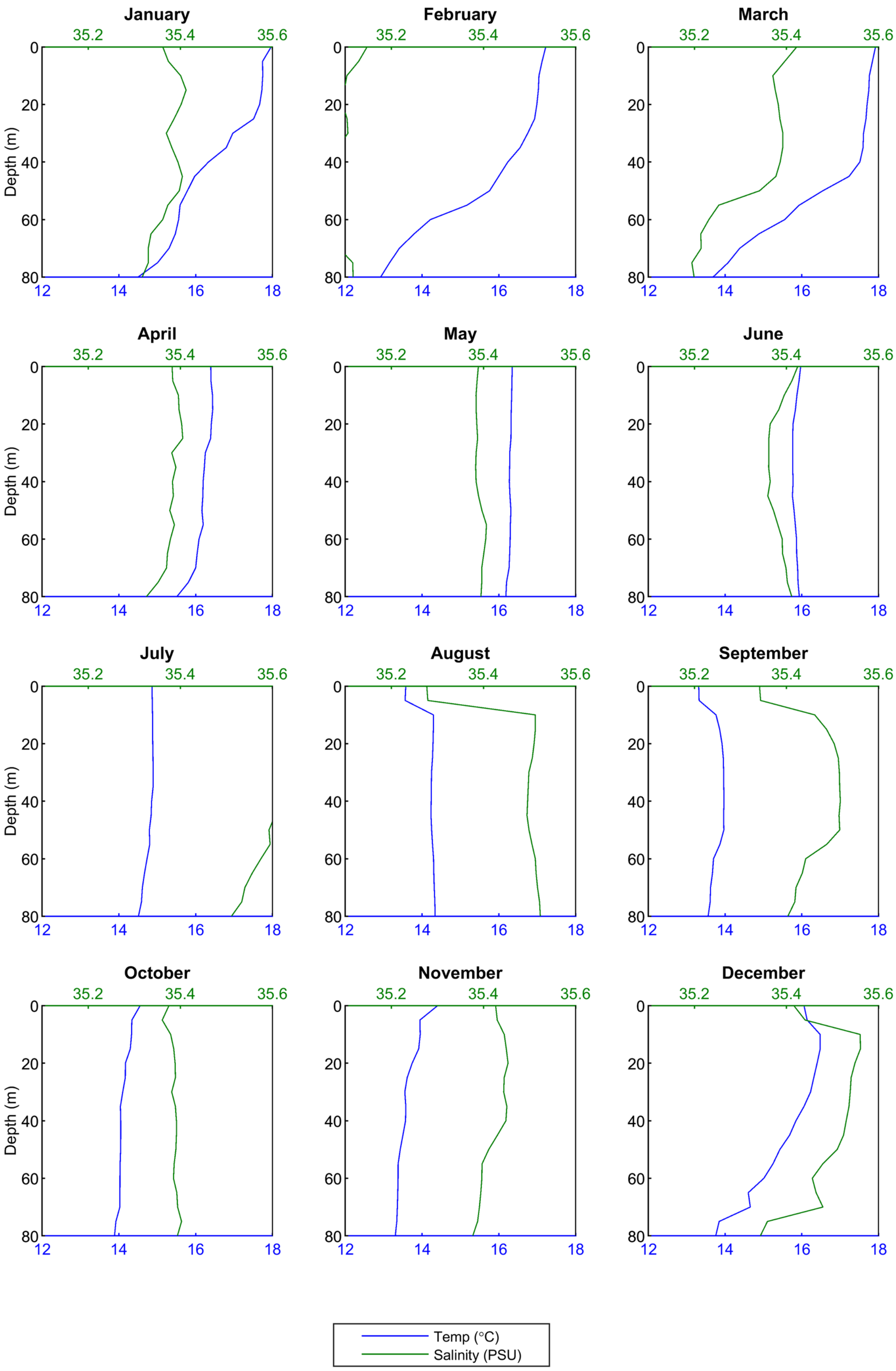

Figure 14 Monthly water temperature and salinity profiles near the release location.

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6 NEAR-FIELD MODEL – OILMAP-DEEP

Near-field modelling was carried out for the loss of well control scenario to better understand the plume dynamics due to the amalgamation of condensate and gas at the seabed using the advanced OILMAP-DEEP blowout model. OILMAP-DEEP was developed by RPS and designed to provide the near-field behaviour of multi-phase gas-condensate plumes during subsurface blowout releases.

The model simulates the plume rise dynamics in two phases, the initial jet phase and the buoyant plume phase. The initial jet phase governs the plume dynamics directly above the subsea release location and is predominantly driven by the exit velocity. During this phase, the condensate droplet size and distribution are calculated. Next, the rise dynamics are dominated by the buoyant nature of the plume until the termination of the plume phase (known as the trapping depth). At this point, the results from OILMAP-DEEP (including plume trapping depth, plume diameter and droplet size distribution) are integrated into the far-field model SIMAP to simulate the rise and dispersion of the condensate droplets.

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 15 illustrates the various stages of an example blowout plume.

Table 6 presents the input parameters and key results of the subsea modelling. Note that a depleting release rate illustrated in Figure 16 was used for the LOWC scenario, starting from 3,758 bbl/day on day 1 and decreasing to 1,718 bbl/day on day 86. The near-field modelling showed that in the event of a blowout from a well, the gas/liquid will propel the condensate upward from the seabed and the plume would rupture the sea surface. Due to the velocity of the plume, the model predicted droplet sizes would be relatively small, ranging from 100 to 400 µm.

Table 6 Input characteristics and key results from the subsea modelling.

Input Variable	Value
Scenario	86-day loss of well control
Water depth (m)	60
Tubing diameter (inch)	8.5”
Condensate Rate (stb/day)	3,758 bbl (day 1) depleting to 1,718 bbl (day 86)
Water Rate (stb/day)	189 bbl (day 1) depleting to 137 bbl (day 86)
Gas Rate (scf/day)	290,000,000 scf (day 1) depleting to 132,000,000 scf (day 86)
Gas to Condensate ratio (scf/bbl)	81,727 (average)
Gas to Total Liquids ratio (scf/bbl)	76,868 (average)
Reservoir temperature (°C)	93
Release Pressure (psia)	2,583 (day 1) depleting to 256 (day 86)
Key Results	
Plume execution depth (m)	Plume ruptures the sea surface
Droplet Sizes	100 – 400 µm

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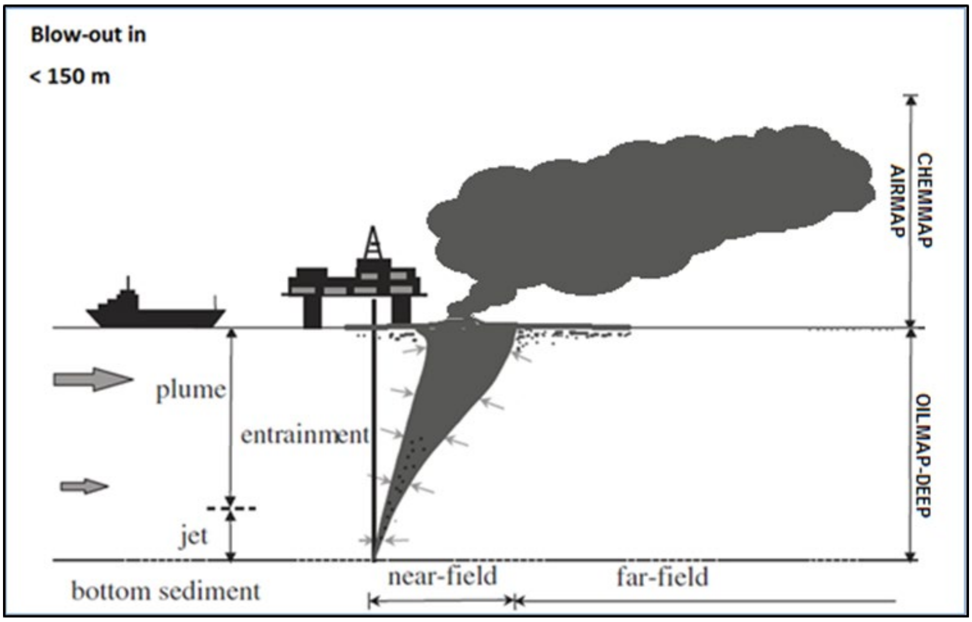

Figure 15 Example of a blowout plume illustrating the various stages of the plume in the water column (Source: Applied Science Associates, 2011).

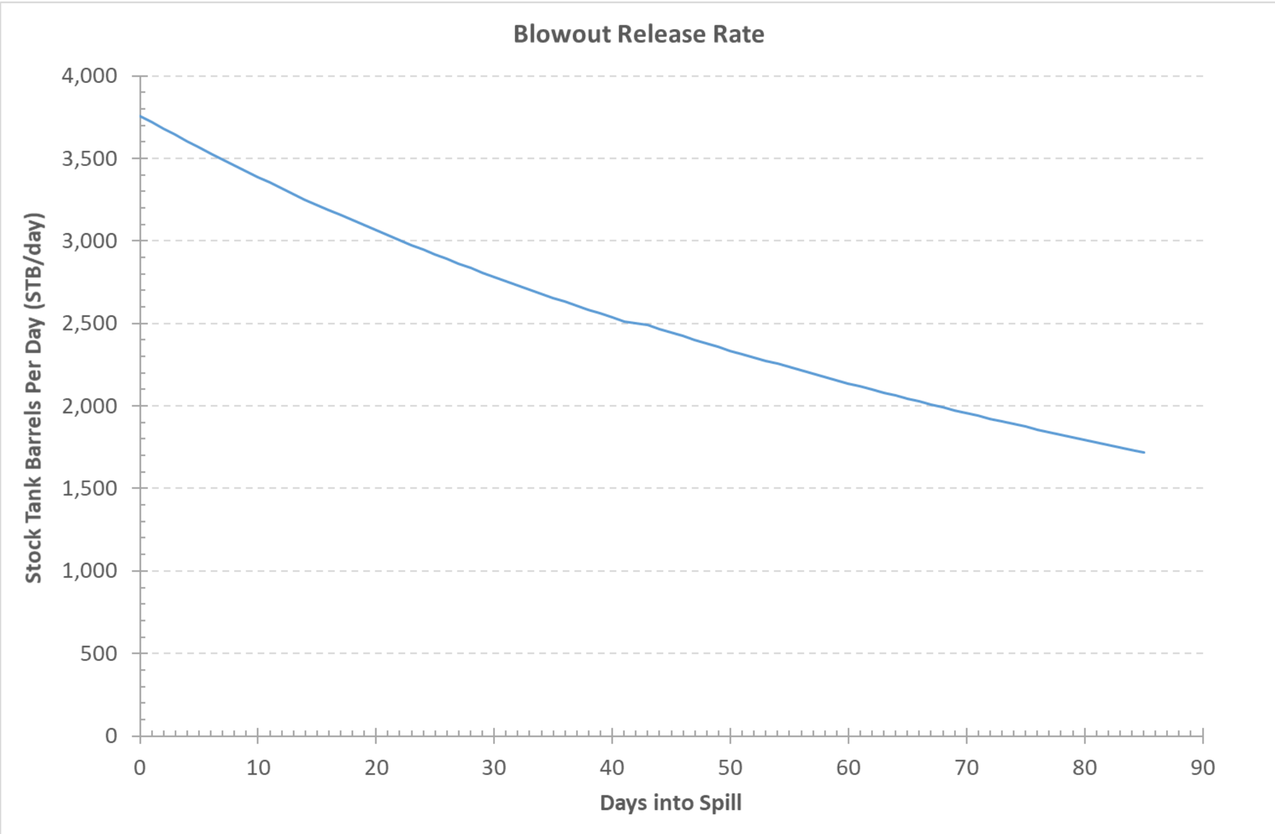

Figure 16 Depleting release rate used for the LOWC scenario

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7 OIL SPILL MODEL – SIMAP

Modelling of the fate of oil was performed using 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; French-McCay, 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 ranges. The SIMAP model uses an interpolation scheme based on an area-weighting scheme of the four nearest points of the wind and currents from the oil particle location.

SIMAP is a 3D 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 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

Stochastic oil spill modelling is created by overlaying a great number (often 100 hundred) simulated hypothetical oil spills (e.g. Figure 17). Stochastic modelling involves running numerous individual oil spill simulations using a range of prevailing wind and current conditions that are historically representative of the season of where the spill event may occur.

For the stochastic modelling presented herein, 100 spills for each of season were simulated and each using the same spill information (release location, spill volume, duration and oil type) but with varied start dates and times corresponding to the period represented by the available wind and current data. 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 were analysed to determine the following statistics for every grid cell:

- Exposure load (concentrations and volumes);
- Minimum time before exposure;
- Probability of contact above defined concentrations;
- Volume of oil that may strand on shorelines from any single simulation;
- Concentration that might occur on sections of individual shorelines; and
- Exposure (concentration x duration of exposure) to entrained and dissolved hydrocarbons in the water column.

Exposure (concentration x duration of exposure) to entrained and dissolved hydrocarbons in the water column

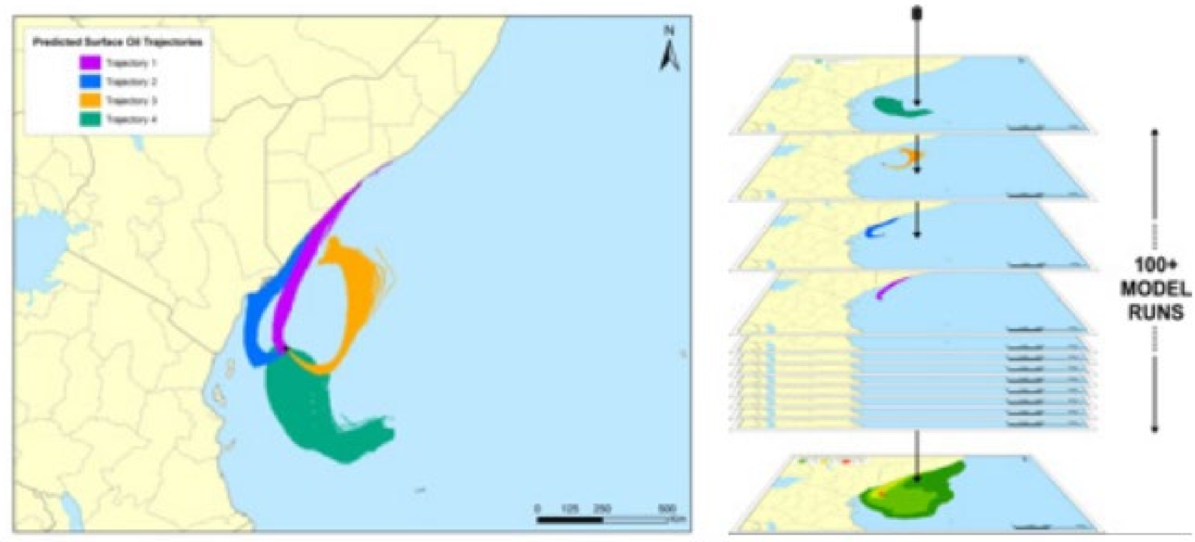

Figure 17 Predicted movement of four single oil spill simulations predicted by SIMAP for the same scenario (left image). All model runs are overlain (shown as the stacked runs on the right) and the number of times that trajectories contact a given location at a concentration is used to calculate the probability.

7.2 Sea surface, Shoreline and In-Water Exposure Thresholds

The thresholds for the sea surface, shoreline and water column (entrained and dissolved hydrocarbons) is presented in Table 7 and their relationship to exposure, are presented in Sections 7.2.1 to 7.2.3. 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 are in line with the thresholds recommended in the NOPSEMA oil spill modelling bulletin April 2019 (https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf), In some instances, slightly more conservative. For example, the low surface exposure of >0.5 g/m^2 was adopted in the study, while the NOPSEMA bulletin recommends 1 g/m^2.

Table 7 Exposure and contact threshold values used for the Artisan-1 oil spill modelling study.

Level	Sea Surface Exposure (g/m^2)	Shoreline Contact (g/m^2)	Dissolved Hydrocarbon Concentration (ppb)#	Entrained Hydrocarbon Concentrations (ppb)#
Low	0.5	10	6	10
Moderate	10	100	50	100
High	25	1,000	400	1,000

#These thresholds were assessed for a) 1 hour exposure and b) 48-hour exposure windows. Both sets of results are provided in the result section(s).

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7.2.1 Sea Surface Exposure Thresholds

The minimum sea surface reporting level for each spill simulation was 0.5 g/m^2, which equates to an average thickness of approximately 0.5 µm. Oil of this thickness is described as a rainbow to metallic sheen in appearance according to the Bonn Agreement Oil Appearance Code (Bonn Agreement, 2009, Table 8). This thickness is considered the minimum level for observing oil in the marine environment by the Australian Maritime Safety Authority (AMSA, 2015). Furthermore, 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.

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 at this average thickness has been described as a metallic sheen (Bonn Agreement, 2009). Concentrations above 10 g/m^2 is also considered the lower actionable threshold, where oil may be thick enough for containment and recovery as well as dispersant treatment (AMSA, 2015).

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).

The sea surface reporting thresholds applied in this study were 0.5–10 g/m^2 (low), 10–25 g/m^2 (moderate) and above 25 g/m^2 (high) (Table 7).

Note that the higher threshold applied in this study falls below the thickness that would begin to present as patches of true oil colour (Table 8).

Figure 18 shows examples of the differences between oil colour and corresponding thickness on the sea surface. Hydrocarbons in the marine environment may appear differently due the ambient environmental conditions (wind and wave action).

Table 8 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 –>

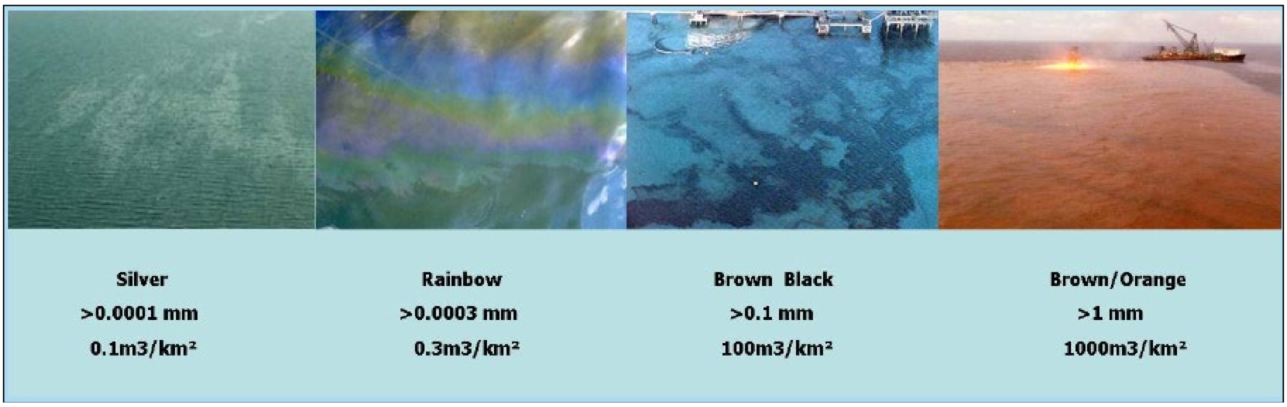

Figure 18 Photograph showing the difference between oil appearance on the sea surface (source: OilSpillSolutions.org, 2015).

The generic oil colour categories used in this report are meant as a guide only. For more accurate description of oil appearance on the sea surface a detailed analysis of an oil should be undertaken.

The specific oil type will determine appearance (i.e. colour) and behaviour on the sea surface. Lighter oils such as marine diesel and condensate, have true oil colours that are pale or transparent. As such, these oil types may not increase beyond a rainbow or metallic sheen, despite their thickness increasing beyond 25 g/m^2 (~25 um). Moreover, the physical properties and appearance of oil types will change due to weathering on the sea surface. For example, oils with high paraffinic wax content will form waxy sheets that break up into flakes or nodules after the more volatile components have evaporated. Take up of water by the oil (emulsification) will also significantly change the appearance and thickness of floating oil. Stable water-in-oil emulsions will have a higher combined mass and thickness and will present as thick, semi-solid, aerated layers that tend to be coloured strongly red/brown, orange or yellow, rather than the true oil colour.

It should be noted that in the case of solidified or emulsified oils, mass per area estimates cannot be directly referenced to the Bonn Agreement visibility scale that refers only to oil present as films or slicks of oil alone.

7.2.2 Shoreline Exposure Thresholds

The reporting threshold of 10 g/m^2 was applied as the visible limit for oil on shore. This threshold may trigger socio-economic impact, such as triggering temporary closures of beaches to recreation or fishing, or closure of commercial fisheries and might trigger attempts for shore clean-up on beaches or man-made features/amenities (breakwaters, jetties, marinas, etc.). In previous risk assessment studies, French-McCay et al (2005a; 2005b) used a threshold of 10 g/m^2, equating to approximately two teaspoons of oil per square meter of shoreline, as a low impact threshold when assessing the potential for shoreline exposure.

French et al. (1996) and French-McCay (2009) define a shoreline oil threshold of 100 g/m^2, or above, as having 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 the AMSA (2015) guidelines. This threshold equates to approximately ½ a cup of oil per square meter of shoreline exposure. The appearance is described as a thin oil coat.

The higher threshold of 1,000 g/m^2, and above, was adopted to inform locations that might receive oil accumulation levels that could have a higher potential for ecological effect. Observations by Lin and Mendelssohn (1996), demonstrated that loadings of more than 1,000 g/m^2 of oil during the growing season would be required to impact marsh plants significantly. Similar thresholds have been found in studies assessing oil impacts on mangroves (Grant et al., 1993; Suprayogi & Murray, 1999). This concentration equates to approximately 1 litre or 4 ¼ cups of fresh oil per square meter of shoreline exposure. The appearance is described as an oil cover.

The shoreline reporting thresholds applied in this study were 10–100 g/m^2 (low), 100–1,000 g/m^2 (moderate) and above 1,000 g/m^2 (high) (Table 7).

7.2.3 Dissolved and Entrained Hydrocarbon 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.

7.2.3.1 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 et al., 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 time averaged exposure (based on 96 hours) at 6, 50 or 400 ppb was applied to indicate increasing potential for sub-lethal to lethal toxic effects (or low to high).

Furthermore, in accordance with the NOPSEMA oil spill modelling bulletin, the same thresholds were assessed over a 1 hour time step (see Table 7).

7.2.3.2 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 (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, 100 ppb and 500 ppb were applied as time averaged exposure (over 96 hours, see Table 7), to cover the range of thresholds outlined in the ANZECC/ARMCANZ (2000) water quality guidelines and the incremental change for greater potential effect.

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.

Furthermore, in accordance with the NOPSEMA oil spill modelling bulletin, the same thresholds were assessed over a 1 hour time step (see Table 7).

7.3 Oil Properties

7.3.1 Marine Diesel Oil

Marine Diesel Oil (MDO) is a light-persistent fuel oil used in the maritime industry. It has a density of 829.1 kg/m^3 (API of 37.6) and a low pour point (-14^{o}C). The low viscosity (4 cP) indicates that this oil will spread quickly when released and will form a thin to low thickness film on the sea surface, increasing the rate of evaporation. According to the International Tankers Owners Pollution Federation (ITOPF, 2014) and AMSA (2015a) guidelines, this oil is categorised as a group II oil (light-persistent).

Table 9 details the physical properties of MDO, while Table 10 presents the boiling point ranges of the MDO used in this study.

Figure 19 illustrates the weathering graph for a 300 m^3 release of MDO over 6 hours during three wind speeds. The 5, 10 and 15 knot wind speeds were selected given that breaking waves and in turn entrainment takes place between 10 – 12 knots. The results illustrate that the prevailing wind speeds can

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and do influence the weathering and fate of the MDO. Under lower wind-speeds (5 knots), the MDO will remain on the surface longer, spread quicker, and in turn greater evaporation. Conversely, sustained stronger winds (>15 knots) will generate breaking waves at the surface, causing a higher amount of MDO to be entrained into the water column and reducing the amount available to evaporate.

7.3.2 Thylacine Condensate

Thylacine condensate was used for the loss of well control scenario (Scenario 2). The condensate has an API of 44.3, density of 804.6 kg/m^3 at 15ºC) with low viscosity (0.875 cP) (refer to Table 9), classifying it as a Group I oil according to the (ITOPF, 2014) and USEPA/USCG classifications. The condensate comprises a significant portion of volatiles and semi to low volatiles (99% total) with very little residual components (<1%) (refer to Table 10). This means that the majority of the condensate will evaporate readily when on the water surface, with a minimal amount of persistent components to remain on the water surface over time.

Figure 1 displays the weathering graph for a 24-hour release (3,758 bbl) of Thylacine condensate during three static wind speeds. The weathering graph shows rapid evaporation occurs during the first 24 hours (while the condensate is still being released) during all three wind speeds. Thylacine condensate is predicted to readily entrain into the water column under the higher wind speeds (10 and 15 knots). Due to the high volatility of the condensate, little is predicted to remain on the water surface after the spill ceases.

Table 9 Physical properties of MDO and Thylacine condensate

Characteristic	MDO	Thylacine Condensate
Density (kg/m^3) at 15°C	829.1	804.6
API	37.6	44.3
Dynamic viscosity (cP) at 20°C	4	0.875
Pour Point (°C)	-14	-50
Wax content (%)	1	NA
Hydrocarbon property category	Group II	Group I
Hydrocarbon property classification	Light - Persistent	Non-persistent oil

Table 10 Boiling point ranges of MDO and Thylacine condensate

Characteristic	Not Persistent			Persistent
	Volatile	Semi-volatile	Low volatility	Residual
Boiling point (ºC)	< 180	180 - 265	265 - 380	>380
MDO	6.0	34.6	54.4	5.0
Thylacine condensate	64.0	19.0	16.0	1

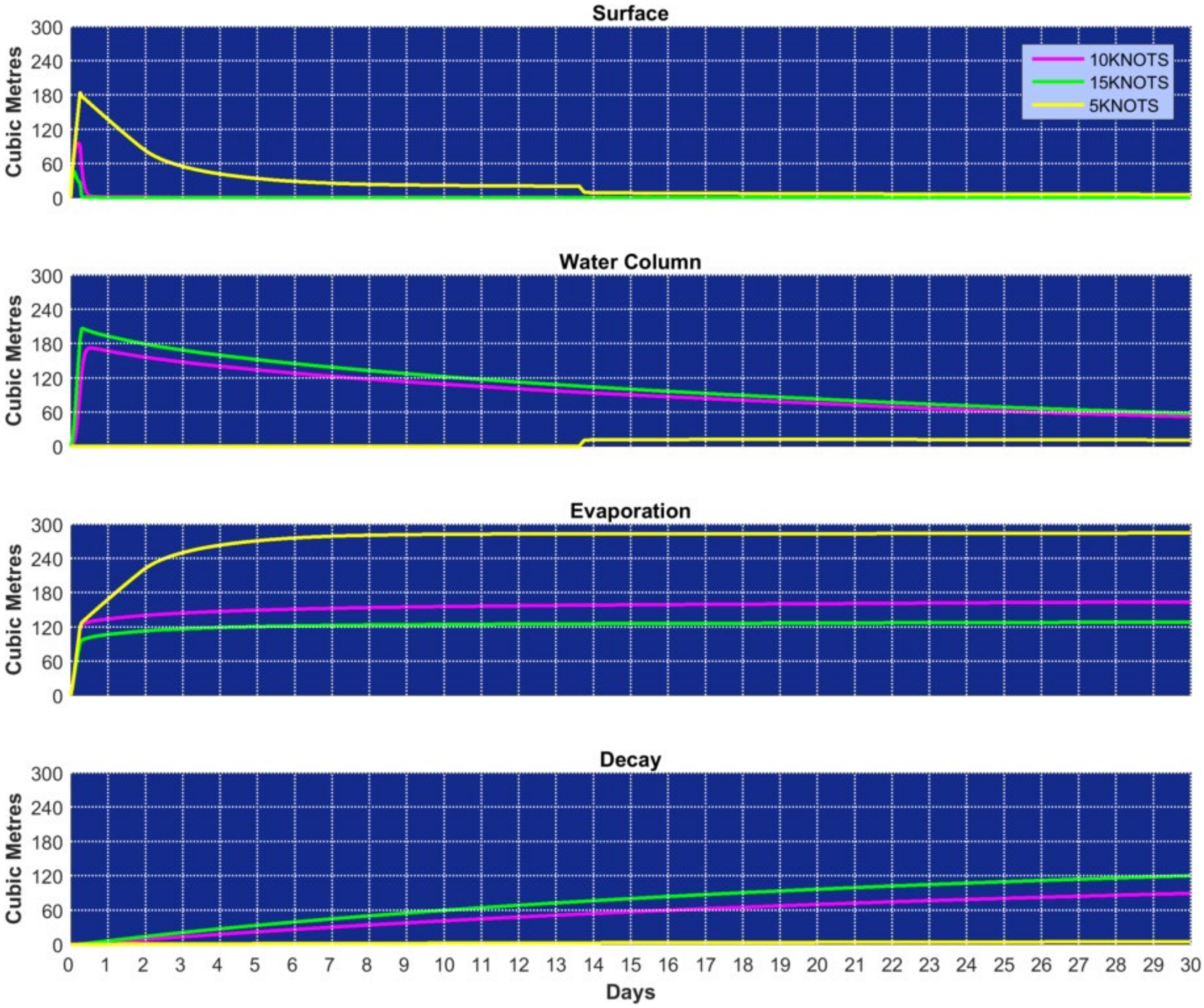

Figure 19 Weathering of a 300 m^3 surface release of MDO over 6 hours (tracked for 30 days) under three static winds conditions (5, 10 and 15 knots).

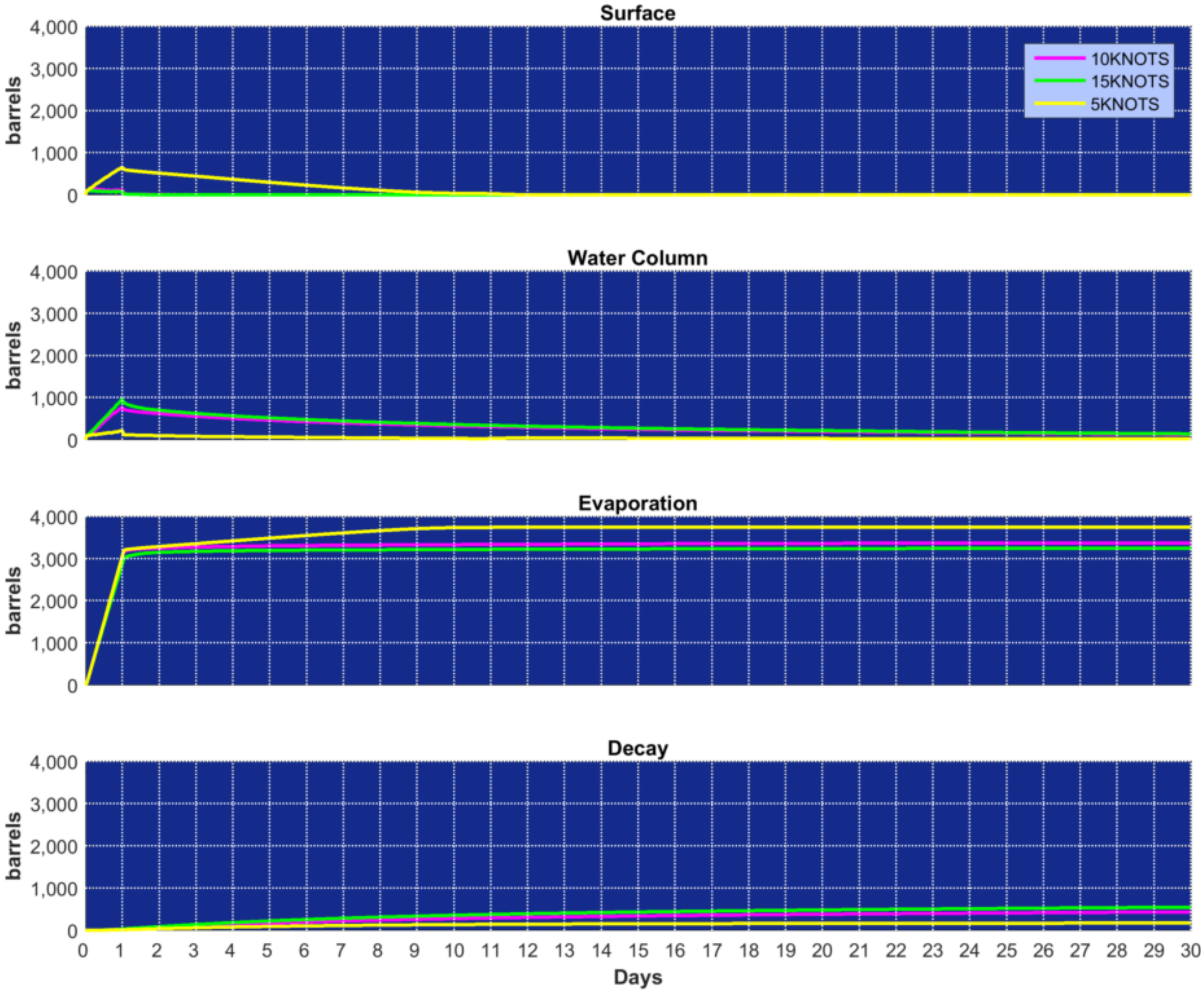

Figure 1 Weathering of 3,758 bbl subsea release of Thylacine condensate over 24 hours (tracked for 30 days) under three static wind speeds (5,10 and 15 knots).

7.4 Model Settings

This oil spill modelling study quantified the seasonal risk and potential exposure to the surrounding waters and shorelines for two plausible, yet hypothetical scenarios:

- 300 m^3 surface release of marine diesel over 6 hours in the event of a containment loss from a vessel at the Artisan-1 well location; and
- 222,224 bbl subsea release of condensate over 86 days to represent an unrestricted open-hole loss of well control (LOWC) event from the Artisan-1 well location

Table 11 provides a summary of the oil spill model settings.

Table 11 Summary of the oil spill model settings

Parameter	Oil Spill Scenario	
Scenario description	Subsea Loss of Well Control	Loss of Containment from a Vessel
Model period	Summer (October to March) Winter (April to September)	
Number of randomly selected spill start times and locations per season	100 (200 total)	100 (200 total)
Oil type	Thylacine condensate	MDO
Spill volume	222,224 bbl	300 m^3
Release type	Subsea (60m)	Surface
Release duration	86 days	6 hr
Simulation length (days)	114	30
Surface oil concentration thresholds	0.5 g/m^2, 10 g/m^2, >25 g/m^2	
Shoreline load threshold	10 g/m^2, 100 g/m^2, >1,000 g/m^2	
Dissolved hydrocarbon exposure to assess the potential exposure (ppb). *These thresholds were assessed for 1 hour and 48-hour exposure windows.*	6 ppb, potential low exposure 50 ppb, potential moderate exposure 400 ppb, potential high exposure	
Entrained hydrocarbon exposure to assess the potential exposure (ppb). *These thresholds were assessed for 1 hour and 48-hour exposure windows.*	10 ppb, potential low exposure 100 ppb, potential moderate exposure 1,000 ppb, potential high exposure	

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8 PRESENTATION AND INTERPRETATION OF MODEL RESULTS

The results from the modelling study are presented in a number of statistical tables, which aim to provide a comprehensive understanding of the predicted sea-surface and in-water (subsurface) exposure and shoreline contact (if predicted).

8.1 Seasonal Analysis

The seasonal analysis is presented in the form of statistical tables 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 shoreline contact*** – is determined by recording the number of spill trajectories to contact the shoreline, at a specific threshold, divided by the total number of spill trajectories within that scenario.
- The ***minimum time before oil exposure*** – is determined by recording the minimum time for a grid cell to record exposure, at a specific threshold.
- The ***average volume of oil ashore for a single spill*** – is determined by calculating the average volume of the all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The ***maximum volume of oil ashore from a single spill trajectory*** – is determined by identifying the single spill trajectory within a scenario/season, that recorded the maximum volume of oil to come ashore and presenting that value.
- The ***average length of shoreline contacted by oil*** – is determined by calculating the average of the length of shoreline (measured as grid cells) contacted by oil above a specified threshold.
- The ***maximum length of shoreline contacted by oil*** – is determined by recording the maximum length of shoreline (measured as grid cells) contacted by oil above a specified threshold.
- 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 ***probability of oil contact to a receptor*** **–** is determined by recording the number of spill trajectories to reach a specified shoreline contact threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.
- The ***minimum time before shoreline contact to a receptor*** **–** is determined by ranking the elapsed time before shoreline contact, at a specified threshold, to grid cells within a receptor polygon and recording the minimum value.
- The ***average potential oil loading within a receptor*** – is determined taking the average of the maximum loading to any grid cell within a polygon, for all simulations within a scenario/season, that recorded shoreline.
- 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.

RPS

- The ***average volume of oil ashore within a receptor*** – is determined by calculating the average volume of oil to come ashore within a receptor polygon, from all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The ***maximum volume of oil ashore within a receptor*** – is determined by recording the maximum volume of oil to come ashore within a receptor polygon, from all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The ***average length of shoreline contacted within a receptor*** – is determined by calculating the average of the length of shoreline (measured as grid cells) contacted by oil within a receptor polygon, at a specified threshold, from all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The ***maximum length of shoreline contacted by oil*** – is determined by recording the maximum length of shoreline (measured as grid cells) contacted by oil within a receptor polygon, at a specified threshold, from all the single spill trajectories which were predicted to make shoreline contact within a scenario.

8.2 Receptors Assessed

A range of environmental receptors and biological receptors and shorelines were assessed for sea surface exposure, shoreline contact and water column exposure as part of the study (see Table 12). The receptors are presented graphically in Figure 20 to Figure 34.

Note, the release location is situated within the Otway Integrated Marine and Coastal Regionalisation of Australia (IMCRA) receptor and hence this receptor will register all maximum values predicted by the modelling.

Table 12 Summary of receptors used to assess surface, shoreline and in-water exposure to hydrocarbons

Receptor Category	Acronym	Hydrocarbon Exposure Assessment		
		Water Column	Sea Surface	Shoreline
Marine National Park	MNP	✓	✓	×
Australian Marine Park	AMP	✓	✓	×
National Park	NP	✓	✓	×
Integrated Marine and Coastal Regionalisation of Australia	IMCRA	✓	✓	×
Interim Biogeographic Regionalisation of Australia	IBRA	✓	✓	✓
Key Ecological Feature	KEF	✓	✓	×
Reefs, Shoals and Banks	RSB	✓	✓	×
Ramsar	Ramsar	✓	✓	✓
State Waters	State Waters	✓	✓	×
Local Government Areas	LGA	✓	✓	✓

Receptor Category	Acronym	Hydrocarbon Exposure Assessment		
		Water Column	Sea Surface	Shoreline
Sub-Local Government Areas	Sub-LGA	✓	✓	✓

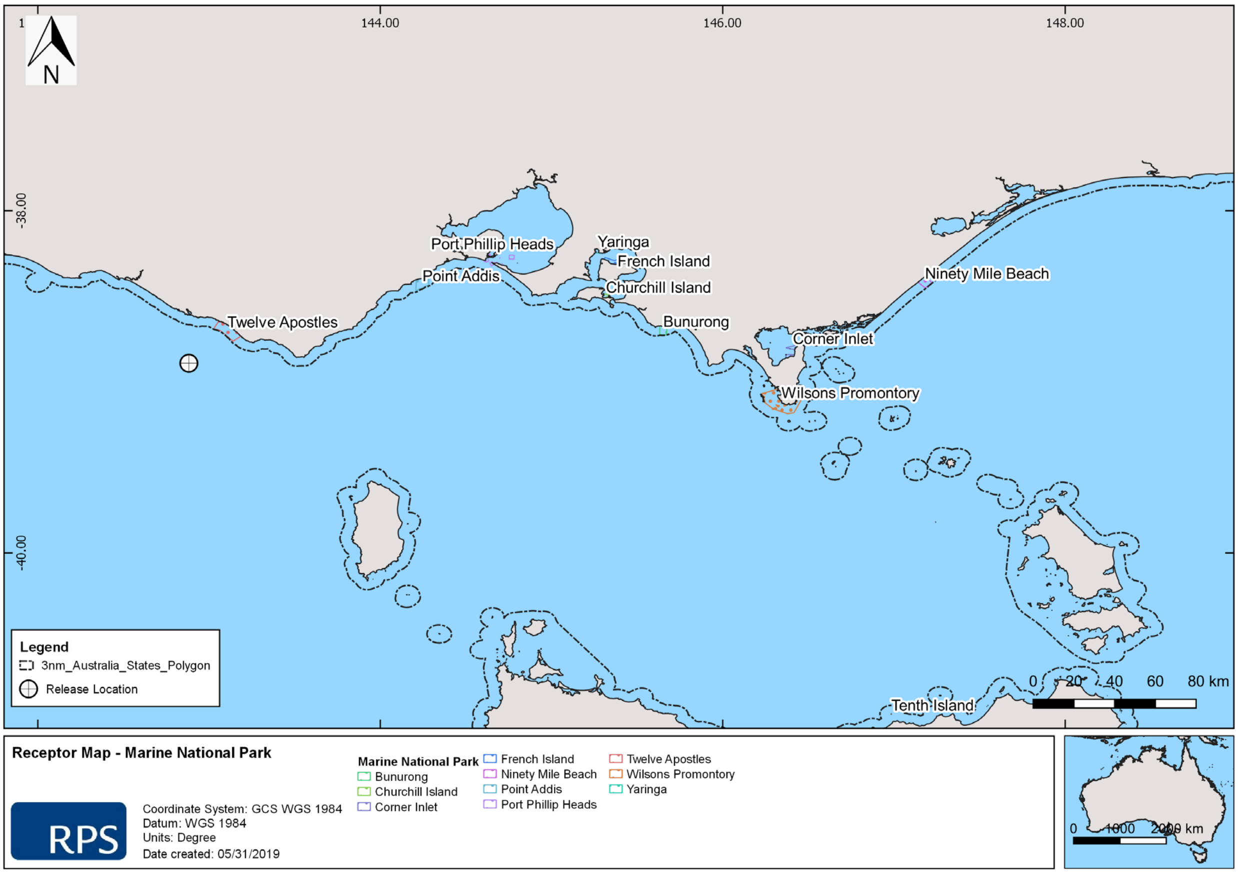

Figure 20 Receptor map for Marine National Parks.

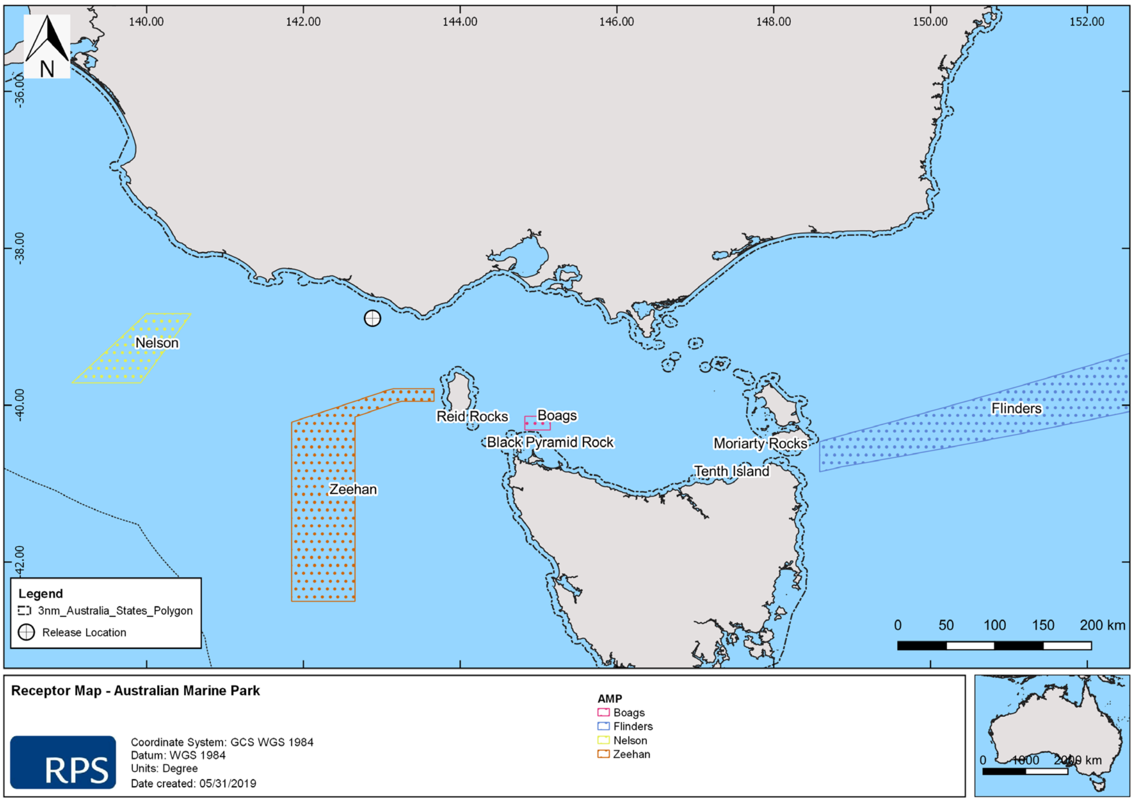

Figure 21 Receptor map for Australian Marine Parks.

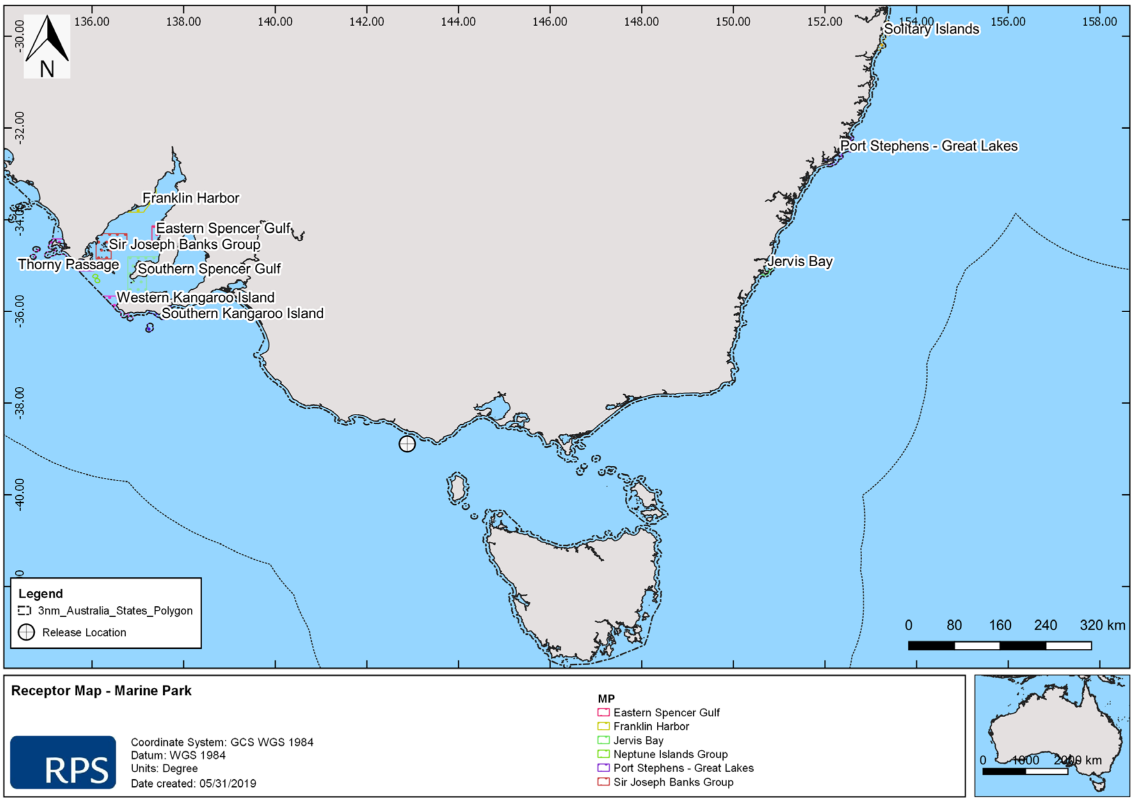

Figure 22 Receptor map for Marine Parks.

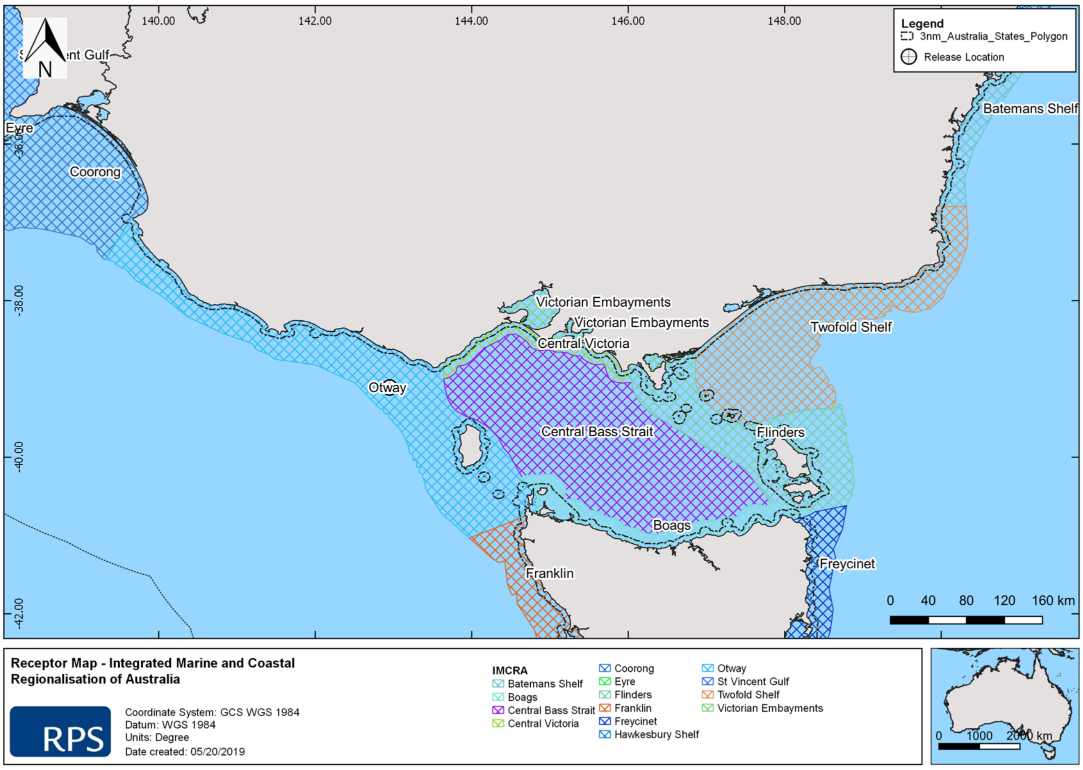

Figure 23 Receptor map illustrating the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) receptors.

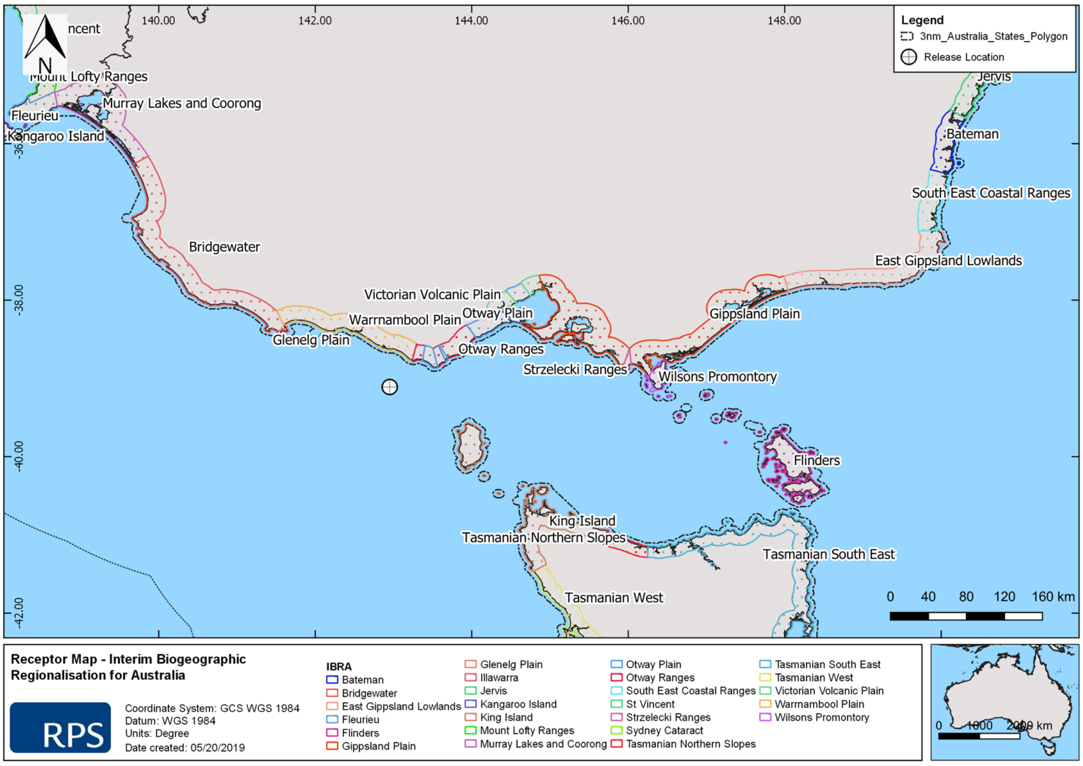

Figure 24 Map illustrating the Interim Biogeographic Regionalisation of Australia (IBRA) receptors.

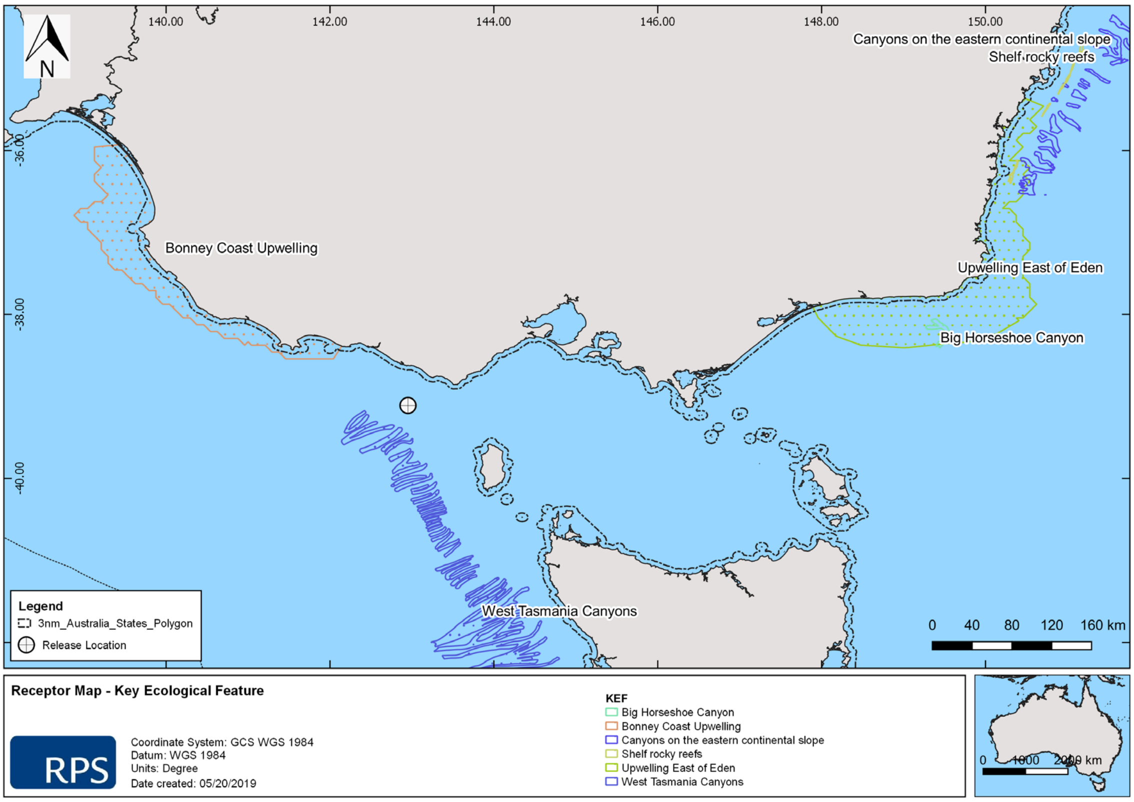

Figure 25 Receptor map of Key Ecological Features (KEF)

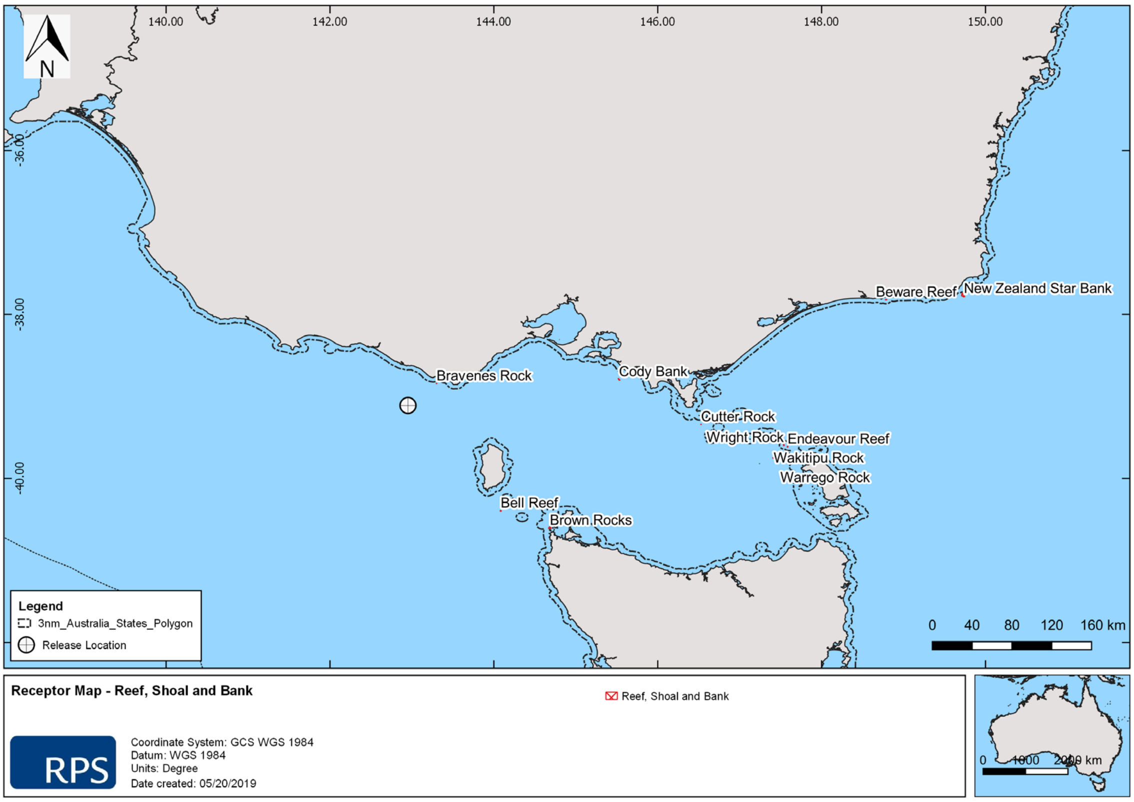

Figure 26 Receptor map of Reefs, Shoals and Banks (RSB)

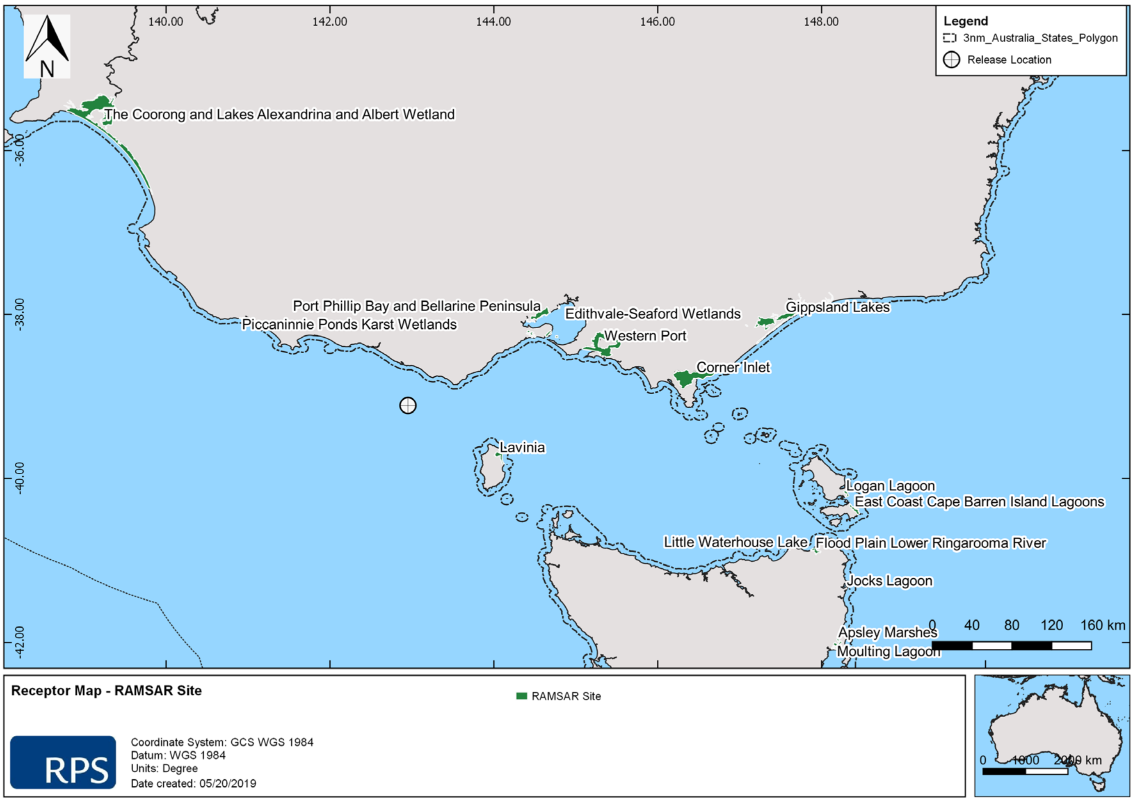

Figure 27 Receptor map of RAMSAR sites

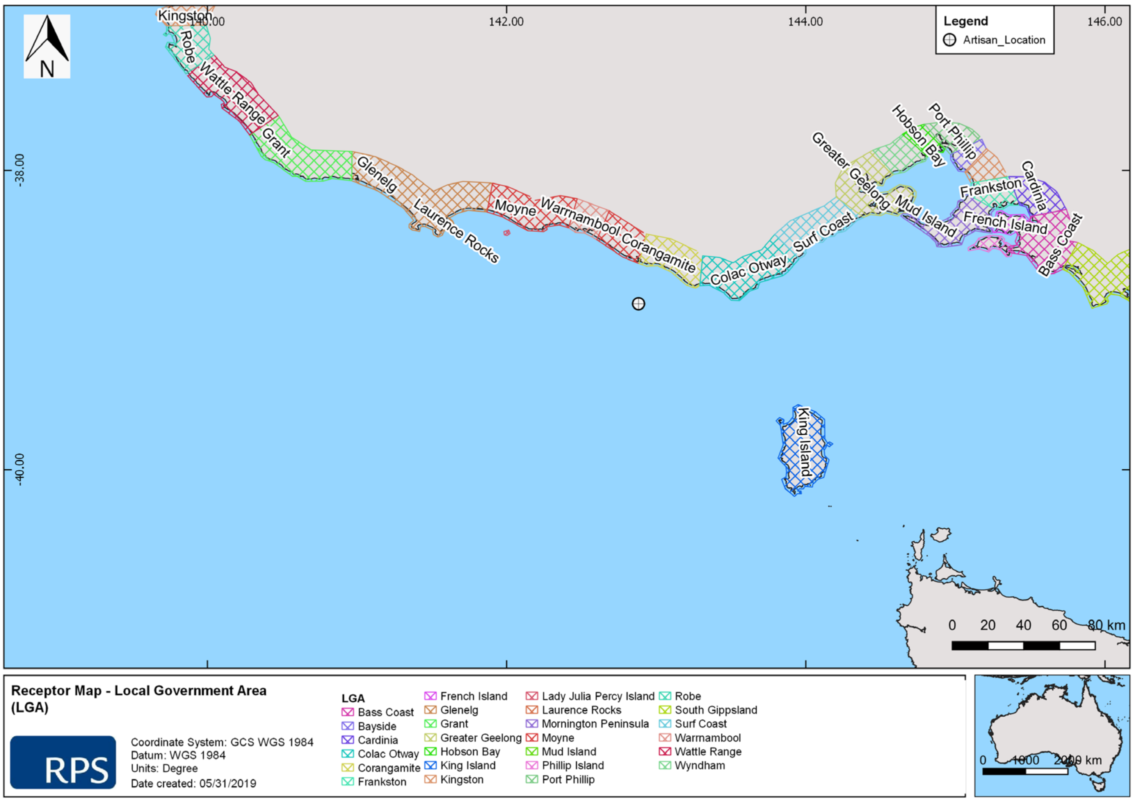

Figure 28 Receptor map of Local Government Areas (LGA) (1/3)

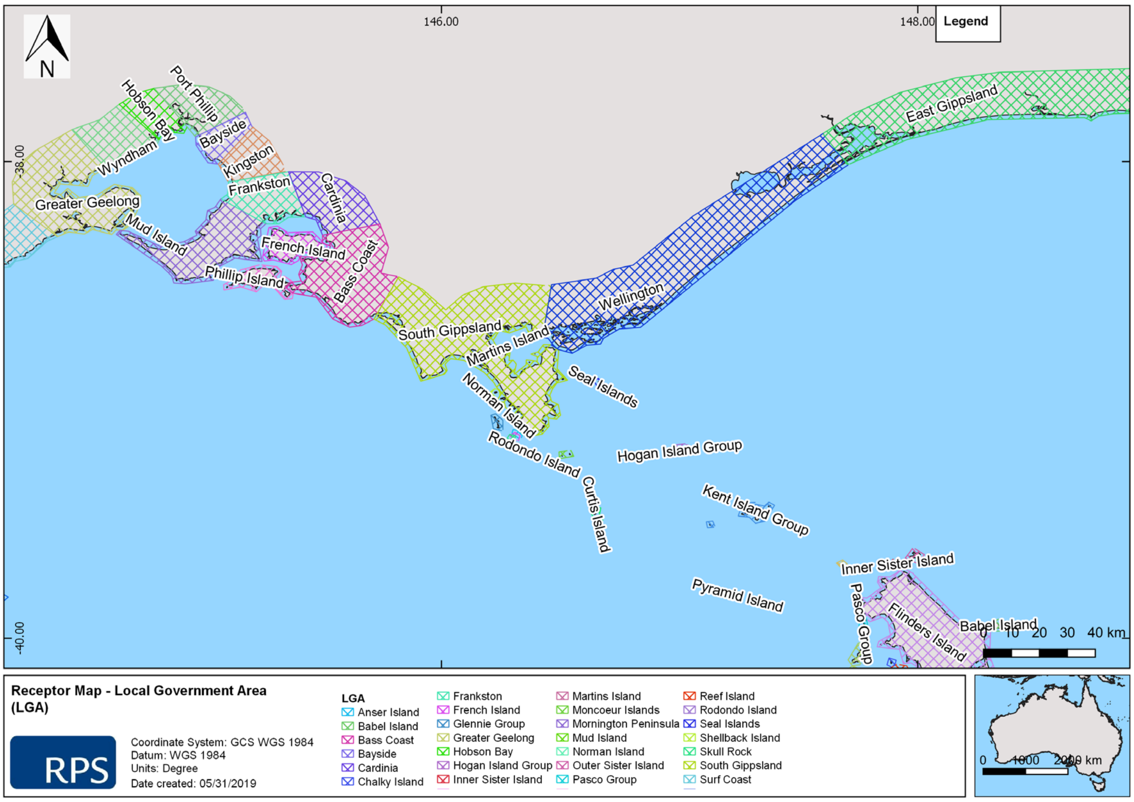

Figure 29 Receptor map of Local Government Areas (LGA) (2/3)

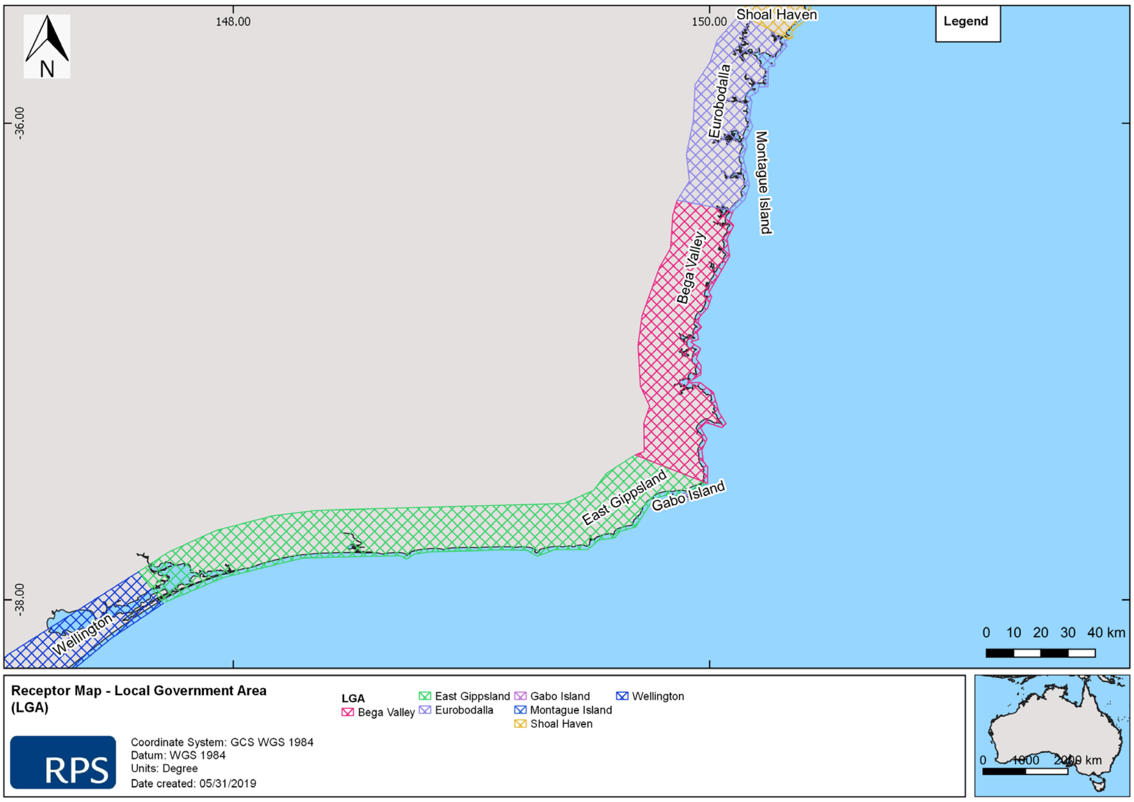

Figure 30 Receptor map of Local Government Areas (LGA) (3/3)

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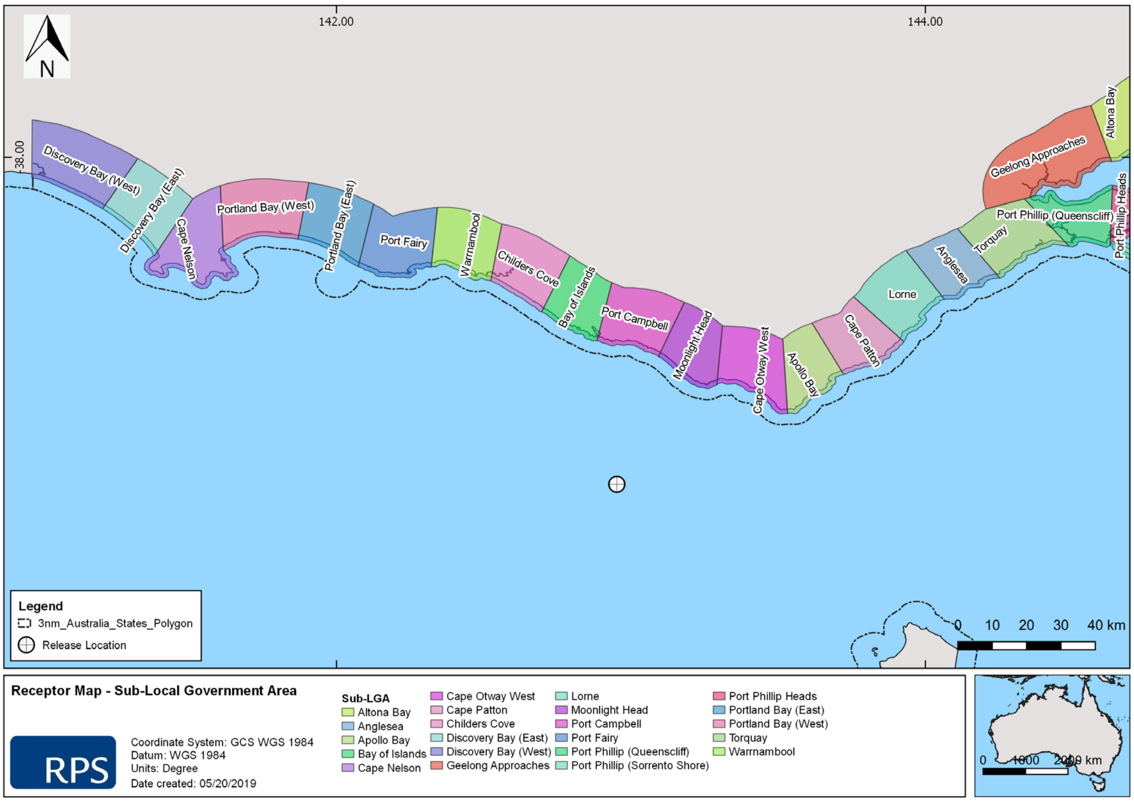

Figure 31 Receptor map of Sub-Local Government Areas (Sub-LGA) (1/3)

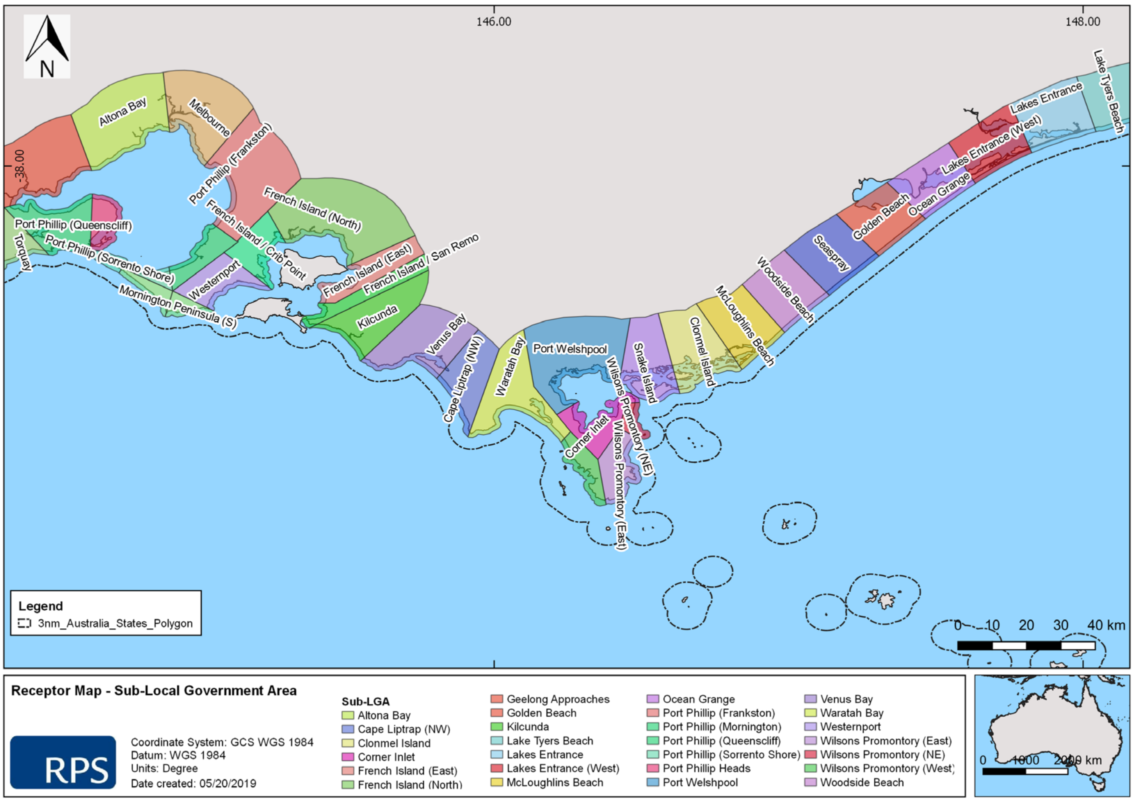

Figure 32 Receptor map of Sub-Local Government Areas (Sub-LGA) (2/3)

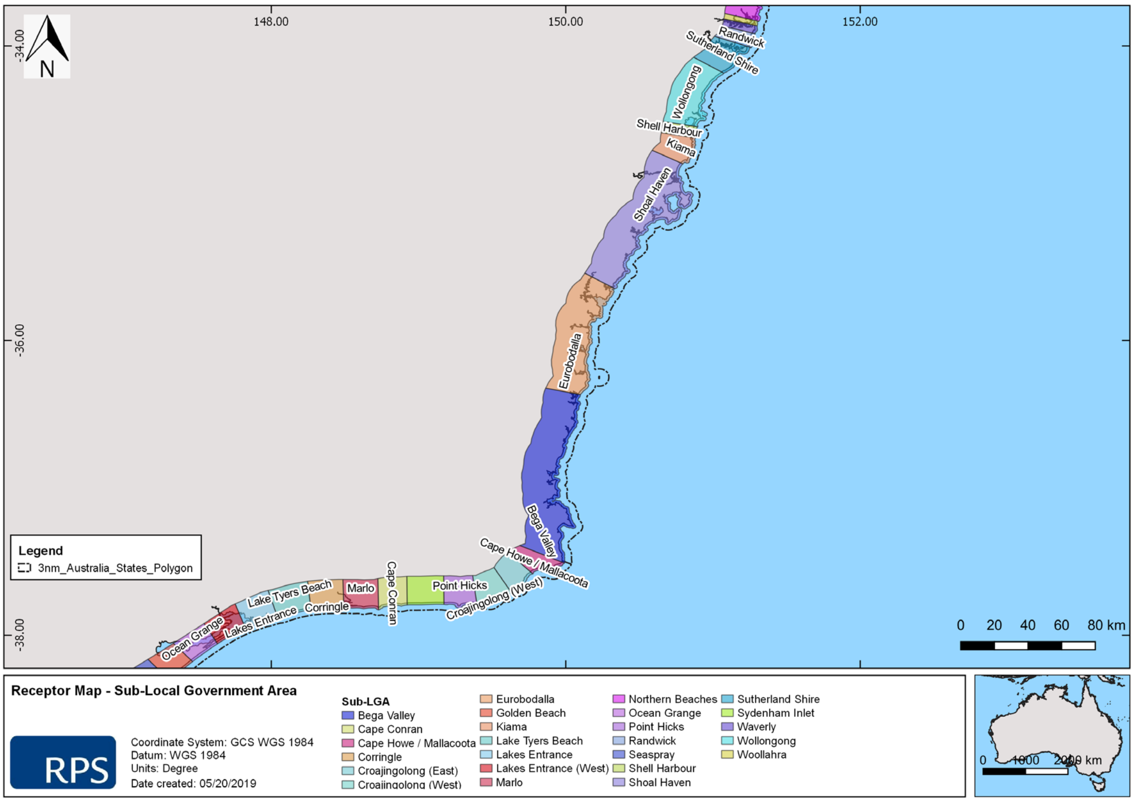

Figure 33 Receptor map of Sub-Local Government Areas (Sub-LGA) (3/3)

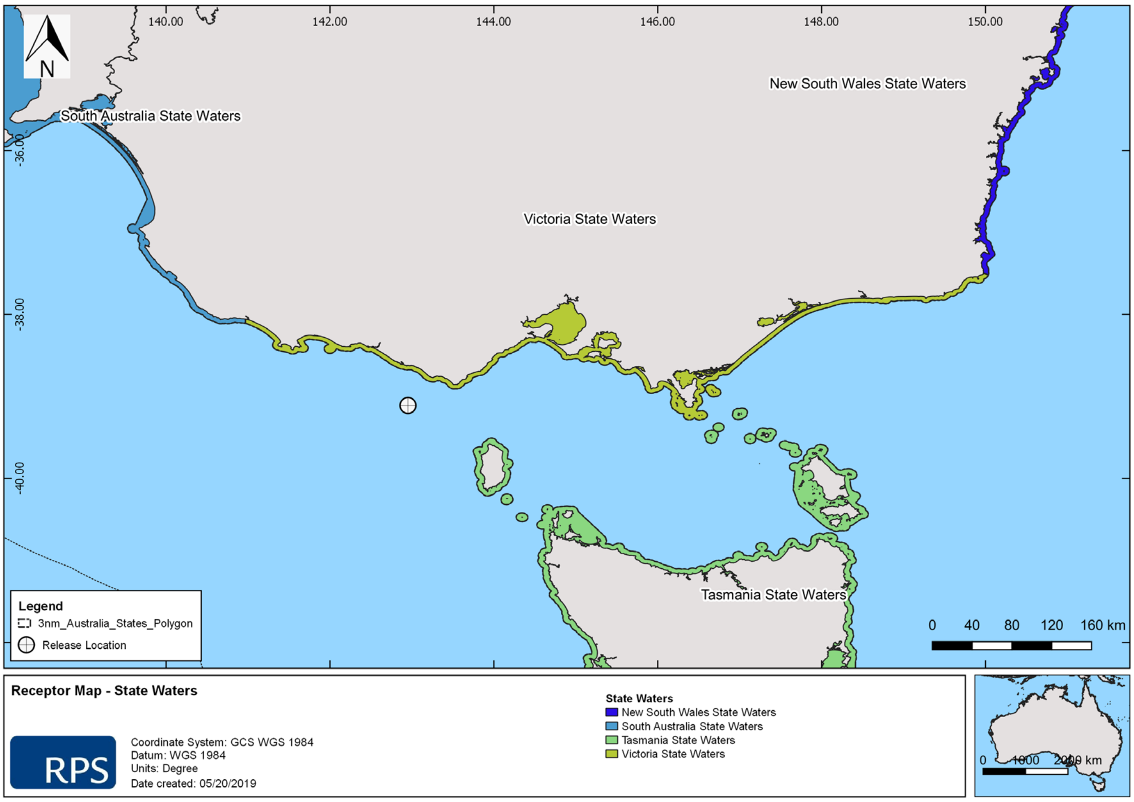

Figure 34 Receptor map of state waters.

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9 RESULTS: 300 M^3 SURFACE RELEASE OF MARINE DIESEL OIL

The scenario examined a 300 m^3 release of MDO over 6 hours (tracked for 30 days) to represent a containment loss from a vessel at the Artisan-1 well location. A total of 100 spill trajectories were simulated for each of the seasons assessed, summer and winter.

Section 9.1 presents stochastic results in tabulated format.

Note, no shoreline contact was predicted for any of the seasons modelled above the minimum threshold.

9.1 Stochastic Analysis

9.1.1 Sea Surface Exposure

Table 13 presents a summary of the maximum distances and directions travelled by oil on the sea surface at the low (0.5-10 g/m^2), moderate (10-25 g/m^2) and high (>25 g/m^2) exposure thresholds for the two seasons. During summer conditions, low and moderate exposure was predicted up to 68 km and 12 km from the release location, respectively. Under winter conditions, low and moderate exposure was predicted up to 93 km and 10 km from the release location, respectively.

Table 14 presents the potential sea surface exposure to individual receptors predicted during summer and winter conditions. The modelling results demonstrated a 1% probability of oil exposure on the sea surface for the Central Victoria IMCRA receptor during the summer conditions. Stochastic results obtained during winter conditions exhibited a 1% probability of oil exposure on the sea surface for several receptors including the Central Victoria and Central Bass Strait IMCRA receptors, Apollo AMP and within Victorian State Waters.

None of the receptors were exposed at or above the moderate or high thresholds, with the exception of Otway IMCRA. Th Otway IMCRA receptor recorded low, moderate and high exposure due to the release location being situated within the boundaries of this receptor.

Table 13 Maximum distance and direction travelled on the sea surface by a single spill trajectory from the release location to the specified oil exposure thresholds.

Season	Distance and direction	Zones of potential sea surface exposure		
		Low	Moderate	High
Summer	Max. distance from release location (km)	68	12	6
	Max distance from release location (km) (99th percentile)	35	11	6
	Direction	E	NNE	E
Winter	Max. distance from release location (km)	93	10	6
	Max distance from release location (km) (99th percentile)	56	10	6
	Direction	E	WNW	ENE

Table 14 Summary of the potential sea surface exposure to individual receptors

Season	Receptor		Probability of oil exposure on the sea surface (%) for each threshold: Low	Moderate	High	Minimum time before oil exposure on the sea surface (hours) for each threshold: Low	Moderate	High
Summer	IMCRA	Otway	100	98	48	1	1	1
		Central Victoria	1	-	-	89	-	-
Winter	IMCRA	Otway	100	98	41	1	1	1
		Central Victoria	1	-	-	133	-	-
		Central Bass Strait	1	-	-	71	-	-
	AMP	Apollo	1	-	-	35	-	-
	State Waters	Victoria State Waters	1	-	-	133	-	-

9.1.2 Water Column Exposure

9.1.2.1 Dissolved Hydrocarbons

Table 15 and Table 16 summarise the probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during summer and winter conditions.

The averaged dissolved hydrocarbon concentrations over 48 hours was highest within the Otway IMCRA receptor which registered 8 ppb and 9 ppb during summer and winter conditions, respectively. A 1% probability of exposure. No other receptors were exposed at or above the specified thresholds.

Based on the 1 hour exposure window, the Otway IMCRA receptor recorded the greatest dissolved hydrocarbon concentration of 76 ppb during summer and 59 ppb during winter. The Otway IMCRA receptor recorded a probability of 2% and 3% during the summer and winter conditions, respectively, based on the moderate threshold. There was no predicted exposure to other receptors at the moderate or high thresholds.

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Table 15 Predicted probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during summer conditions.

SUMMER Receptor		Maximum dissolved hydrocarbon exposure (ppb) for 48 hour window	Probability of time-averaged dissolved hydrocarbon exposure for 48 hour window			Maximum dissolved hydrocarbon exposure (ppb) for 1 hour window	Probability of instantaneous dissolved hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
LGA	Colac Otway	1	-	-	-	6	1	-	-
SUB-LGA	Apollo Bay	1	-	-	-	6	1	-	-
IMCRA	Otway	8	1	-	-	76	47	2	-
	Central Victoria	1	-	-	-	21	2	-	-
	Central Bass Strait	1	-	-	-	20	1	-	-
IBRA	Otway Ranges	1	-	-	-	6	1	-	-
	Otway Plain	1	-	-	-	5	-	-	-
AMP	Apollo	1	-	-	-	22	3	-	-
State Waters	Victoria State Waters	1	-	-	-	17	2	-	-

RPS

Table 16 Predicted probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during winter conditions.

WINTER Receptor		Maximum dissolved hydrocarbon exposure (ppb) for 48 hour window	Probability of time-averaged dissolved hydrocarbon exposure*			Maximum dissolved hydrocarbon exposure (ppb) for 1 hour window	Probability of instantaneous dissolved hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderat e	High
LGA	Colac Otway	1	-	-	-	8	1	-	-
SUB-LGA	Cape Otway West	1	-	-	-	8	1	-	-
IMCRA	Otway	9	2	-	-	59	70	3	-
	Central Victoria	2	-	-	-	19	3	-	-
	Central Bass Strait	1	-	-	-	17	2	-	-
IBRA	Otway Ranges	1	-	-	-	5	-	-	-
	Otway Plain	1	-	-	-	8	1	-	-
AMP	Apollo	2	-	-	-	24	5	-	-
State Waters	Victoria State Waters	1	-	-	-	13	2	-	-

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9.1.2.2 Entrained Hydrocarbons

Table 17 and Table 18 summarise the probability and maximum entrained hydrocarbon exposure for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during summer and winter conditions.

The maximum entrained hydrocarbon concentrations over 48 hour exposure window during summer and winter conditions was 2,182 ppb and 792 ppb, respectively. None of the receptors with the exception of the Otway IMCRA receptor were exposed at or above the moderate (100-1,000 ppb) or high (>1,000 ppb) thresholds during summer or winter conditions.

Based on the 1 hour exposure window, the maximum entrained hydrocarbon concentrations predicted for the Otway IMCRA receptor during summer and winter conditions was 5,933 ppb and 5,046 ppb, respectively. The probability of exposure at or above the moderate (100-1,000 ppb) threshold to receptors other than IMCRA Otway (83% summer and 93% winter) ranged from 1% (Cape Patton sub-LGA) to 8% (Victorian State Waters) during summer conditions and 1% (Twelve Apostles MNP) to 16% (Apollo AMP) during winter conditions. None of the receptors was exposed at or above the high threshold (1,000 ppb), with the exception of IMCRA – Otway.

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Table 17 Predicted probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer during summer conditions.

SUMMER Receptor		Maximum time-entrained hydrocarbon exposure (ppb) for 48 hour window	Probability of entrained hydrocarbon exposure for 48 hour window			Maximum entrained hydrocarbon exposure (ppb) for 1 hour window	Probability of entrained hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	166	-	-	-	406	25	7	-
IBRA	Glenelg Plain	58	-	-	-	33	9	-	-
	Bridgewater	58	-	-	-	31	5	-	-
	Warrnambool Plain	317	-	-	-	228	25	4	-
	Otway Ranges	254	-	-	-	218	25	2	-
	Otway Plain	284	-	-	-	208	28	3	-
	Gippsland Plain	39	-	-	-	21	1	-	-
	Wilsons Promontory	21	-	-	-	12	1	-	-
IMCRA	Otway	2,182	1	-	-	5,933	97	83	39
	Victorian Embayments	14	-	-	-	11	1	-	-
	Central Victoria	178	-	-	-	399	22	5	-
	Central Bass Strait	172	-	-	-	334	13	2	-
	Flinders	22	-	-	-	13	1	-	-
KEF	Bonney Coast Upwelling	125	-	-	-	98	22	-	-
MNP	Discovery Bay	48	-	-	-	25	3	-	-
	Twelve Apostles	372	-	-	-	278	26	6	-
NP	Lower South East	24	-	-	-	22	2	-	-
	Bunurong Marine Park	24	-	-	-	14	1	-	-
	Wilsons Promontory Marine Park	21	-	-	-	12	1	-	-
LGA	Phillip Island	20	-	-	-	19	1	-	-
	Norman Island	21	-	-	-	12	1	-	-

	Shellback Island	20	-	-	-	11	1	-	-
	Glenelg	58	-	-	-	33	9	-	-
	Warrnambool	46	-	-	-	24	8	-	-
	Moyne	172	-	-	-	96	17	-	-
	Corangamite	317	-	-	-	218	26	4	-
	Colac Otway	284	-	-	-	208	28	3	-
	Surf Coast	69	-	-	-	48	5	-	-
	Mornington Peninsula	19	-	-	-	11	1	-	-
	Bass Coast	40	-	-	-	21	1	-	-
	South Gippsland	22	-	-	-	12	1	-	-
	Grant	26	-	-	-	20	1	-	-
	Lady Julia Percy Island	73	-	-	-	43	5	-	-
	Laurence Rocks	41	-	-	-	26	7	-	-
State Waters	South Australia State Waters	31	-	-	-	26	2	-	-
	Victoria State Waters	372	-	-	-	388	30	8	-
SUB-LGA	Wilsons Promontory (West)	22	-	-	-	12	1	-	-
	Venus Bay	21	-	-	-	13	1	-	-
	Kilcunda	40	-	-	-	21	1	-	-
	French Island / San Remo	14	-	-	-	10	1	-	-
	Mornington Peninsula (SW)	18	-	-	-	10	1	-	-
	Port Phillip (Sorrento Shore)	18	-	-	-	11	1	-	-
	Anglesea	21	-	-	-	13	3	-	-
	Lorne	78	-	-	-	49	5	-	-
	Cape Patton	156	-	-	-	132	14	1	-
	Apollo Bay	168	-	-	-	208	21	3	-
	Cape Otway West	284	-	-	-	197	28	2	-
	Moonlight Head	317	-	-	-	218	26	4	-
	Port Campbell	220	-	-	-	157	18	2	-

RPS

Bay of Islands	172	-	-	-	96	17	-	-
Childers Cove	62	-	-	-	43	10	-	-
Warrnambool	27	-	-	-	23	7	-	-
Port Fairy	56	-	-	-	36	2	-	-
Portland Bay (East)	31	-	-	-	21	2	-	-
Portland Bay (West)	38	-	-	-	21	1	-	-
Cape Nelson	58	-	-	-	31	9	-	-
Discovery Bay (East)	46	-	-	-	24	2	-	-
Discovery Bay (West)	24	-	-	-	16	2	-	-

RPS

Table 18 Predicted probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer during winter conditions.

WINTER Receptor		Maximum time-entrained hydrocarbon exposure (ppb) for 48 hour window	Probability of entrained hydrocarbon exposure for 48 hour window			Maximum entrained hydrocarbon exposure (ppb) for 1 hour window	Probability of entrained hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	99	-	-	-	501	54	16	-
	Beagle	6	-	-	-	11	2	-	-
IBRA	Flinders	5	-	-	-	10	1	-	-
	Warrnambool Plain	54	-	-	-	98	17	-	-
	Otway Ranges	169	-	-	-	196	21	4	-
	Otway Plain	298	-	-	-	448	27	6	-
	Gippsland Plain	20	-	-	-	23	8	-	-
	Strzelecki Ranges	12	-	-	-	13	1	-	-
	Wilsons Promontory	19	-	-	-	21	3	-	-
IMCRA	Twofold Shelf	5	-	-	-	10	1	-	-
	Otway	792	2	-	-	5,046	99	93	58
	Victorian Embayments	18	-	-	-	20	3	-	-
	Central Victoria	137	-	-	-	446	54	14	-
	Central Bass Strait	69	-	-	-	386	51	13	-
	Flinders	19	-	-	-	22	4	-	-
KEF	West Tasmania Canyons	12	-	-	-	14	1	-	-
	Bonney Coast Upwelling	13	-	-	-	15	1	-	-
MNP	Bunurong	10	-	-	-	12	1	-	-
	Point Addis	16	-	-	-	17	2	-	-
	Port Phillip Heads	15	-	-	-	19	4	-	-

RPS

	Twelve Apostles	129	-	-	-	283	15	1	-
	Wilsons Promontory	14	-	-	-	16	3	-	-
NP	Wilsons Promontory Marine Park	17	-	-	-	20	2	-	-
RAMSAR	Port Phillip Bay and Bellarine Peninsula	7	-	-	-	10	1	-	-
LGA	Phillip Island	19	-	-	-	22	3	-	-
	Hogan Island Group	5	-	-	-	10	1	-	-
	Glennie Group	14	-	-	-	15	3	-	-
	Norman Island	19	-	-	-	20	3	-	-
	Shellback Island	17	-	-	-	21	2	-	-
	Anser Island	11	-	-	-	12	2	-	-
	Kanowna Island	10	-	-	-	12	2	-	-
	Skull Rock	10	-	-	-	12	2	-	-
	Warrnambool	8	-	-	-	10	1	-	-
	Moyne	49	-	-	-	71	6	-	-
	Corangamite	44	-	-	-	98	18	-	-
	Colac Otway	298	-	-	-	448	27	6	-
	Surf Coast	21	-	-	-	23	3	-	-
	Greater Geelong	20	-	-	-	22	3	-	-
	Mornington Peninsula	20	-	-	-	23	8	-	-
	South Gippsland	18	-	-	-	21	2	-	-
	Lady Julia Percy Island	8	-	-	-	11	1	-	-
State Waters	Tasmania State Waters	6	-	-	-	11	2	-	-
	Victoria State Waters	298	-	-	-	548	40	9	-
SUB-LGA	Wilsons Promontory (West)	18	-	-	-	21	2	-	-
	Waratah Bay	12	-	-	-	13	1	-	-
	Cape Liptrap (NW)	13	-	-	-	15	1	-	-

RPS

Westernport	11	-	-	-	14	2	-	-
Mornington Peninsula (S)	14	-	-	-	16	8	-	-
Mornington Peninsula (SW)	20	-	-	-	23	8	-	-
Port Phillip (Sorrento Shore)	20	-	-	-	22	4	-	-
Port Phillip Heads	10	-	-	-	13	3	-	-
Port Phillip (Queenscliff)	11	-	-	-	15	3	-	-
Torquay	20	-	-	-	22	2	-	-
Anglesea	12	-	-	-	14	2	-	-
Lorne	16	-	-	-	18	3	-	-
Cape Patton	68	-	-	-	95	7	-	-
Apollo Bay	70	-	-	-	84	27	-	-
Cape Otway West	298	-	-	-	448	27	6	-
Moonlight Head	44	-	-	-	98	18	-	-
Port Campbell	43	-	-	-	65	7	-	-
Bay of Islands	49	-	-	-	71	6	-	-
Childers Cove	31	-	-	-	41	1	-	-

*Concentration recorded over a 48-hour window.
^Instantaneous concentration recorded over one hour.

RPS

10 RESULTS: 222,224 BBL SUBSEA RELEASE OF CONDENSATE

The scenario examined a 222,224 bbl subsea release of Thylacine condensate over 86 days (tracked for 114 days) to represent an unrestricted open-hole loss of well control from Artisan-1 well location. A total of 100 spill trajectories were simulated for each of the seasons assessed, summer and winter.

Section 10.1 presents stochastic results for sea surface, shoreline and in-water exposure in tabulated format.

10.1 Stochastic Analysis

10.1.1 Sea Surface Exposure and Shoreline Contact

Table 19 presents a summary of the maximum distance and direction travelled by condensate on the sea surface at the low (0.5-10 g/m^2), moderate (10-25 g/m^2) and high (>25 g/m^2) exposure thresholds for each of the two seasons considered, summer and winter. During summer conditions, low and moderate exposure of surface hydrocarbons were predicted up to 52 km and 4 km from the release location, respectively, while during winter, low and moderate exposure surface hydrocarbons extended to a maximum distance of 53 km and 3 km from the release location, respectively. Note, no high exposure from surface hydrocarbons was predicted for any of the seasons assessed.

Table 20 presents the potential sea surface exposure to individual receptors predicted during summer and winter conditions. The probability of hydrocarbon exposure on the sea surface at or above the low threshold was predicted to range from 6% (Otway Ranges IBRA) to 16% (Colac Otway LGA, Cape Otway West sub-LGA and Victorian State Waters) during summer conditions, with the exception of Otway IMCRA receptor (100%). The winter stochastic modelling results demonstrated a larger number of receptors potentially exposed to surface hydrocarbons at or above low levels with a probability of exposure predicted to range from 3% (Twelve Apostles MNP and Otway Ranges IBRA) to 40% (Otway Plain IBRA, Cape Otway West sub-LGA and Colac Otway LGA), with the exception of Otway IMCRA (100%) and within Victorian State Waters (57%). None of the receptors other than the Otway IMCRA were exposed at or above the moderate or high thresholds for any seasons assessed.

Table 21 presents a summary of potential hydrocarbon contact to any shorelines for summer and winter conditions while Table 22 summarises potential shoreline contact to individual receptors, for each season.

The probability of contact to any shoreline was 16% and 57% for the summer and winter season, respectively, while the minimum time for visible surface hydrocarbon to reach a shoreline was 3 days for 5 days, respectively. The maximum volume of hydrocarbons predicted to come ashore was 15 m^3 and 33 m^3, during summer and winter conditions, respectively, while the maximum length of shoreline contacted above the low threshold (>10 g/m^2) was 7.0 km and 11.0 km, respectively. Note, no shoreline loading above 1,000 g/m^2 was predicted.

The Otway IMCRA shoreline was the only receptor to record of contact above 100 g/m^2 with a probability of 3% during summer and 2% during winter conditions. The modelling results during winter conditions demonstrated additional shoreline contact to Moyne, Corangamite, Moonlight head and Childers Cove.

RPS

Table 19 Maximum distance and direction travelled on the sea surface by a single spill trajectory from the release location to the specified oil exposure thresholds.

Season	Distance and direction	Zones of potential sea surface exposure		
		Low	Moderate	High
Summer	Max. distance from release site (km)	52	4	NA
	Max distance from release site (km) (99th percentile)	34	4	NA
	Direction	E	E	NA
Winter	Max. distance from release site (km)	53	3	NA
	Max distance from release site (km) (99th percentile)	49	3	NA
	Direction	NNW	W	NA

Table 20 Summary of the potential sea surface exposure to individual receptors

			Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (hours)		
Season		Receptor	Low	Moderate	High	Low	Moderate	High
Summer	LGA	Colac Otway	16	-	-	80	-	-
	SUB-LGA	Cape Otway West	16	-	-	80	-	-
	IMCRA	Otway	100	100	-	1	3	-
	IBRA	Otway Ranges	6	-	-	1,343	-	-
		Otway Plain	12	-	-	80	-	-
	State Waters	Victoria State Waters	16	-	-	80	-	-
Winter	LGA	Moyne	8	-	-	649	-	-
		Corangamite	14	-	-	311	-	-
		Colac Otway	40	-	-	188	-	-
	SUB-LGA	Cape Otway West	40	-	-	188	-	-
		Moonlight Head	14	-	-	311	-	-
		Childers Cove	8	-	-	649	-	-
	IMCRA	Otway	100	100	-	1	2	-
	IBRA	Warrnambool Plain	22	-	-	311	-	-
		Otway Ranges	3	-	-	413	-	-
		Otway Plain	40	-	-	188	-	-
	MNP	Twelve Apostles	3	-	-	821	-	-
	State Waters	Victoria State Waters	57	-	-	188	-	-

RPS

Table 21 Summary of potential oil contact to any shoreline for each season assessed

Shoreline statistics	Summer	Winter
Probability of contact to any shoreline (%)	16	57
Minimum time for visible oil to reach a shoreline (days)	3	5
Maximum volume of hydrocarbons ashore (m^3)	15	33
Average volume of hydrocarbons ashore (m^3)	1	5
Maximum length of the shoreline >10 g/m^2 (km)	7.0	11.0
Average shoreline length (km) >10 g/m^2 (km)	4.7	5.6
Maximum length of the shoreline >100 g/m^2 (km)	4.0	8.0
Average shoreline length (km) >100 g/m^2 (km)	2.4	3.5
Maximum length of the shoreline >1,000 g/m^2 (km)	-	-
Average shoreline length (km) > 1,000 g/m^2 (km)	-	-

RPS

Table 22 Summary of the potential shoreline contact to individual receptors for each season assessed

		Probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
Season	Receptor	>10 g/m^2	>100 g/m^2	>1,000 g/m^2	>10 g/m^2	>100 g/m^2	>1,000 g/m^2	Mean	Peak	Mean	Peak	>10 g/m^2	>100 g/m^2	>1,000 g/m^2	>10 g/m^2	>100 g/m^2	>1,000 g/m^2
Summer	Colac Otway	16	15	-	77	277	-	136	520	1	15	5	2	-	7	4	-
	Cape Otway West	16	15	-	77	277	-	136	520	1	15	5	2	-	7	4	-
Winter	Moyne	8	8	-	26	27	-	88	130	<1	5	4	2	-	5	2	-
	Corangamite	14	10	-	635	654	-	241	984	2	23	4	3	-	5	3	-
	Colac Otway	40	40	-	125	247	-	194	670	5	33	6	4	-	11	8	-
	Cape Otway West	40	40	-	109	174	-	194	670	5	33	6	4	-	11	8	-
	Moonlight Head	14	10	-	109	174	-	241	984	2	23	4	3	-	5	3	-
	Childers Cove	8	8	-	125	247	-	88	130	<1	5	4	2	-	5	2	-

10.1.2 Water Column Exposure

10.1.2.1 Dissolved Hydrocarbons

Table 23 and Table 24 summarise the probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during summer and winter conditions.

For the 48 hour time-averaged exposure window, dissolved hydrocarbons remained below 30 ppb in summer and 34 ppb in winter conditions, and hence no moderate or high exposure was predicted under the seasonal conditions modelled. During summer conditions, the probability of low exposure ranged from 1% (Bonney Coast Upwelling KEF, Moyne LGA, Bay of Islands and Childers Cove sub-LGAs) to 17% (Otway Plain IBRA, Colac Otway LGA, Cape Otway West sub-LGA and within Victoria State Waters)The Otway IMCRA recorded a probability of 50% during summer. During winter conditions, the probability of low exposure to dissolved hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF, Bay of Islands and Lorne sub-LGA) to 16% (within Victoria State Waters). The Otway IMCRA registered a probability of 42% for winter. None of the receptors were exposed to moderate (50 – 400 ppb) or high (>400 ppb) dissolved hydrocarbons (over a 48 hour basis) during the summer or winter season.

The analysis for the dissolved hydrocarbons over a 1 hour window showed that the maximum exposure was 309 ppb during summer and 289 ppb during winter, which was predicted within the Otway IMCRA and Victorian State Waters. During summer conditions, the probability of moderate exposure to dissolved hydrocarbons ranged from 1% (Glenelg Plain and Bridgewater IBRA's; Glenelg, Moyne and Surf Coast LGAs; Lorne, Bay of Islands, Childers Cove and Cape Nelson sub-LGAs) to 43% (Otway Plain IBRA, Colac Otway LGA, Cape Otway West sub-LGA and within Victoria State Waters). The probability for Otway IMCRA was 58%. Under winter conditions, the probability of moderate exposure (over 1 hour) to dissolved hydrocarbons ranged from 1% (Gippsland Plain IBRA; Flinders IMCRA; Point Addis and Wilsons Promontory MNP; Mornington Peninsula LGA; Lorne, Mornington Peninsula and Childers Cove sub-LGAs) to 57% for the Victorian State Waters. The probability of exposure to the Otway IMCRA was 68%. None of the receptors were exposed high concentrations during the summer or winter season.

Table 23 Predicted probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during summer conditions.

SUMMER Receptor		Maximum dissolved hydrocarbon exposure (ppb) for 48 hour window	Probability of time-averaged dissolved hydrocarbon exposure for 48 hour window			Maximum dissolved hydrocarbon exposure (ppb) for 1 hour window	Probability of instantaneous dissolved hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	20	11	-	-	225	98	30	-
	Beagle	1	-	-	-	9	1	-	-
	Nelson	1	-	-	-	18	3	-	-
	Zeehan	1	-	-	-	19	4	-	-
IBRA	Glenelg Plain	6	-	-	-	53	25	1	-
	Bridgewater	4	-	-	-	54	20	1	-
	Warrnambool Plain	24	5	-	-	217	99	14	-
	Otway Ranges	13	7	-	-	161	100	27	-
	Otway Plain	23	17	-	-	235	98	43	-
	Gippsland Plain	3	-	-	-	28	11	-	-
	Wilsons Promontory	1	-	-	-	12	3	-	-
IMCRA	Coorong	0	-	-	-	12	1	-	-
	Otway	30	50	-	-	309	100	58	-
	Victorian Embayment	3	-	-	-	31	6	-	-
	Central Victoria	18	9	-	-	253	95	28	-
	Central Bass Strait	17	6	-	-	254	88	20	-
	Flinders	2	-	-	-	26	5	-	-
KEF	West Tasmania Canyons	2	-	-	-	34	8	-	-
	Bonney Coast Upwelling	10	1	-	-	97	60	2	-
MNP	Churchill Island	1	-	-	-	7	2	-	-
	Discovery Bay	3	-	-	-	41	15	-	-
	Point Addis	2	-	-	-	34	14	-	-
	Port Phillip Heads	2	-	-	-	21	7	-	-
	Twelve Apostles	27	6	-	-	217	98	20	-
	Wilsons Promontory	2	-	-	-	12	2	-	-

MP	Lower South East	1	-	-	-	16	3	-	-
	Bunurong Marine Park	1	-	-	-	10	3	-	-
NP	Wilsons Promontory Marine Park	1	-	-	-	6	1	-	-
	Port Phillip Bay and Bellarine Peninsula	1	-	-	-	31	4	-	-
RAMSAR	Western Port	1	-	-	-	12	2	-	-
SHORE	Phillip Island	2	-	-	-	24	11	-	-
	Mud Island	1	-	-	-	12	2	-	-
	Moncoeur Islands	1	-	-	-	9	1	-	-
	Rodondo Island	1	-	-	-	11	2	-	-
	Glennie Group	1	-	-	-	12	3	-	-
	Norman Island	1	-	-	-	10	1	-	-
	Anser Island	1	-	-	-	6	1	-	-
	Kanowna Island	1	-	-	-	10	1	-	-
	Skull Rock	1	-	-	-	7	1	-	-
	Glenelg	6	-	-	-	54	25	1	-
	Warrnambool	5	-	-	-	46	25	-	-
	Moyne	7	1	-	-	66	74	1	-
	Corangamite	24	5	-	-	217	100	17	-
	Colac Otway	23	17	-	-	235	100	43	-
	Surf Coast	5	-	-	-	57	24	1	-
	Greater Geelong	2	-	-	-	31	8	-	-
	Mornington Peninsula	3	-	-	-	28	11	-	-
	Bass Coast	1	-	-	-	21	5	-	-
	South Gippsland	1	-	-	-	7	1	-	-
	Grant	1	-	-	-	19	3	-	-
	Lady Julia Percy Island	2	-	-	-	28	22	-	-
	Laurence Rocks	5	-	-	-	18	20	-	-
State Waters	South Australia State Waters	1	-	-	-	26	6	-	-
	Victoria State Waters	30	17	-	-	309	100	43	-
SUB-LGA	Wilsons Promontory (West)	1	-	-	-	6	1	-	-
	Cape Liptrap (NW)	1	-	-	-	7	1	-	-
	Venus Bay	1	-	-	-	10	3	-	-

Kilcunda	1	-	-	-	21	5	-	-
French Island / San Remo	1	-	-	-	14	4	-	-
French Island / Crib Point	1	-	-	-	6	1	-	-
Westernport	1	-	-	-	13	6	-	-
Mornington Peninsula (S)	1	-	-	-	14	7	-	-
Mornington Peninsula (SW)	2	-	-	-	24	11	-	-
Port Phillip (Sorrento Shore)	3	-	-	-	23	8	-	-
Port Phillip Heads	1	-	-	-	31	6	-	-
Port Phillip (Queenscliff)	2	-	-	-	23	7	-	-
Torquay	3	-	-	-	23	8	-	-
Anglesea	3	-	-	-	32	12	-	-
Lorne	5	-	-	-	57	24	1	-
Cape Patton	11	2	-	-	161	85	8	-
Apollo Bay	13	4	-	-	154	95	15	-
Cape Otway West	23	17	-	-	235	100	43	-
Moonlight Head	24	5	-	-	217	100	17	-
Port Campbell	12	3	-	-	103	77	6	-
Bay of Islands	7	1	-	-	66	74	1	-
Childers Cove	7	1	-	-	55	55	1	-
Warrnambool	3	-	-	-	36	16	-	-
Port Fairy	2	-	-	-	23	11	-	-
Portland Bay (East)	1	-	-	-	10	2	-	-
Cape Nelson	6	-	-	-	54	25	1	-
Discovery Bay (East)	1	-	-	-	11	2	-	-
Discovery Bay (West)	1	-	-	-	8	1	-	-

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Table 24 Predicted probability and maximum dissolved hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer, during winter conditions .

WINTER Receptor		Maximum dissolved hydrocarbon exposure (ppb) for 48 hour window	Probability of time-averaged dissolved hydrocarbon exposure for 48 hour window			Maximum dissolved hydrocarbon exposure (ppb) for 1 hour window	Probability of instantaneous dissolved hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	13	7	-	-	237	100	39	-
	Beagle	2	-	-	-	37	13	-	-
	Zeehan	1	-	-	-	16	3	-	-
IBRA	King Island	1	-	-	-	9	1	-	-
	Flinders	1	-	-	-	9	2	-	-
	Glenelg Plain	4	-	-	-	19	2	-	-
	Bridgewater	2	-	-	-	8	1	-	-
	Warrnambool Plain	14	4	-	-	237	100	21	-
	Otway Ranges	14	6	-	-	248	100	35	-
	Otway Plain	30	10	-	-	203	100	51	-
	Gippsland Plain	6	-	-	-	51	16	1	-
	Strzelecki Ranges	4	-	-	-	31	18	-	-
	Wilsons Promontory	4	-	-	-	34	21	-	-
IMCRA	Twofold Shelf	2	-	-	-	28	6	-	-
	Otway	34	42	-	-	289	100	68	-
	Victorian Embayments	4	-	-	-	36	9	-	-
	Central Victoria	25	7	-	-	235	100	33	-
	Central Bass Strait	17	4	-	-	282	100	26	-
	Flinders	5	-	-	-	66	27	1	-
KEF	West Tasmania Canyons	4	-	-	-	36	8	-	-
	Bonney Coast Upwelling	6	1	-	-	86	19	2	-
	Upwelling East of Eden	1	-	-	-	9	1	-	-
MNP	Bunurong	2	-	-	-	34	10	-	-
	Churchill Island	1	-	-	-	8	1	-	-
	Point Addis	5	-	-	-	51	41	1	-

RPS

	Port Phillip Heads	1	-	-	-	15	8	-	-
	Twelve Apostles	16	6	-	-	155	100	18	-
	Wilsons Promontory	5	-	-	-	66	23	1	-
NP	Bunurong Marine Park	1	-	-	-	24	8	-	-
	Wilsons Promontory Marine Park	4	-	-	-	33	9	-	-
RAMSAR	Port Phillip Bay and Bellarine Peninsula	1	-	-	-	14	2	-	-
	Western Port	3	-	-	-	22	2	-	-
SHORE	King Island	1	-	-	-	9	1	-	-
	Seal Islands	2	-	-	-	15	2	-	-
	Phillip Island	3	-	-	-	26	13	-	-
	French Island	1	-	-	-	10	1	-	-
	Moncoeur Islands	1	-	-	-	26	8	-	-
	Hogan Island Group	1	-	-	-	9	2	-	-
	Rodondo Island	1	-	-	-	24	13	-	-
	Glennie Group	4	-	-	-	34	21	-	-
	Norman Island	3	-	-	-	33	16	-	-
	Shellback Island	2	-	-	-	24	9	-	-
	Anser Island	2	-	-	-	27	18	-	-
	Kanowna Island	3	-	-	-	18	18	-	-
	Skull Rock	3	-	-	-	16	18	-	-
	Glenelg	4	-	-	-	19	2	-	-
	Warrnambool	5	-	-	-	34	13	-	-
	Moyne	14	4	-	-	87	60	5	-
	Corangamite	14	5	-	-	237	100	21	-
	Colac Otway	30	10	-	-	212	100	51	-
	Surf Coast	4	-	-	-	46	50	-	-
	Greater Geelong	2	-	-	-	26	15	-	-
	Mornington Peninsula	6	-	-	-	52	13	1	-
	Bass Coast	2	-	-	-	24	9	-	-
	South Gippsland	4	-	-	-	43	18	-	-
	Lady Julia Percy Island	2	-	-	-	20	7	-	-

	Laurence Rocks	1	-	-	-	19	2	-	-
State Waters	Tasmania State Waters	1	-	-	-	15	3	-	-
	Victoria State Waters	34	16	-	-	289	100	57	-
SUB-LGA	Wilsons Promontory (East)	2	-	-	-	31	11	-	-
	Wilsons Promontory (West)	4	-	-	-	33	14	-	-
	Waratah Bay	4	-	-	-	31	18	-	-
	Cape Liptrap (NW)	4	-	-	-	43	16	-	-
	Venus Bay	2	-	-	-	24	9	-	-
	Kilcunda	1	-	-	-	18	7	-	-
	French Island / San Remo	1	-	-	-	8	2	-	-
	French Island / Crib Point	1	-	-	-	8	1	-	-
	Westernport	6	-	-	-	31	6	-	-
	Mornington Peninsula (S)	6	-	-	-	51	12	1	-
	Mornington Peninsula (SW)	4	-	-	-	33	11	-	-
	Port Phillip (Sorrento Shore)	2	-	-	-	26	10	-	-
	Port Phillip Heads	1	-	-	-	14	4	-	-
	Port Phillip (Queenscliff)	2	-	-	-	25	15	-	-
	Torquay	3	-	-	-	44	16	-	-
	Anglesea	4	-	-	-	40	31	-	-
	Lorne	7	1	-	-	57	50	1	-
	Cape Patton	13	3	-	-	124	92	8	-
	Apollo Bay	14	4	-	-	212	100	21	-
	Cape Otway West	30	10	-	-	203	100	51	-
	Moonlight Head	14	4	-	-	237	100	21	-
	Port Campbell	9	3	-	-	112	67	5	-
	Bay of Islands	14	1	-	-	90	60	5	-
	Childers Cove	14	4	-	-	78	24	1	-
	Warrnambool	1	-	-	-	9	3	-	-
	Port Fairy	5	-	-	-	29	3	-	-
	Portland Bay (East)	1	-	-	-	15	1	-	-
	Cape Nelson	4	-	-	-	19	2	-	-

*Concentration recorded over a 48-hour window.
^Instantaneous concentration recorded over one hour.

10.1.2.2 Entrained Hydrocarbons

Table 25 and Table 26 summarise the probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer at, or above the exposure thresholds during summer and winter.

The maximum entrained hydrocarbon exposure over 48 hour window predicted for the summer and winter season was 559 ppb and 569 ppb, respectively, and hence no moderate or high exposure was predicted. During summer conditions, the probability of low exposure to entrained hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF; Moyne LGA; Bay of Islands and Childers Cove sub-LGAs) to 17% (Otway Plain IBRA; Colac Otway LGA; Cape Otway West sub-LGA and within Victorian State Waters), with the exception of IMCRA – Otway (50%). During winter conditions, the probability of low exposure to entrained hydrocarbons over 48 hours ranged from 1% (Bonney Coast Upwelling KEF; Bay of Islands and Lorne sub-LGAs) to 16% (Victoria State Waters), with the exception of Otway IMCRA (42%).

For the 1 hour exposure window, the entrained hydrocarbon concentrations had peaked at 948 ppb during summer and 932 ppb during winter with the maximum values predicted within the Otway IMCRA During summer conditions, the probability of moderate entrained hydrocarbon exposure ranged from 7% (Cape Patton sub-LGA) to 73% (Victorian State Waters). The probability of exposure to the Otway IMCRA receptor was 100% during both seasons. For other receptors during winter conditions, the probability of moderate entrained hydrocarbon exposure ranged from 8% (along the shoreline of Childers Cove sub-LGA; Moyne and Warrnambool LGA) to 73% (within Victorian State Waters).

Table 25 Predicted probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer during summer conditions.

Receptor		Maximum time-entrained hydrocarbon exposure (ppb) for 48 hour window	Probability of entrained hydrocarbon exposure for 48 hour window			Maximum entrained hydrocarbon exposure (ppb) for 1 hour window	Probability of entrained hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	81	11	-	-	255	98	50	-
	Beagle	12	-	-	-	15	14	-	-
	Murray	7	-	-	-	10	1	-	-
	Zeehan	7	-	-	-	14	8	-	-
IBRA	Glenelg Plain	36	-	-	-	41	45	-	-
	Bridgewater	32	-	-	-	37	36	-	-
	Warrnambool Plain	255	5	-	-	293	100	38	-
	Otway Ranges	184	7	-	-	215	100	29	-
	Otway Plain	294	17	-	-	333	100	71	-
	Gippsland Plain	41	-	-	-	47	62	-	-
	Strzelecki Ranges	18	-	-	-	20	14	-	-
	Wilsons Promontory	24	-	-	-	28	21	-	-
IMCRA	Coorong	9	-	-	-	13	12	-	-
	Otway	559	50	-	-	948	100	100	-
	Victorian Embayment	37	-	-	-	42	52	-	-
	Central Victoria	117	9	-	-	255	96	50	-
	Central Bass Strait	94	6	-	-	220	95	38	-
	Flinders	24	-	-	-	28	29	-	-
KEF	West Tasmania Canyons	16	-	-	-	25	16	-	-
	Bonney Coast Upwelling	36	1	-	-	53	74	-	-
MNP	Bunurong	12	-	-	-	14	19	-	-
	Churchill Island	11	-	-	-	13	12	-	-
	Discovery Bay	14	-	-	-	17	20	-	-
	Point Addis	35	-	-	-	41	49	-	-
	Port Phillip Heads	31	-	-	-	35	49	-	-

	Twelve Apostles	256	6	-	-	302	100	60	-
	Wilsons Promontory	23	-	-	-	26	22	-	-
MP	Lower South East	10	-	-	-	13	16	-	-
NP	Bunurong Marine Park	17	-	-	-	20	36	-	-
	Corner Inlet Marine and Coastal	10	-	-	-	11	2	-	-
	Wilsons Promontory Marine Park	23	-	-	-	27	8	-	-
RAMSAR	Corner Inlet	10	-	-	-	11	2	-	-
	Port Phillip Bay and Bellarine	19	-	-	-	25	39	-	-
	Western Port	21	-	-	-	24	19	-	-
SHORE	Phillip Island	30	-	-	-	35	46	-	-
	Mud Island	23	-	-	-	28	29	-	-
	Moncoeur Islands	12	-	-	-	14	14	-	-
	Rodondo Island	13	-	-	-	17	16	-	-
	Glennie Group	22	-	-	-	25	20	-	-
	Norman Island	24	-	-	-	28	15	-	-
	Shellback Island	23	-	-	-	27	6	-	-
	Kanowna Island	14	-	-	-	16	21	-	-
	Skull Rock	15	-	-	-	17	21	-	-
	Glenelg	36	-	-	-	41	45	-	-
	Warrnambool	34	-	-	-	38	63	-	-
	Moyne	82	1	-	-	90	95	-	-
	Corangamite	255	5	-	-	293	100	30	-
	Colac Otway	294	17	-	-	333	100	71	-
	Surf Coast	47	-	-	-	59	48	-	-
	Greater Geelong	46	-	-	-	52	44	-	-
	Mornington Peninsula	41	-	-	-	47	62	-	-
	Bass Coast	20	-	-	-	23	41	-	-
	South Gippsland	24	-	-	-	27	28	-	-
	Grant	10	-	-	-	14	16	-	-
	Lady Julia Percy Island	33	-	-	-	40	58	-	-
	Laurence Rocks	33	-	-	-	37	46	-	-
State Waters	South Australia State Waters	13	-	-	-	22	17	-	-
	Victoria State Waters	296	17	-	-	336	100	73	-

SUB-LGA	Corner Inlet	10	-	-	-	12	3	-	-
	Wilsons Promontory (East)	11	-	-	-	14	17	-	-
	Wilsons Promontory (West)	24	-	-	-	27	20	-	-
	Waratah Bay	18	-	-	-	22	14	-	-
	Cape Liptrap (NW)	20	-	-	-	24	28	-	-
	Venus Bay	17	-	-	-	20	36	-	-
	Kilcunda	20	-	-	-	23	41	-	-
	French Island / San Remo	16	-	-	-	19	24	-	-
	French Island / Crib Point	9	-	-	-	12	9	-	-
	Westernport	25	-	-	-	29	42	-	-
	Mornington Peninsula (S)	33	-	-	-	39	60	-	-
	Mornington Peninsula (SW)	41	-	-	-	47	62	-	-
	Port Phillip (Sorrento Shore)	41	-	-	-	45	53	-	-
	Port Phillip (Mornington)	11	-	-	-	12	18	-	-
	Port Phillip Heads	25	-	-	-	32	41	-	-
	Port Phillip (Queenscliff)	31	-	-	-	36	44	-	-
	Torquay	46	-	-	-	52	39	-	-
	Anglesea	30	-	-	-	34	38	-	-
	Lorne	48	-	-	-	59	48	-	-
	Cape Patton	78	2	-	-	121	95	7	-
	Apollo Bay	80	4	-	-	139	95	17	-
	Cape Otway West	294	17	-	-	333	100	71	-
	Moonlight Head	255	5	-	-	293	100	30	-
	Port Campbell	155	3	-	-	196	100	27	-
	Bay of Islands	82	1	-	-	90	95	-	-
	Childers Cove	63	1	-	-	72	68	-	-
	Warrnambool	28	-	-	-	34	56	-	-
	Port Fairy	26	-	-	-	31	46	-	-
	Portland Bay (East)	15	-	-	-	18	12	-	-
	Portland Bay (West)	22	-	-	-	25	19	-	-
	Cape Nelson	36	-	-	-	41	45	-	-
	Discovery Bay (East)	11	-	-	-	14	8	-	-

*Concentration recorded over a 48-hour window.
^Instantaneous concentration recorded over one hour.

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Table 26 Predicted probability and maximum entrained hydrocarbon exposure (for 1 hour and 48-hour exposure windows) to individual receptors in the 0–10 m depth layer during winter conditions.

Receptor		Maximum time-entrained hydrocarbon exposure (ppb) for 48 hour window	Probability of entrained hydrocarbon exposure for 48 hour window			Maximum entrained hydrocarbon exposure (ppb) for 1 hour window	Probability of entrained hydrocarbon exposure for 1 hour window		
			Low	Moderate	High		Low	Moderate	High
AMP	Apollo	85	7	-	-	225	100	48	-
	Beagle	18	-	-	-	24	40	-	-
IBRA	King Island	10	-	-	-	14	10	-	-
	Flinders	14	-	-	-	23	19	-	-
	Warrnambool Plain	178	4	-	-	214	100	39	-
	Otway Ranges	168	6	-	-	202	100	47	-
	Otway Plain	303	10	-	-	333	100	58	-
	Gippsland Plain	55	-	-	-	67	83	-	-
	Strzelecki Ranges	22	-	-	-	25	54	-	-
	Wilsons Promontory	69	-	-	-	79	74	-	-
	Bateman	6	-	-	-	6	-	-	-
IMCRA	Batemans Shelf	9	-	-	-	12	8	-	-
	Twofold Shelf	14	-	-	-	23	21	-	-
	Otway	569	42	-	-	932	100	100	-
	Victorian Embayments	28	-	-	-	32	57	-	-
	Central Victoria	112	7	-	-	225	100	48	-
	Central Bass Strait	105	4	-	-	227	100	23	-
	Flinders	72	-	-	-	84	75	-	-
KEF	West Tasmania Canyons	17	-	-	-	21	17	-	-
	Bonney Coast Upwelling	32	1	-	-	42	32	-	-
	Upwelling East of Eden	14	-	-	-	17	21	-	-
MNP	Bunurong	11	-	-	-	15	29	-	-
	Cape Howe	9	-	-	-	9	-	-	-
	Churchill Island	14	-	-	-	16	16	-	-
	Point Addis	34	-	-	-	38	72	-	-
	Port Phillip Heads	25	-	-	-	30	59	-	-
	Twelve Apostles	169	6	-	-	230	100	43	-

	Wilsons Promontory	71	-	-	-	84	74	-	-
AMP	Apollo	85	7	-	-	225	100	48	-
MP	Batemans	7	-	-	-	9	-	-	-
NP	Bunurong Marine Park	16	-	-	-	19	47	-	-
	Corner Inlet Marine and Coastal Park	10	-	-	-	12	10	-	-
	Shallow Inlet Marine and Coastal Park	10	-	-	-	12	9	-	-
	Wilsons Promontory Marine Park	60	-	-	-	67	72	-	-
RAMSAR	Corner Inlet	10	-	-	-	12	10	-	-
	Port Phillip Bay and Bellarine Peninsula	18	-	-	-	23	27	-	-
	Western Port	16	-	-	-	21	30	-	-
RSB	New Zealand Star Bank	7	-	-	-	9	-	-	-
SHORE	King Island	10	-	-	-	14	10	-	-
	Seal Islands	7	-	-	-	11	2	-	-
	Phillip Island	28	-	-	-	33	79	-	-
	French Island	11	-	-	-	18	11	-	-
	Mud Island	15	-	-	-	19	25	-	-
	Curtis Island	8	-	-	-	11	5	-	-
	Moncoeur Islands	18	-	-	-	24	38	-	-
	Hogan Island Group	14	-	-	-	23	19	-	-
	Rodondo Island	19	-	-	-	25	59	-	-
	Glennie Group	68	-	-	-	78	74	-	-
	Norman Island	71	-	-	-	84	74	-	-
	Shellback Island	36	-	-	-	44	69	-	-
	Montague Island	6	-	-	-	9	-	-	-
	Anser Island	41	-	-	-	49	69	-	-
	Kanowna Island	36	-	-	-	42	69	-	-
	Skull Rock	37	-	-	-	42	70	-	-
	Warrnambool	80	-	-	-	137	30	8	-
	Moyne	143	4	-	-	207	72	8	-
	Corangamite	178	5	-	-	214	100	36	-
	Colac Otway	303	10	-	-	333	100	58	-
	Surf Coast	45	-	-	-	50	69	-	-
	Greater Geelong	45	-	-	-	51	54	-	-

	Mornington Peninsula	37	-	-	-	42	83	-	-
	Bass Coast	19	-	-	-	23	52	-	-
	South Gippsland	65	-	-	-	72	73	-	-
	Eurobodalla	6	-	-	-	9	-	-	-
	Lady Julia Percy Island	32	-	-	-	37	24	-	-
	Laurence Rocks	8	-	-	-	12	4	-	-
State Waters	Tasmania State Waters	14	-	-	-	23	21	-	-
	Victoria State Waters	303	16	-	-	333	100	73	-
	New South Wales State Waters	9	-	-	-	13	11	-	-
SUB-LGA	Eurobodalla	6	-	-	-	9	-	-	-
	Corner Inlet	10	-	-	-	12	10	-	-
	Wilsons Promontory (East)	22	-	-	-	27	56	-	-
	Wilsons Promontory (West)	65	-	-	-	72	73	-	-
	Waratah Bay	22	-	-	-	25	54	-	-
	Cape Liptrap (NW)	27	-	-	-	31	66	-	-
	Venus Bay	16	-	-	-	18	45	-	-
	Kilcunda	19	-	-	-	23	52	-	-
	French Island / San Remo	13	-	-	-	15	28	-	-
	French Island / Crib Point	12	-	-	-	19	11	-	-
	Westernport	23	-	-	-	28	64	-	-
	Mornington Peninsula (S)	36	-	-	-	42	83	-	-
	Mornington Peninsula (SW)	37	-	-	-	42	83	-	-
	Port Phillip (Sorrento Shore)	31	-	-	-	35	75	-	-
	Port Phillip Heads	24	-	-	-	29	46	-	-
	Port Phillip (Queenscliff)	29	-	-	-	36	50	-	-
	Torquay	45	-	-	-	51	34	-	-
	Anglesea	29	-	-	-	34	49	-	-
	Lorne	39	1	-	-	50	69	-	-
	Cape Patton	67	3	-	-	95	99	-	-
	Apollo Bay	70	4	-	-	132	100	11	-
	Cape Otway West	303	10	-	-	333	100	58	-
	Moonlight Head	178	4	-	-	214	100	36	-
	Port Campbell	127	3	-	-	182	91	11	-

Bay of Islands	84	1	-	-	104	72	2	-
Childers Cove	143	4	-	-	207	46	8	-
Warrnambool	16	-	-	-	22	21	-	-
Port Fairy	12	-	-	-	16	14	-	-
Portland Bay (East)	9	-	-	-	11	2	-	-

*Concentration recorded over a 48-hour window.
^Instantaneous concentration recorded over one hour.

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11 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.

Australian Maritime Safety Authority (AMSA) 2015a, Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities.

Australian Maritime Safety Authority (AMSA) 2015b, National Plan - Response, Assessment and Termination of Cleaning for Oil Contaminated Foreshores (NP-GUI-025)

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.

Bonn Agreement 2009, 'Bonn Agreement aerial operations handbook, 2009 - Publication of the Bonn Agreement', London, viewed 13 January 2015, http://www.bonnagreement.org/site/assets/files/3947/ba-aoh_revision_2_april_2012.pdf

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.

Brandvik, PJ, Johansen, O, Farooq, U, Angell, G and 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.

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.

Condie, SA., & Andrewartha, JR (2008). Circulation and connectivity on the Australian Northwest Shelf. Continental Shelf Research, 28, 1724-1739.

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.

DEWHA, 2007. Characterisation of the marine environment in the north marine region. Marine Division, Department of the environment, water heritage and the arts.

DEWHA. 2008. The North-West Marine Bioregional Plan - Bioregional Profile. Retrieved February 12, 2013, from Australian Government Department of Environment, Water, Heritage and the Arts: http://www.environment.gov.au/coasts/mbp/publications/north-west/pubs/bioregional-profile.pdf

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 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, 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.

Gordon, R 1982, 'Wind driven circulation in Narragansett Bay' PhD thesis, Department of Ocean Engineering, University of Rhode Island.

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.

International Tankers Owners Pollution Federation (ITOPF) 2014, 'Technical Information Paper 2 - Fate of Marine Oil Spills', International Tankers Owners Pollution Federation td, UK.

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.

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 I, vol. 103, no. C2, pp. 2995–3011.

RPS

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.

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.

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, pp. 1098–1110.

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.

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, MS, 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.

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 C EP Revision Change Register

Any changes to the EP should be assessed against the OPGGS(E)R revision submission criteria detailed in Table 8-9.

Date	EP Revision	Section Revised	Changes	MOC No.	EP Submission Required

Appendix D Fair Ocean Access Information Sheet

Fair Ocean Access

Minimising fishing impacts from offshore operations

beach

Information Sheet | May 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.

Fair Ocean Access – Minimising fishing impacts in offshore operations | May 2021 Page 1 of 2

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

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Appendix E Environmental Survey – Otway Basin

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		
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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.

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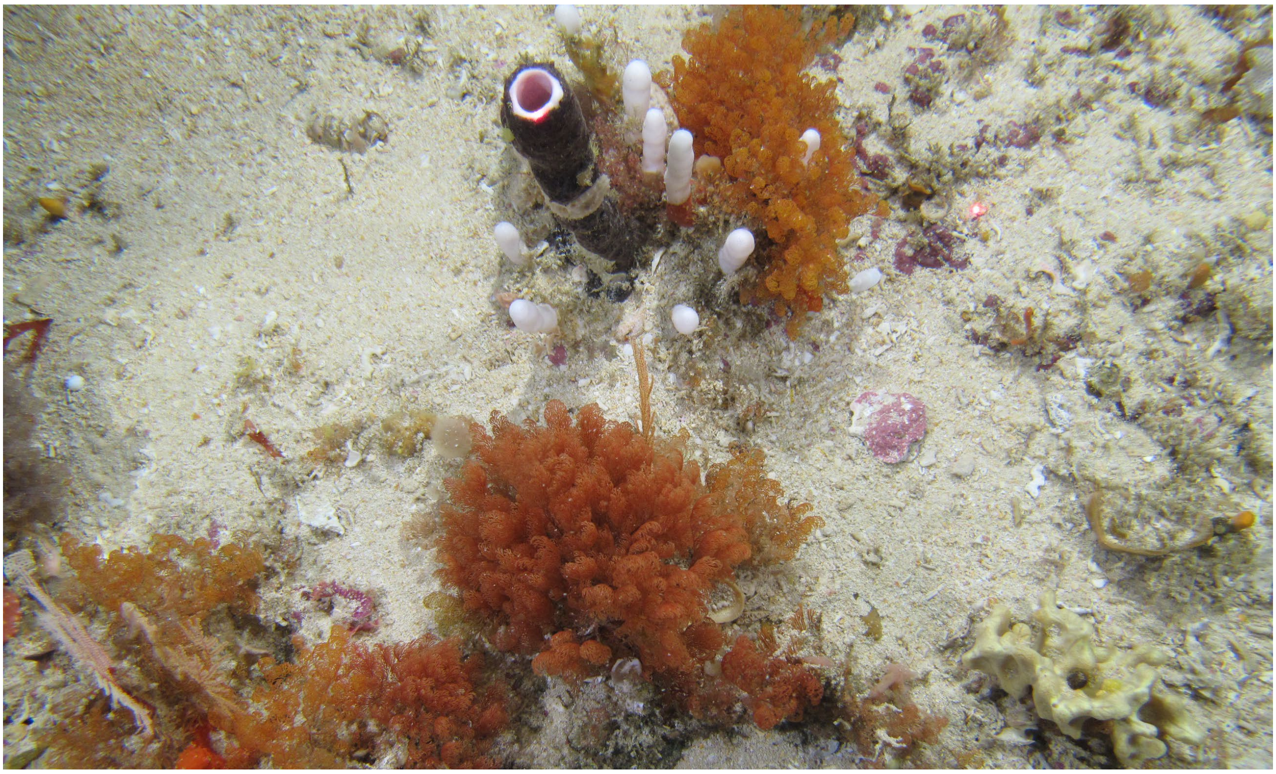
Intended for
Fugro Australia Pty Ltd

Document type
Report

Date
March 2020

ENVIRONMENTAL SURVEY
OTWAY BASIN



RAMBOLL 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**

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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

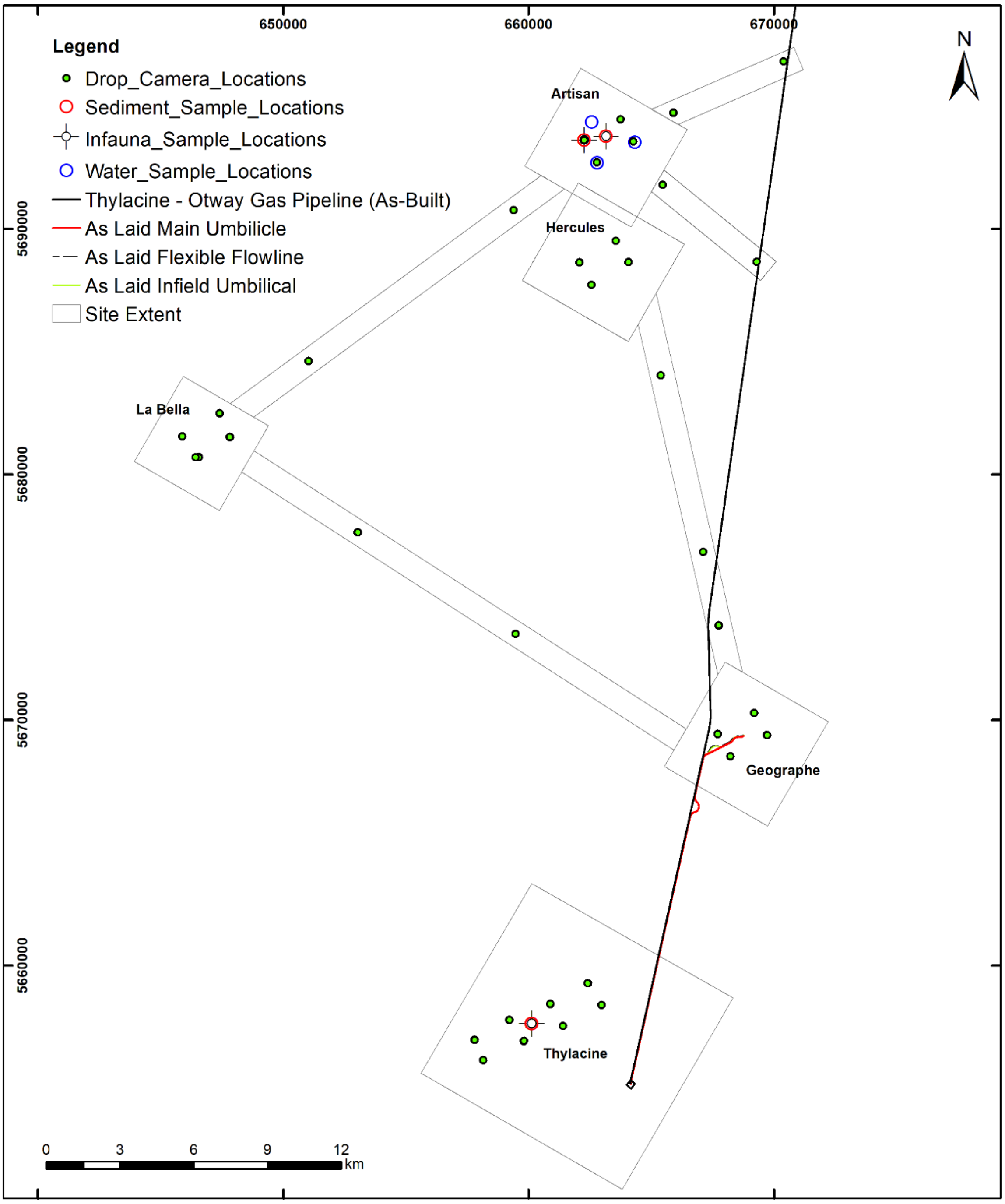


Figure 1 Locations of environmental survey site extents in Otway Basin. Provided by Fugro, April 2020.

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

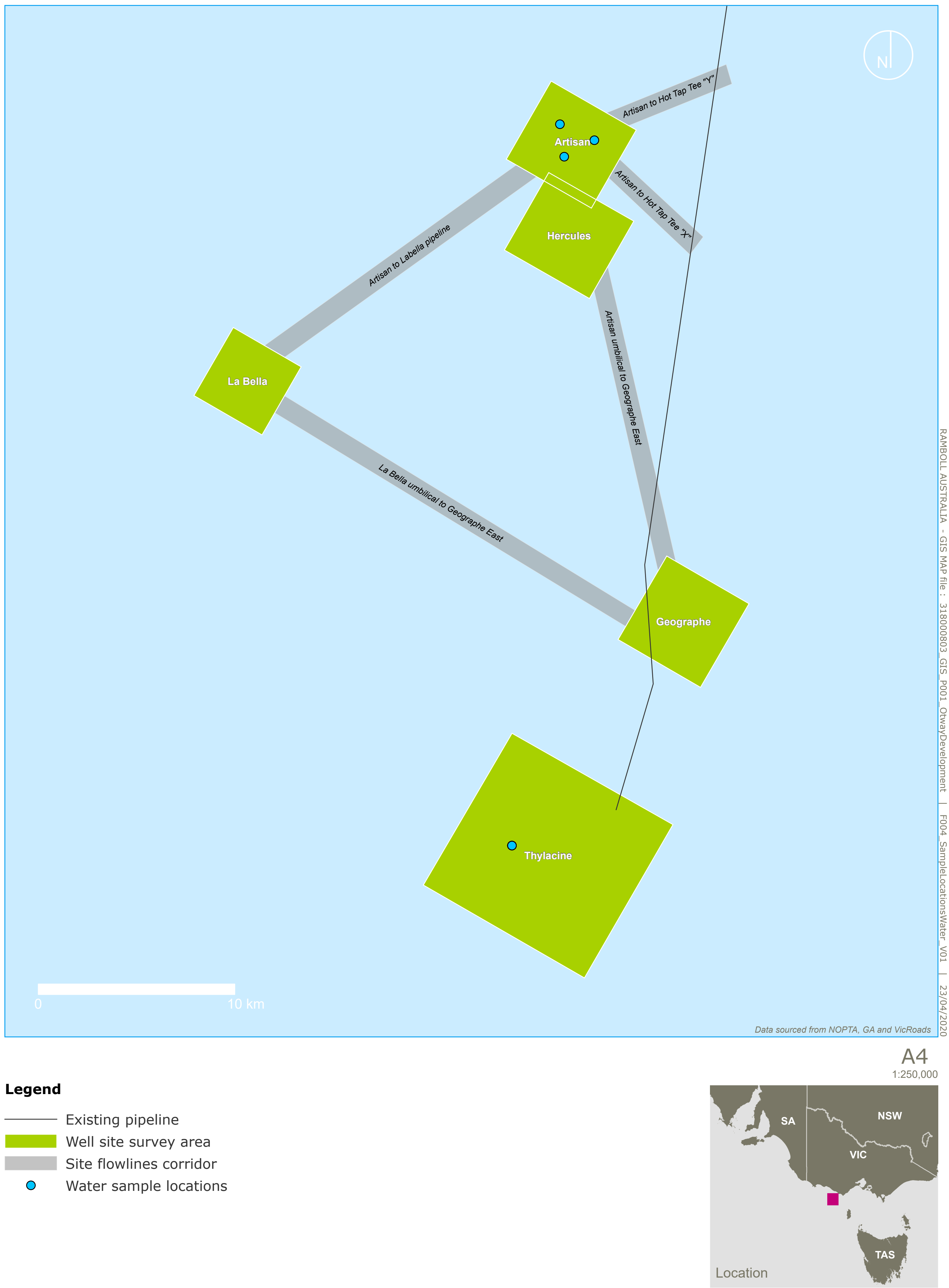


FIGURE 2 | Water sampling locations for Thylacine and Artisan survey areas.

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.

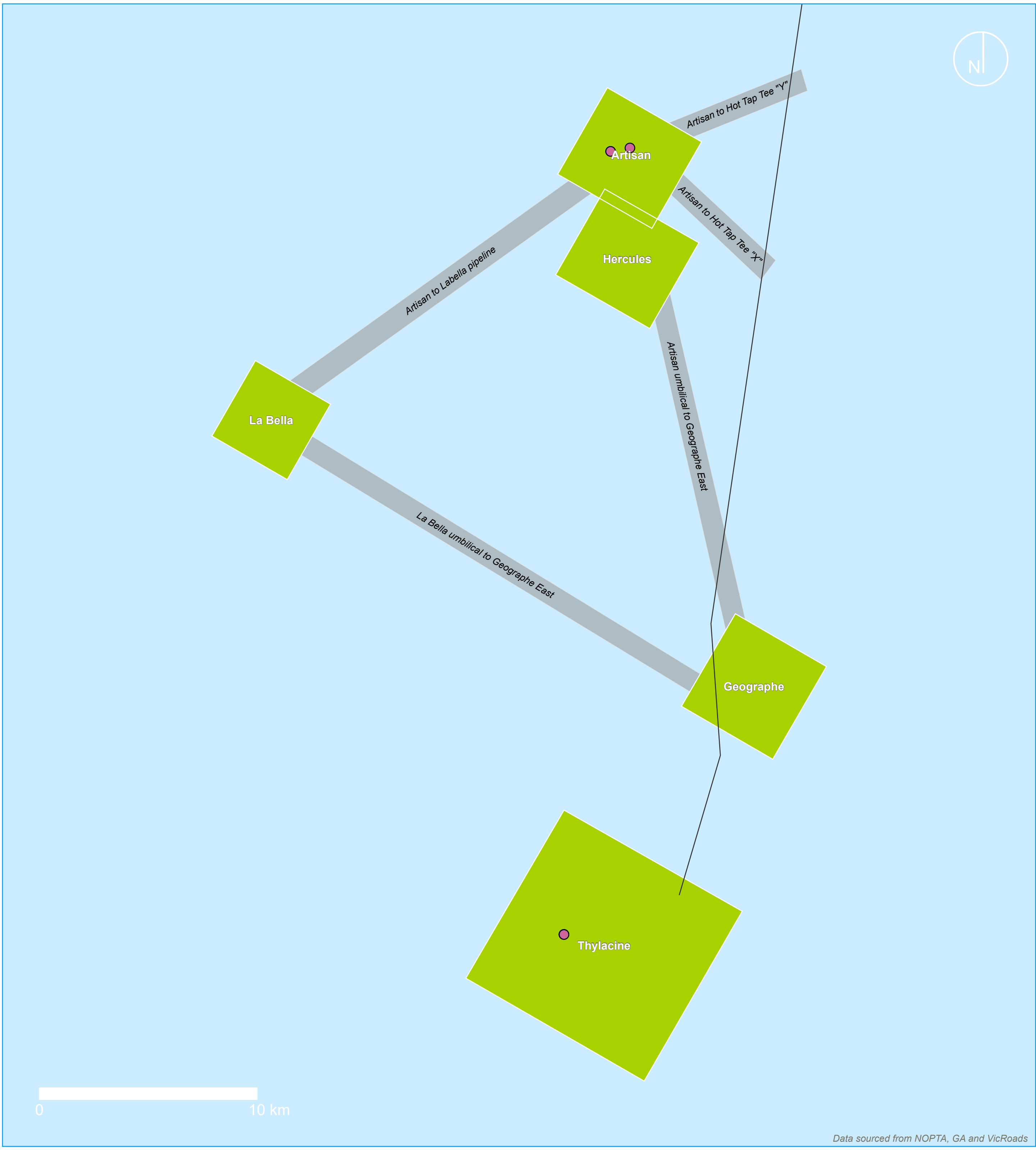
Prior to deployment, the jaws of both grabs were opened and fixed into position using a tension-based catch. The grab sampler was then winched over the stern of the vessel and lowered at a slow, steady rate to prevent the catch from being released too early. When the jaws made contact with the bottom, 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.



RAMBOLL AUSTRALIA - GIS MAP file : 318000803_GIS_P001_OtwayDevelopment | F003_SampleLocationsSedimentInfauna_V01 | 23/04/2020

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Legend

- Existing pipeline
- Well site survey area
- Site flowlines corridor
- Sediment/Infauna sample locations

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.

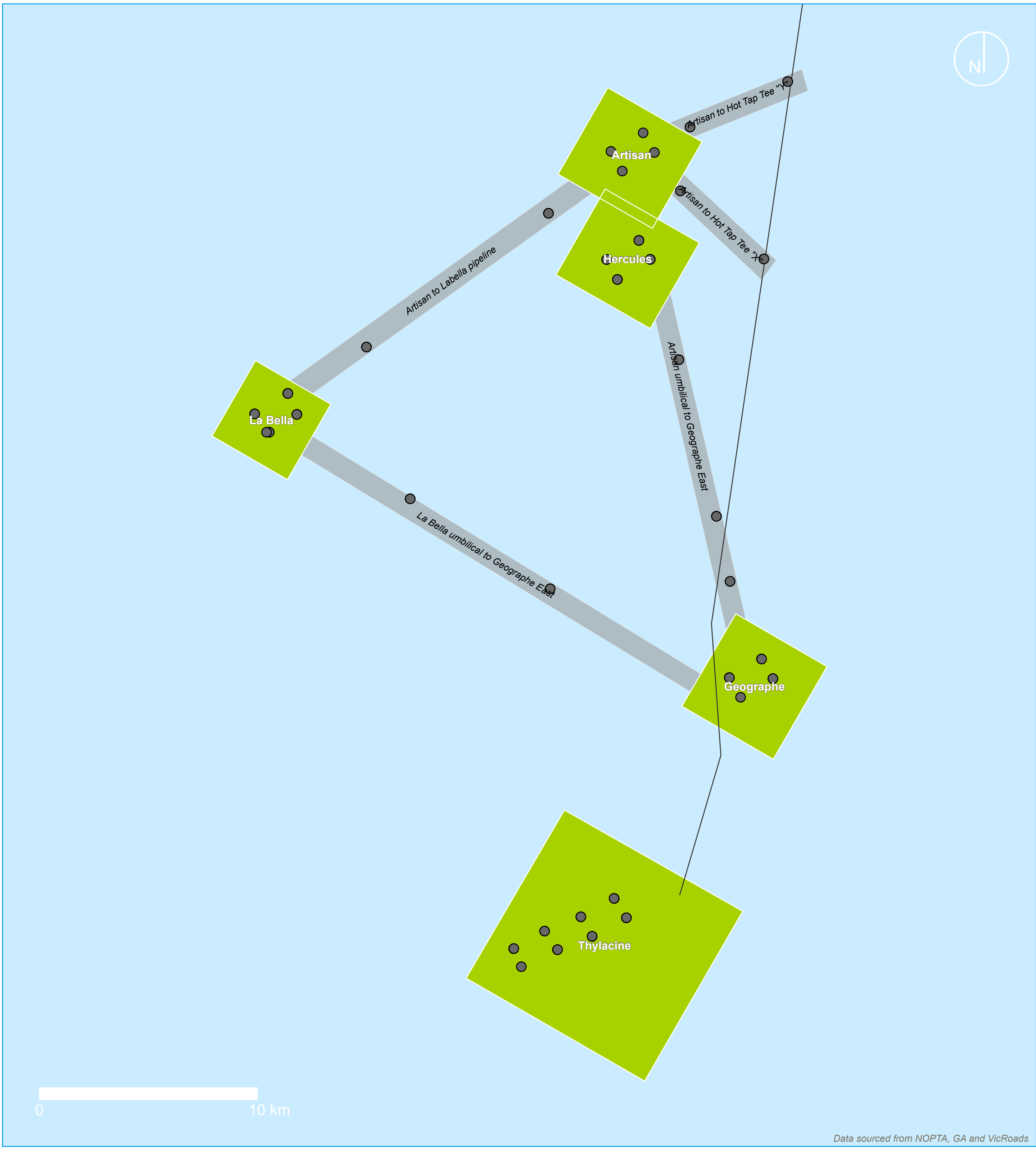
At each sampling site the camera was lowered and then to three locations approximately 1-2 m apart to obtain a collection of representative samples. At least five photographs were taken at each location to provide a selection of photographs for analysis. Drop camera sites are listed in Appendix 4. Drop 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.



RAMBOLL AUSTRALIA - GIS MAP file : 318000803_GIS_F001_OtwayDevelopment | F002_DropCameraLocations_V01 | 23/04/2020

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Legend

- Existing pipeline
- Well site survey area
- Site flowlines corridor
- Drop camera locations

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.

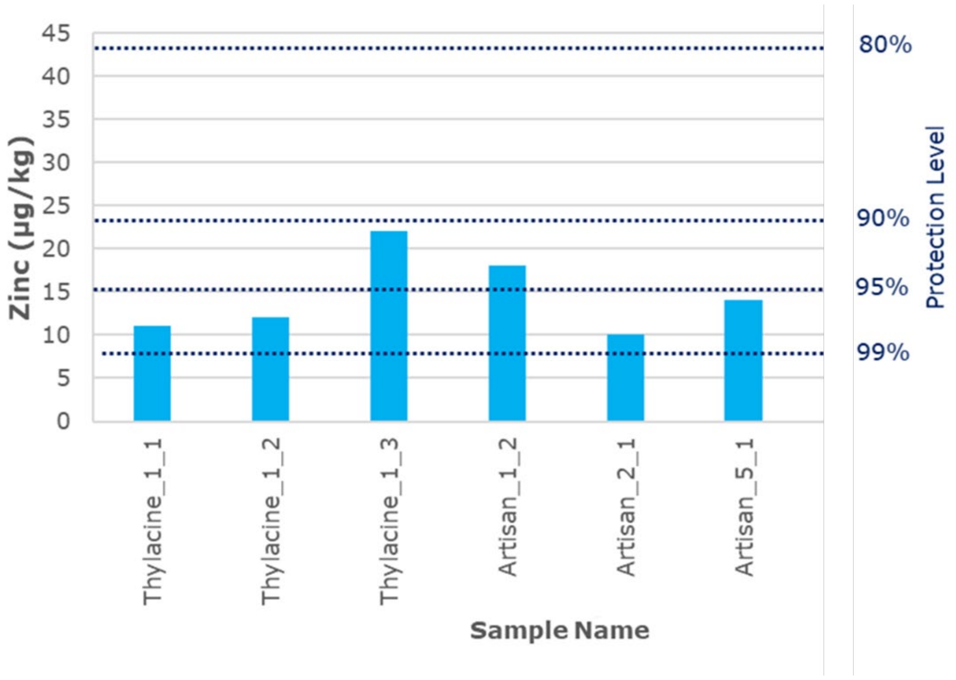

Figure 5 Concentration of Zn in water samples from Thylacine and Artisan survey areas.

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.

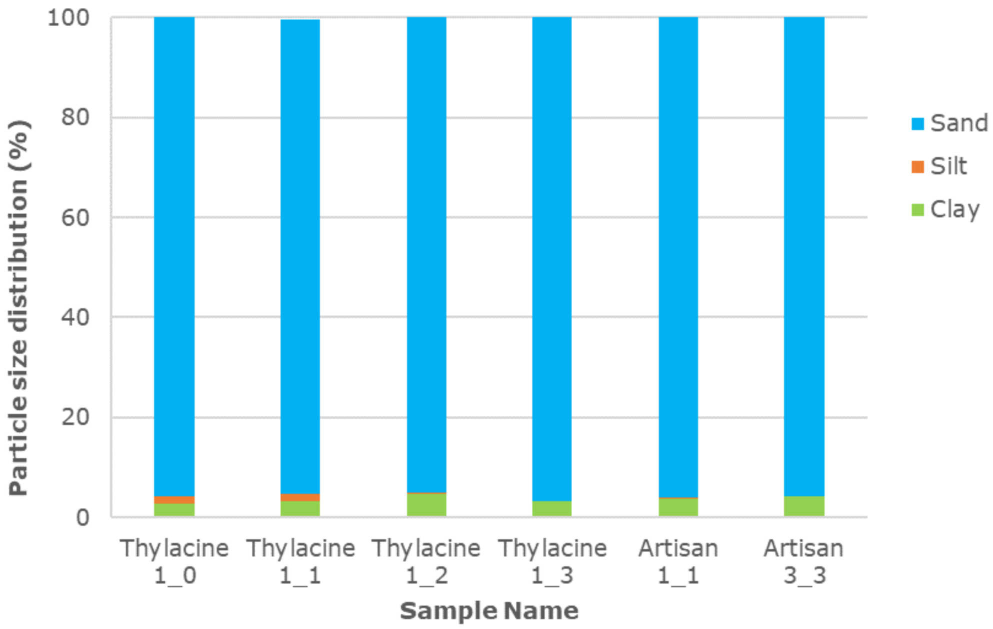

Figure 6 Particle size distribution (%) in sediment samples collected at Thylacine and Artisan survey areas.

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.

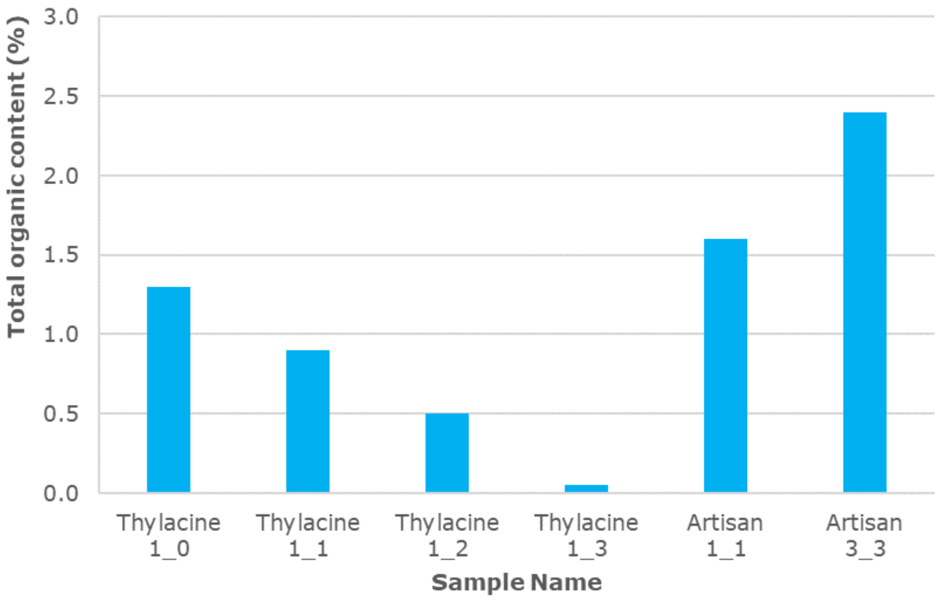

Figure 7 Total organic content (%) in sediment samples collected at Thylacine and Artisan survey areas.

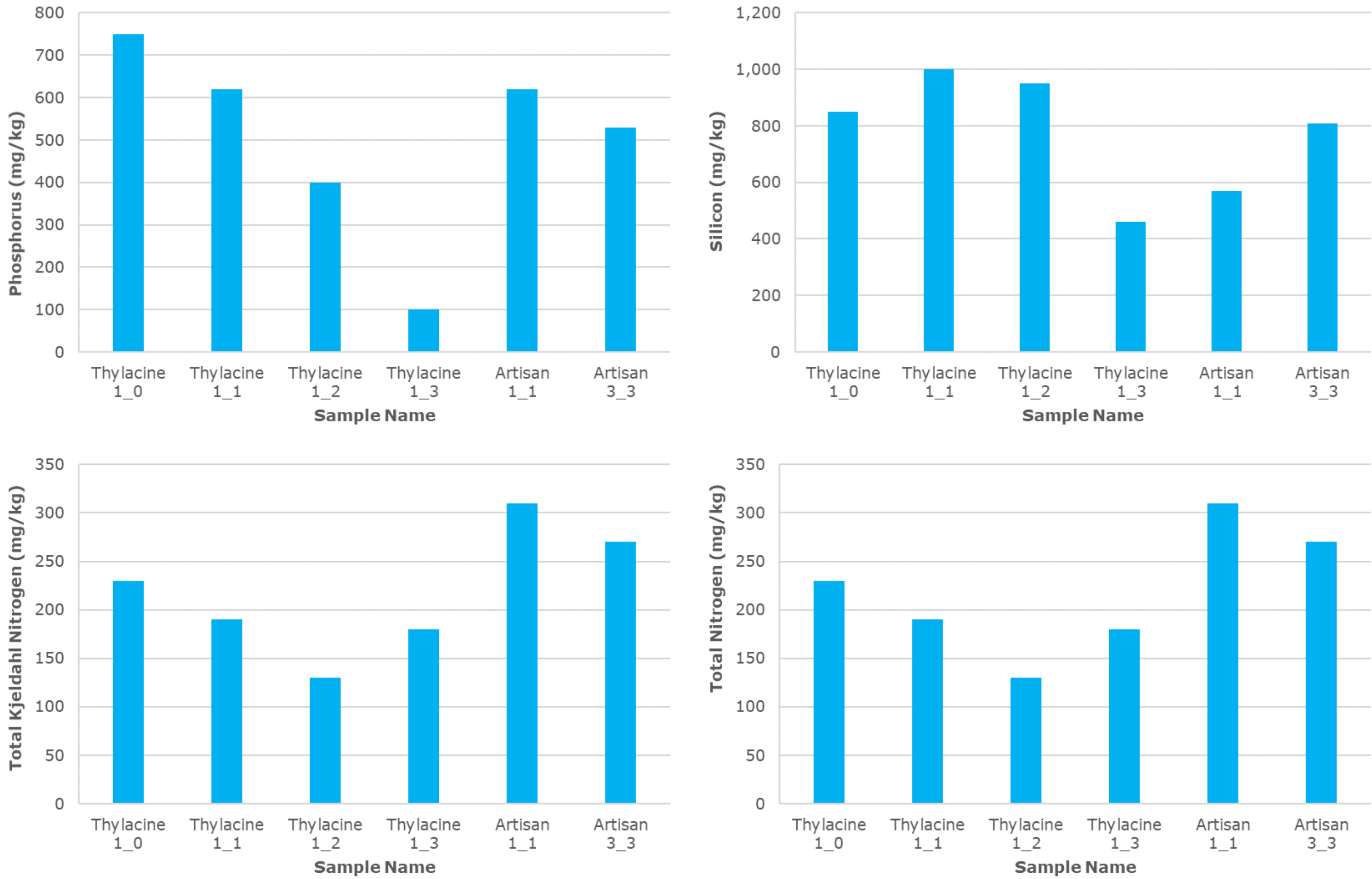

Figure 8 Nutrient concentrations (mg/kg) in sediment samples collected at Thylacine and Artisan survey areas, including phosphorus (top left), silicon (top right), total Kjeldahl nitrogen (bottom left) and total nitrogen (bottom right).

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).

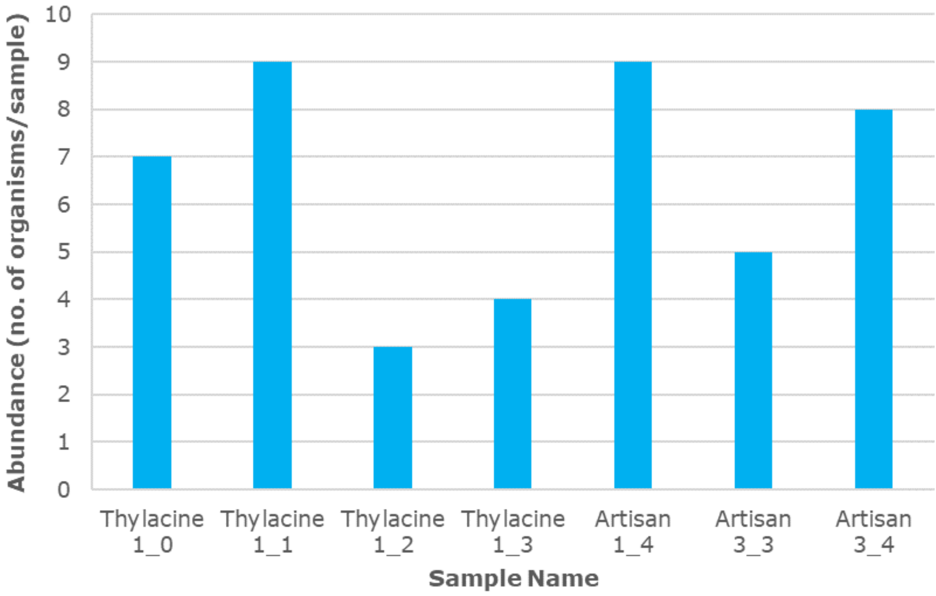

Figure 9 Abundance of benthic infauna in grab samples at Thylacine and Artisan survey areas.

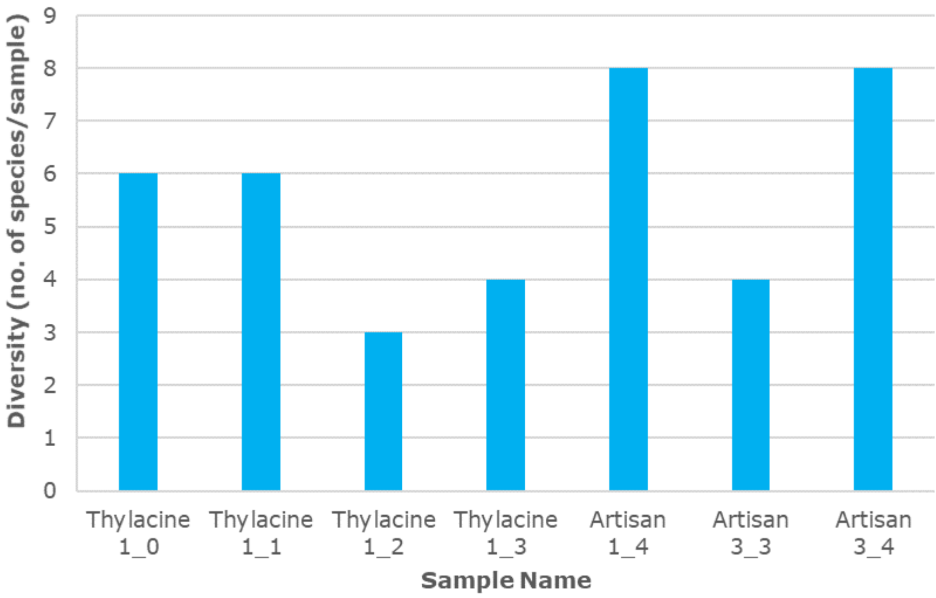

Figure 10 Diversity of benthic infauna in grab samples at Thylacine and Artisan survey areas.

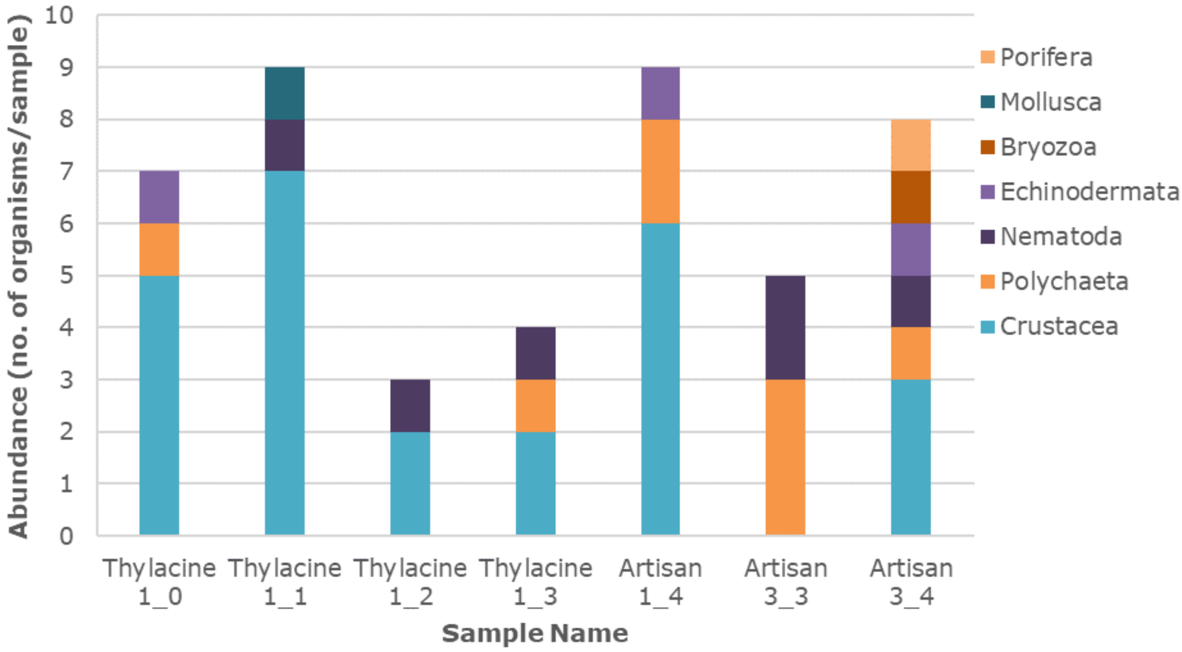

Figure 11 Abundance of benthic infauna by taxonomic group in grab samples at Thylacine and Artisan survey areas.

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.

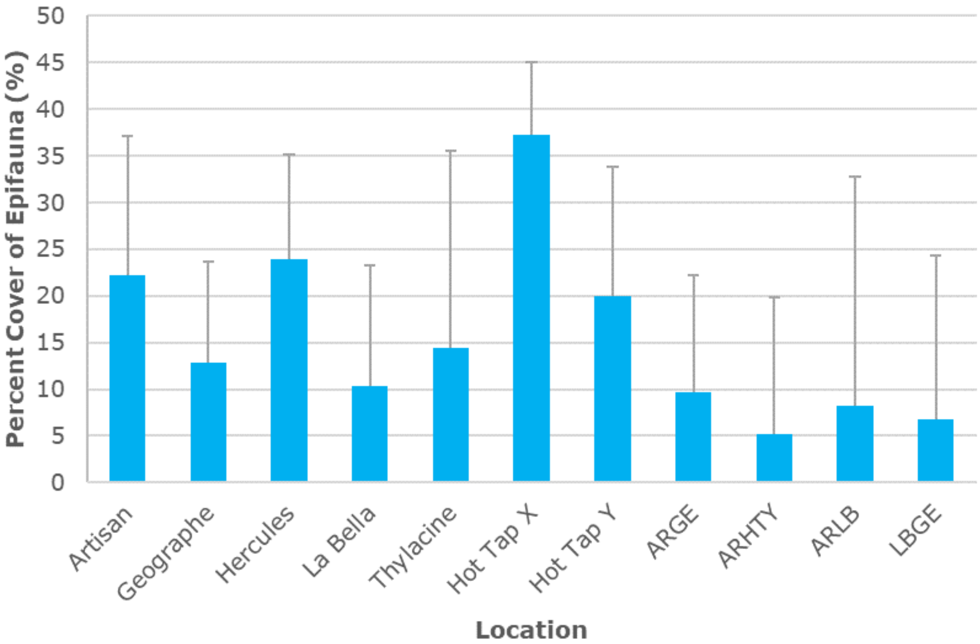

Figure 12 Percent cover of epifauna at drop camera location in Otway Basin.

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.

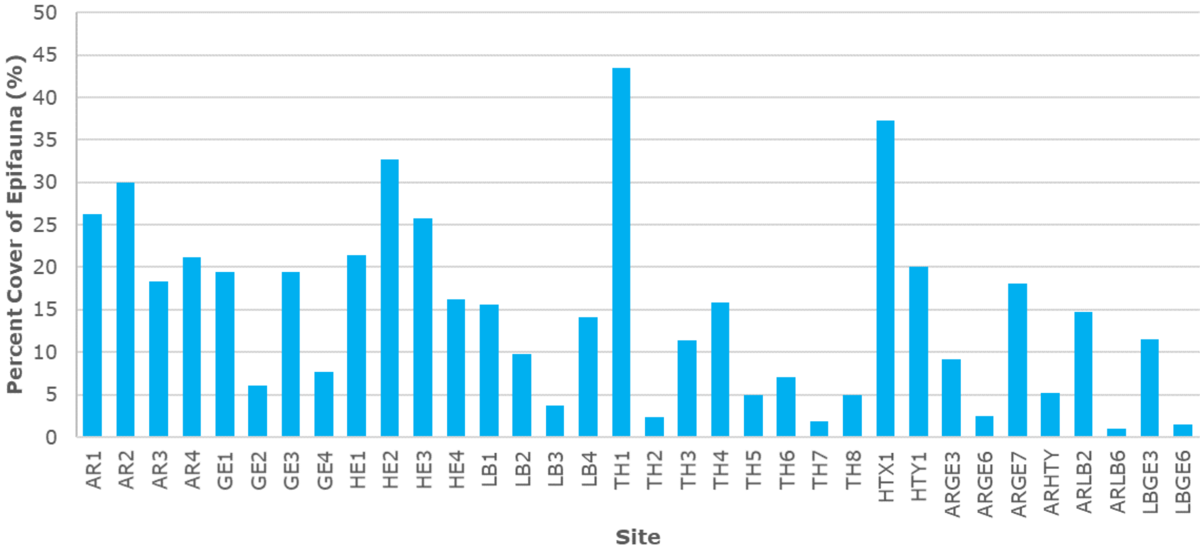

Figure 13 Percent cover of epifauna at drop camera sites in Otway Basin.

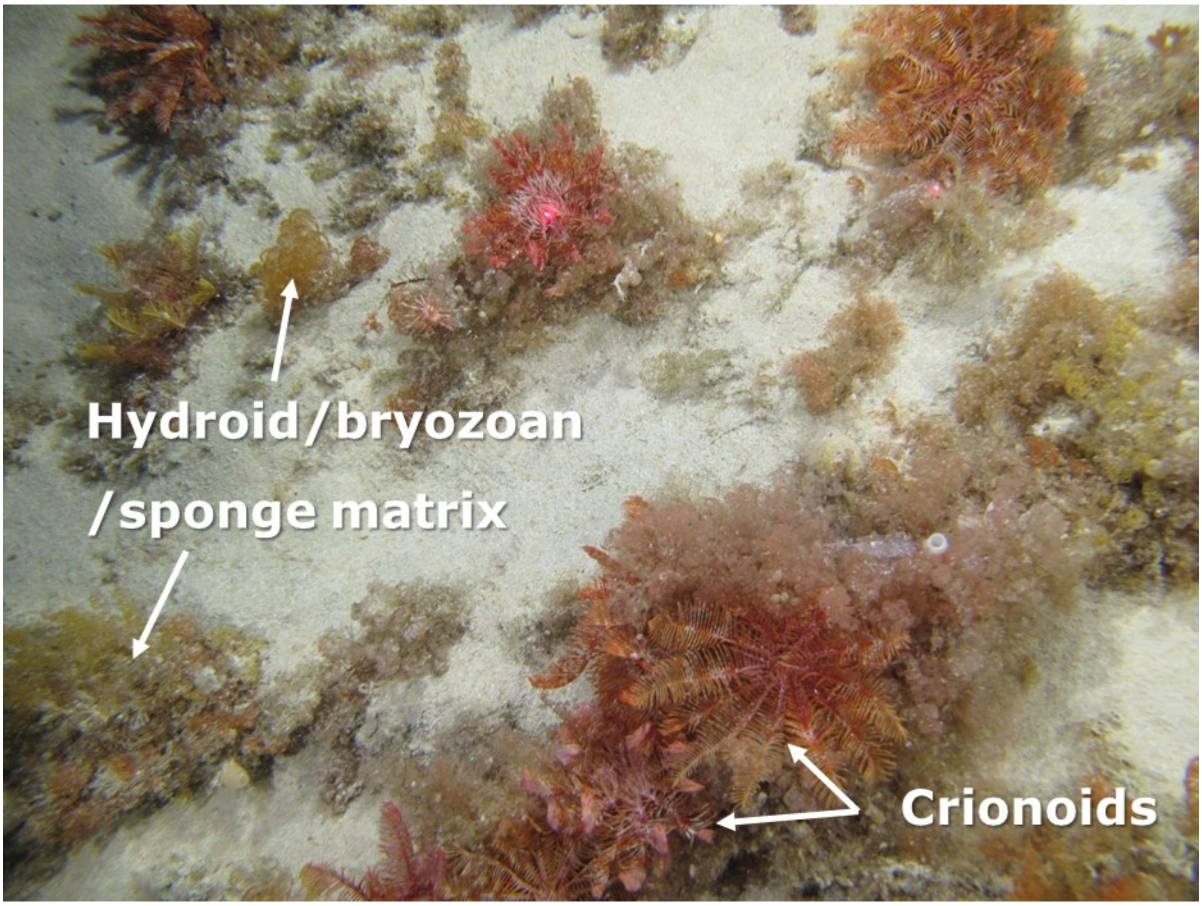

Figure 14 Example of the typical seabed epifauna with high percent cover at Thylacine 1 (TH1).

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/spon ges	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

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.

Ramboll Australia Pty Ltd
Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

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

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Environment Testing

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	**Order No.:**		**Received:**	Dec 4, 2019 10:56 AM
Address:	Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	**Report #:**	690395	**Due:**	Dec 11, 2019
		Phone:	08 9225 5199	**Priority:**	5 Day
		Fax:		**Contact Name:**	ALL INVOICES
Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

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

eurofins Environment Testing

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Company Name:	Ramboll Australia Pty Ltd	**Order No.:**		**Received:**	Dec 4, 2019 10:56 AM
Address:	Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	**Report #:**	690395	**Due:**	Dec 11, 2019
		Phone:	08 9225 5199	**Priority:**	5 Day
		Fax:		**Contact Name:**	ALL INVOICES
Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

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.

Environment Testing

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	

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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.

Certificate of Analysis

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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.

Ramboll Australia Pty Ltd
Suite 3, Level 2, 200 Adelaide Terrace
East Perth
WA 6004

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:

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Site # 1254 & 14271

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NATA # 1261 Site # 18217

Brisbane
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NATA # 1261 Site # 20794

Perth
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Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**	
Address:	Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	**Report #:**	690387
		Phone:	08 9225 5199
		Fax:	
Project Name:	OTWAY OFFSHORE EBS	**Received:**	Dec 4, 2019 1:54 PM
Project ID:	318000803	**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																					
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

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Site # 23736

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Address:	Suite 3, Level 2, 200 Adelaide Terrace	**Report #:**	690387	**Due:**	Dec 5, 2019
	East Perth	**Phone:**	08 9225 5199	**Priority:**	7 Day
	WA 6004	**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

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NATA # 1261
Site # 23736

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

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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											

eurofins Environment Testing

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Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**		**Received:**	Dec 4, 2019 1:54 PM
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		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																					
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	**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.

Environment Testing

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

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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 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

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Environment Testing

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

Eurofins Environment Testing

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	**Report #:**	690387	**Due:**	Dec 5, 2019
	East Perth	**Phone:**	08 9225 5199	**Priority:**	7 Day
	WA 6004	**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

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		Fax:	
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Project ID:	318000803		

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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

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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

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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											

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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	**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	Lab Sample ID	QA Source	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.

Certificate of Analysis

Environment Testing

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

eurofins

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

Environment Testing

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	**Order No.:**		**Received:**	Feb 5, 2020 3:36 AM
Address:	Suite 3, Level 2, 200 Adelaide Terrace East Perth WA 6004	**Report #:**	700321	**Due:**	Feb 12, 2020
		Phone:	08 9225 5199	**Priority:**	5 Day
		Fax:		**Contact Name:**	Serena Orr
Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

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	**Order No.:**		**Received:**	Feb 5, 2020 3:36 AM
Address:	Suite 3, Level 2, 200 Adelaide Terrace	**Report #:**	700321	**Due:**	Feb 12, 2020
	East Perth	**Phone:**	08 9225 5199	**Priority:**	5 Day
	WA 6004	**Fax:**		**Contact Name:**	Serena Orr
Project Name:	OTWAY OFFSHORE EBS				
Project ID:	318000803				

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

Environment Testing

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.

Environment Testing

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	Lab Sample ID	QA Source	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					

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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	

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Environment Testing

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

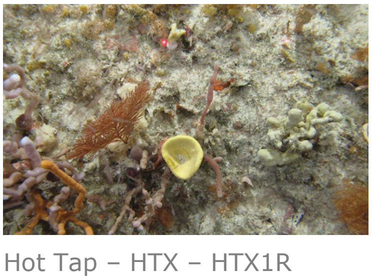

La Bella – LB4 Extra DC

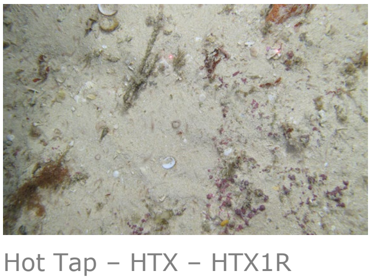

Thylacine – TH2


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

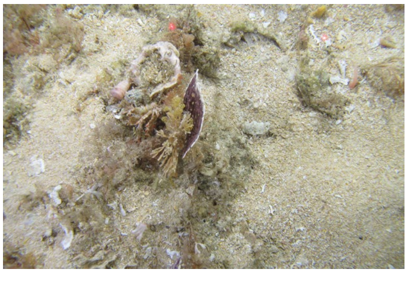
Routes – ARHTX – ARHTX1R

Routes – ARHTY – ARHTY1R

Routes – ARHTY – ARHTY1R

Routes – ARLB – ARLB2R

Routes – ARLB – ARLB6R



Routes – LBGE – LBGE3R

Routes – LBGE – LBGE6R

Appendix F Acoustic Modelling Report

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TECHNICAL ADDENDUM

DATE: 23 July 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.

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	Thylacine A	Platform Operations + OSV resupply	7.28	6.56
5		Platform Operations + OSV Standby	0.45	0.43
7	Thylacine North-1	Pipelay Vessel stationary (June), operating at 20% MCR	2.71	2.57
8		Pipelay Vessel stationary (November), operating at 20% MCR	2.70	2.55
11	Artisan-1	Pipelay Vessel stationary (June), operating at 20% MCR	2.27	2.09
12		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
19	Thylacine North-1 + Thylacine A	MODU Drilling + Platform + OSV resupply	7.90	6.65
21		MODU Drilling + Platform + Skid installation	4.85	4.29

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	0.65	1.10

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% 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.

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	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

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

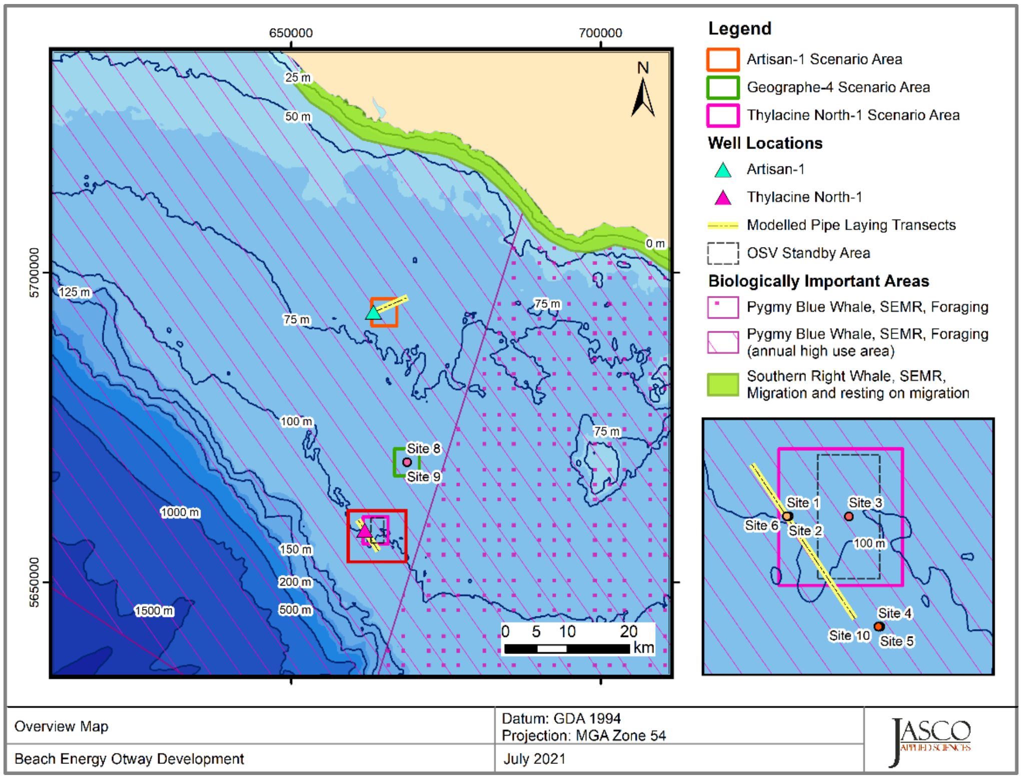


Figure 1. Overview of the modelled area (focus on Thylacine North-1 Scenario Area) and local features within the South East Marine Region (SEMR).

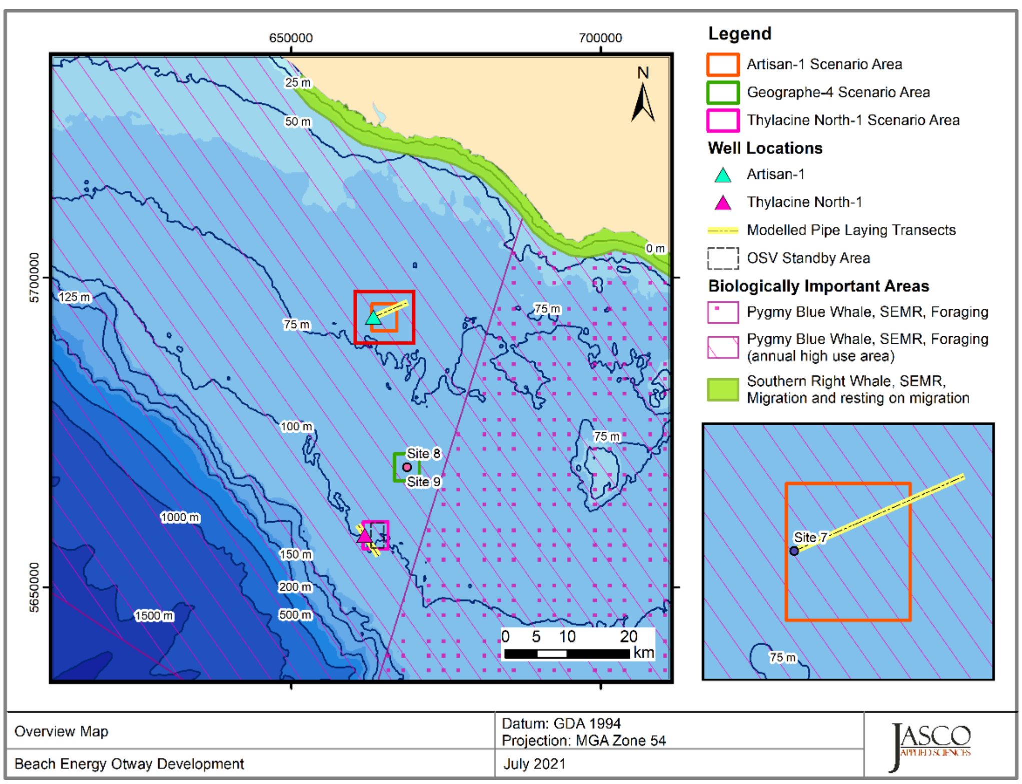


Figure 2. Overview of the modelled area (focus on Artisan-1 Scenario Area) and local features within the South East Marine Region (SEMR).

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 a 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

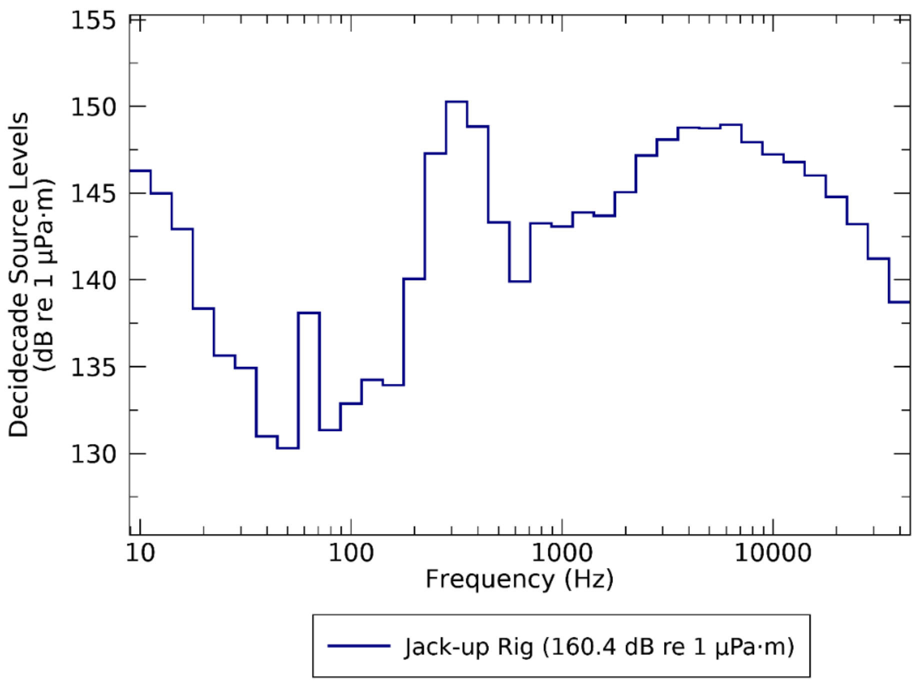


Figure 3. Energy source level (ESL) spectra (in decidecade frequency-band) for the Jack-up Rig considered as a proxy source for the Thylacine WHP.

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 9–14 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
110	3.90	3.53	21.1	17.6	1.03	0.97	0.57	0.54	21.1	17.8	4.96	4.45

[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, Thylacine				PLV stationary, 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
110	21.2	17.6	1.02	0.98	8.29	6.72	8.29	6.55	4.95	4.67	4.91	4.65

[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, at Thylacine and ROV Operations at Geographe-4				PLV stationary, at Artisan and ROV Operations at Geographe-4				MODU Drilling, Platform and OSV resupply		MODU Drilling, Platform and Skid Installation	
	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
110	11.3	8.64	11.3	8.70	7.14	6.14	7.11	6.01	21.2	17.7	9.42	7.80

[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. 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

Table 9. *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 µPa²·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 10. *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 11. *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, at Thylacine				PLV laying pipe, 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 12. *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, at Artisan				PLV laying pipe, 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 13. *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 µPa²·s)†	PLV stationary, at Thylacine and ROV Operations at Geographe-4				PLV stationary, 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 14. *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 (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

4.2. Sound Field Maps

4.2.1. SPL Maps

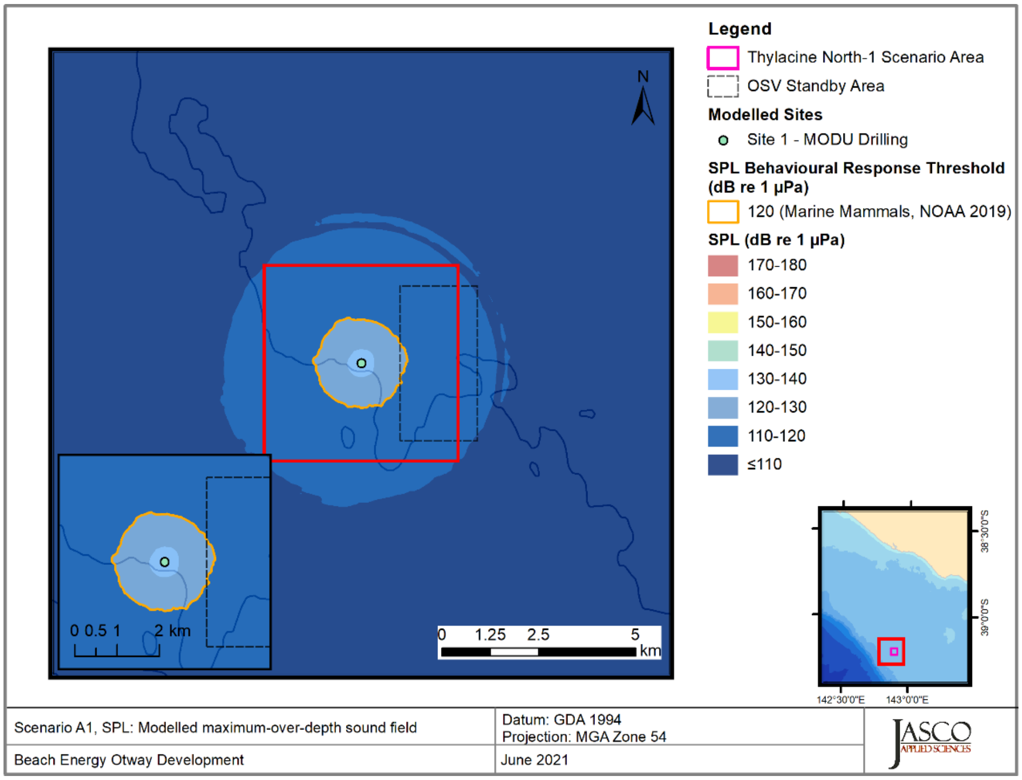


Figure 4. *Thylacine North-1, MODU Drilling (Scenario A1) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

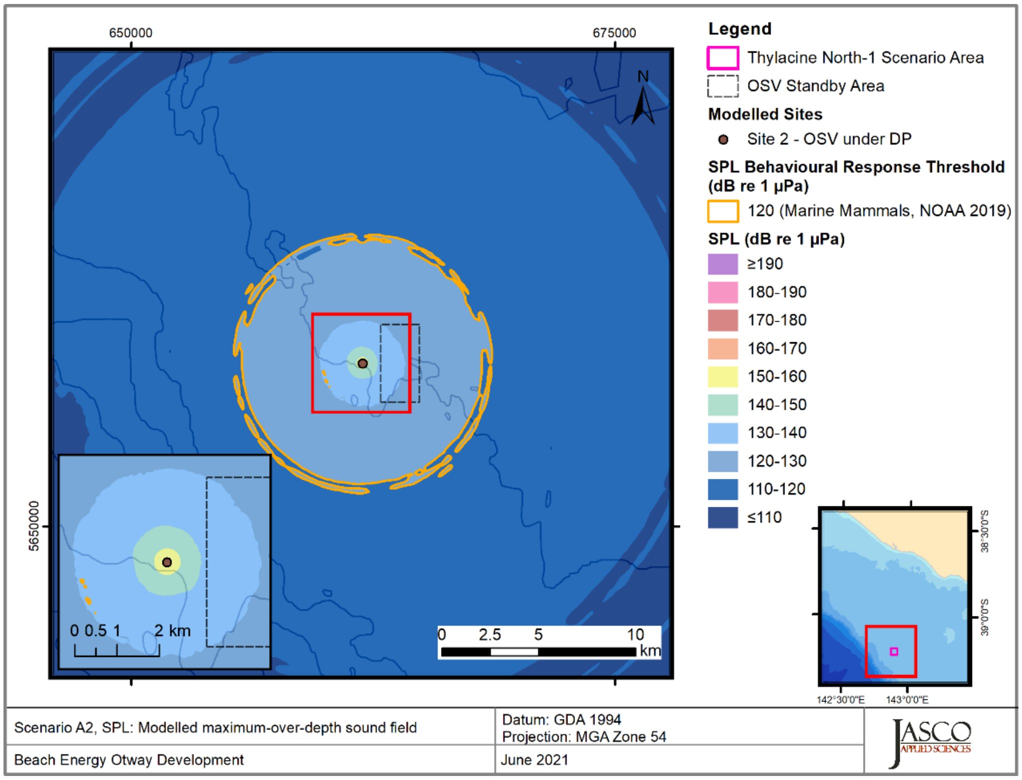


Figure 5. *Thylacine North-1, OSV on DP (Scenario A2) :* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

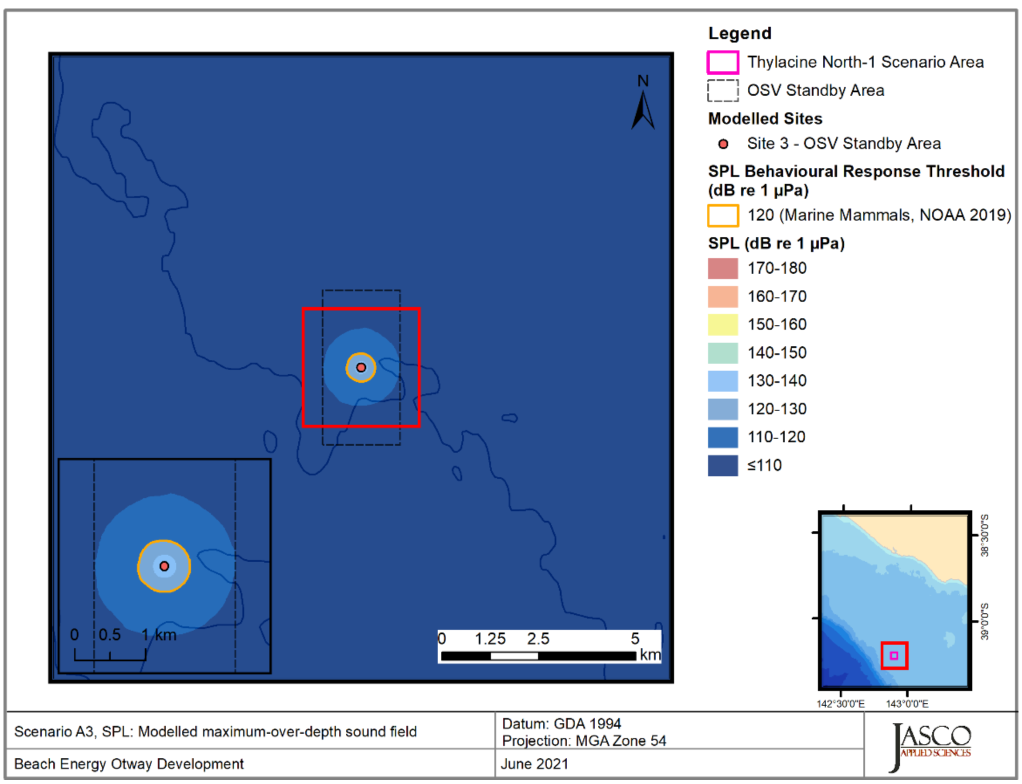


Figure 6. *Thylacine North-1, OSV Standby (Scenario A3) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

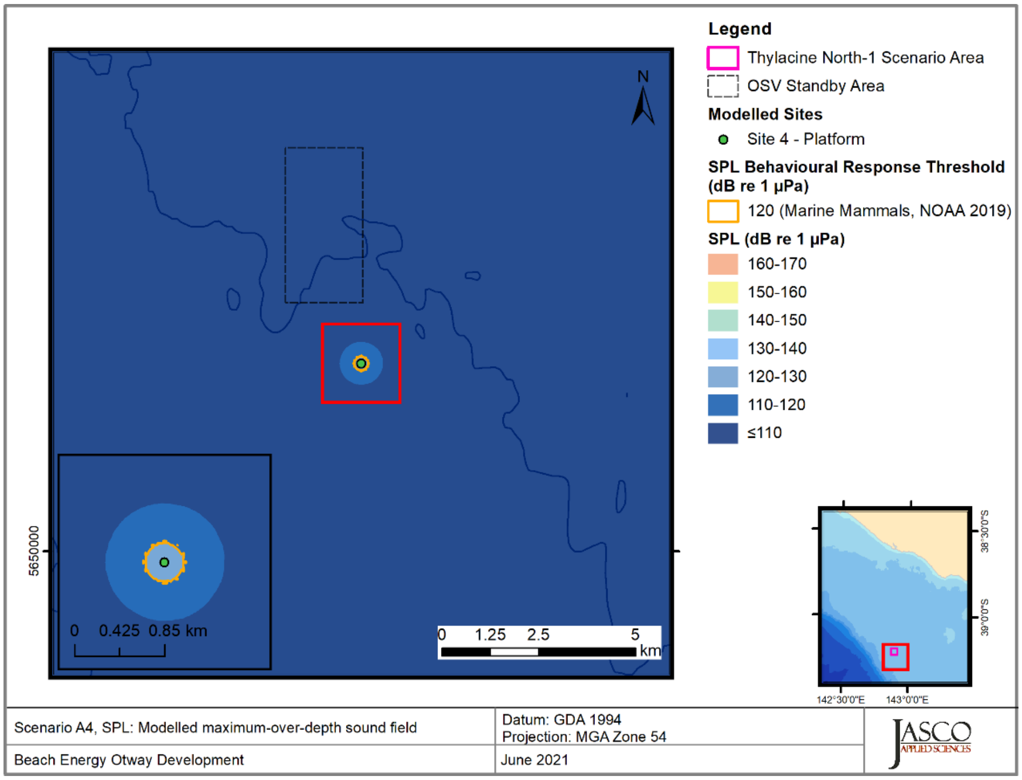


Figure 7. *Thylacine A, Platform Operations (Scenario A4) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

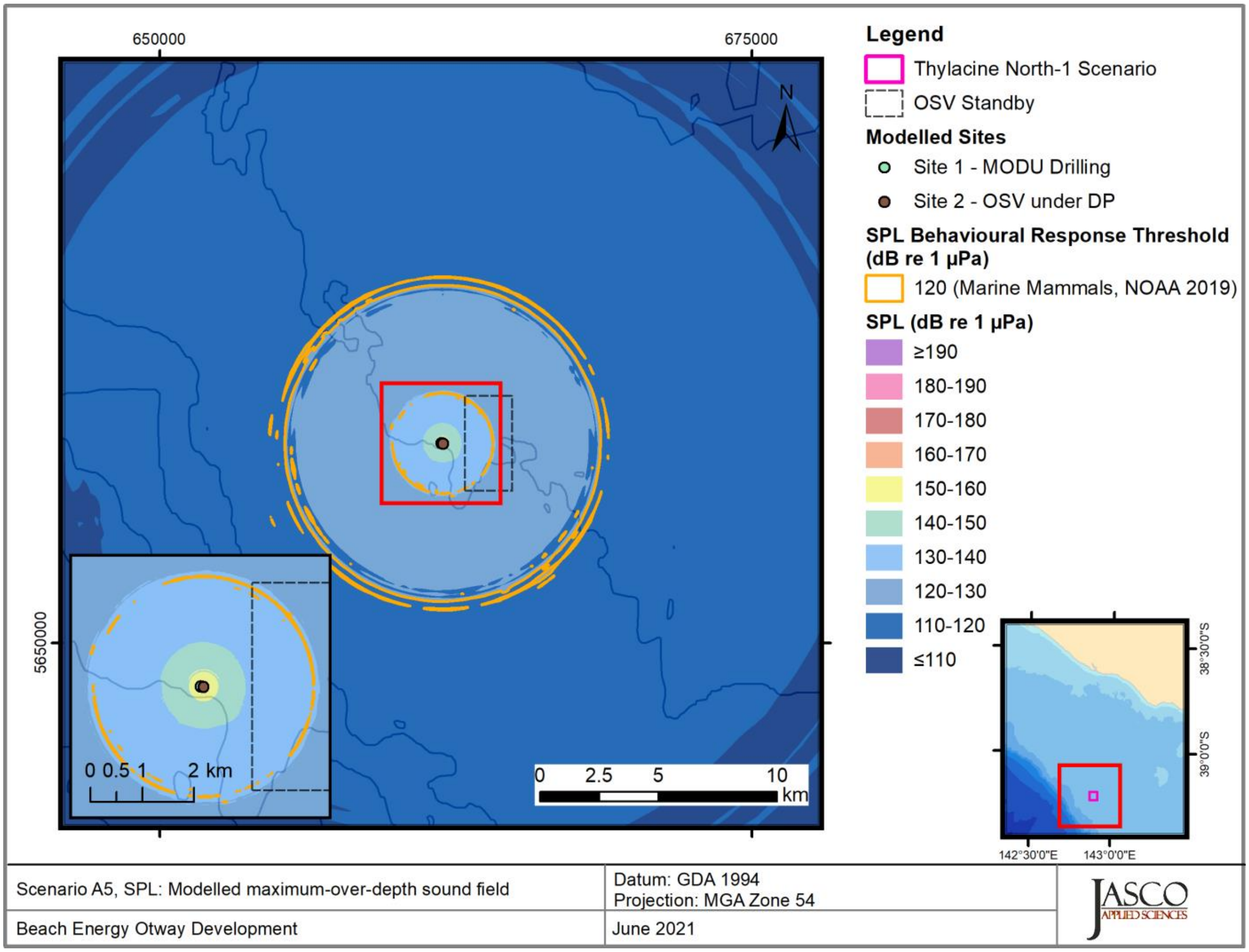


Figure 8. *Thylacine North-1, MODU Drilling and OSV Resupply (Scenario A5) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

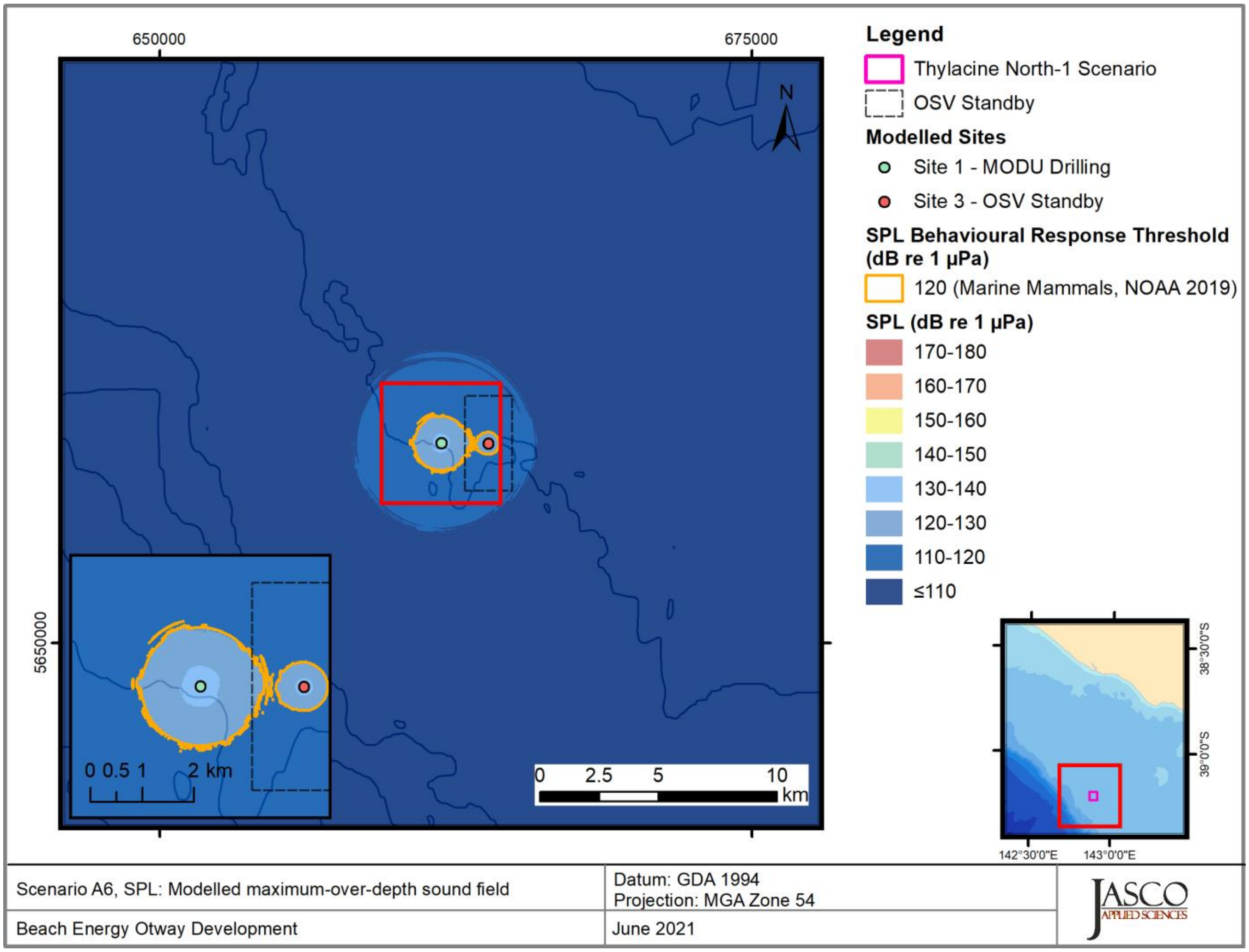


Figure 9. *Thylacine North-1, MODU Drilling and OSV Standby (Scenario A7) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

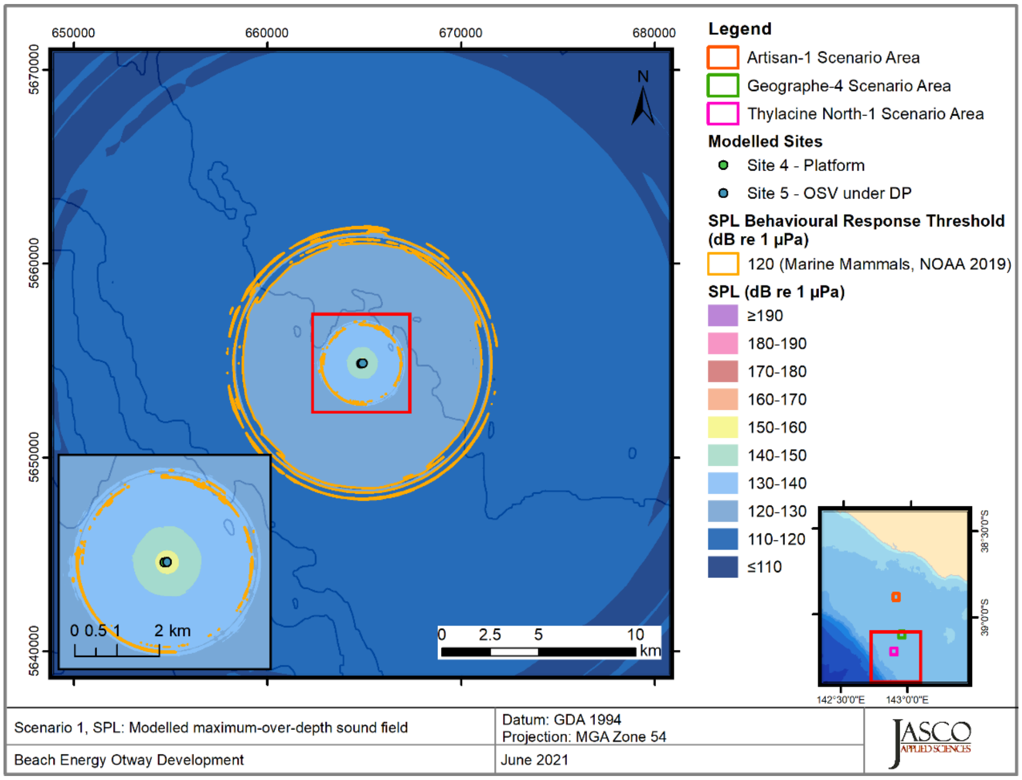


Figure 10. *Thylacine A Platform, Platform Resupply (Scenario1) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

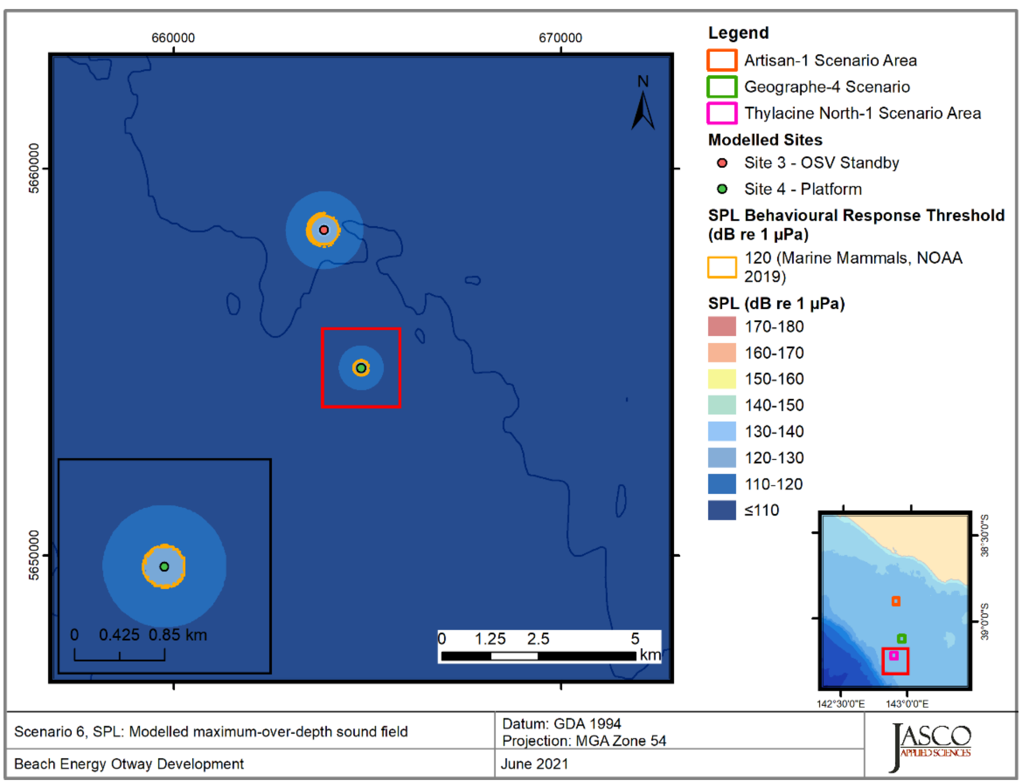


Figure 11. *Thylacine A Platform, OSV standby (Scenario 6) SPL :* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

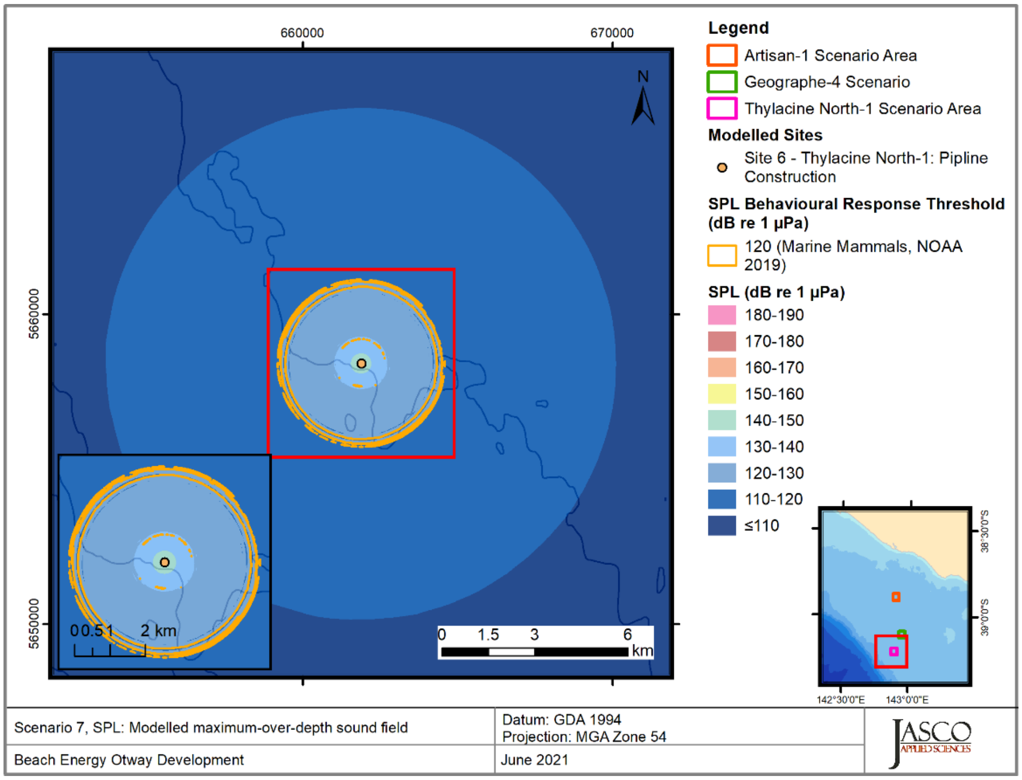


Figure 12. *Thylacine North-1, PLV stationary -June (Scenario 7) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

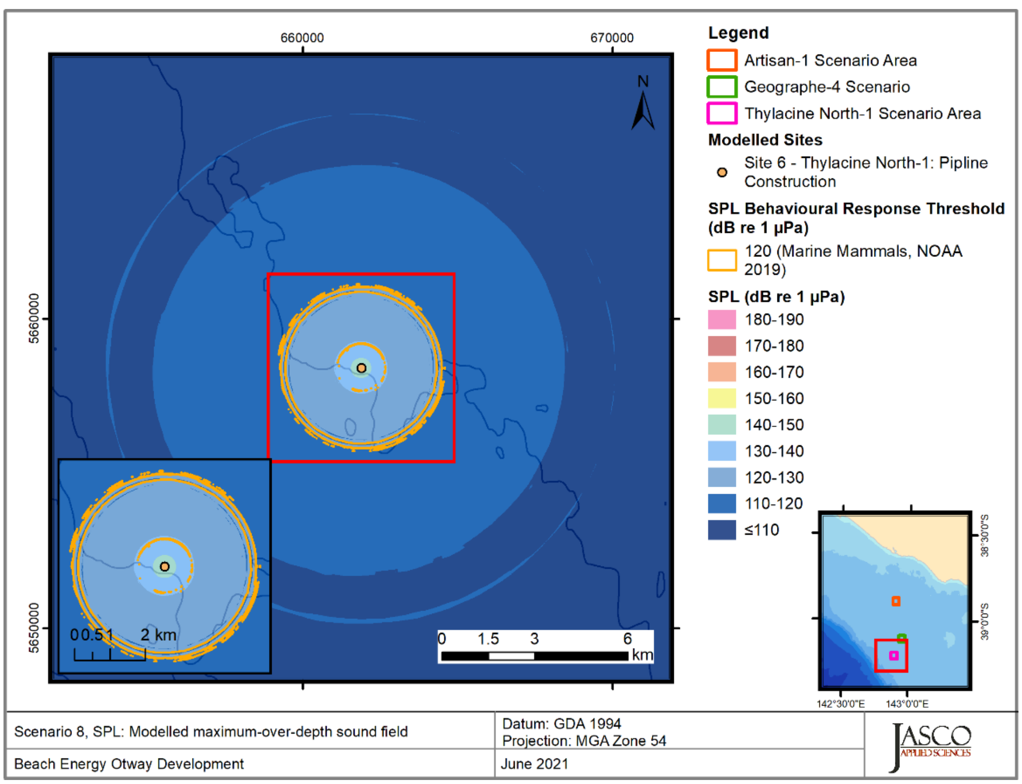


Figure 13. *Thylacine North-1, PLV stationary -November (Scenario 8) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

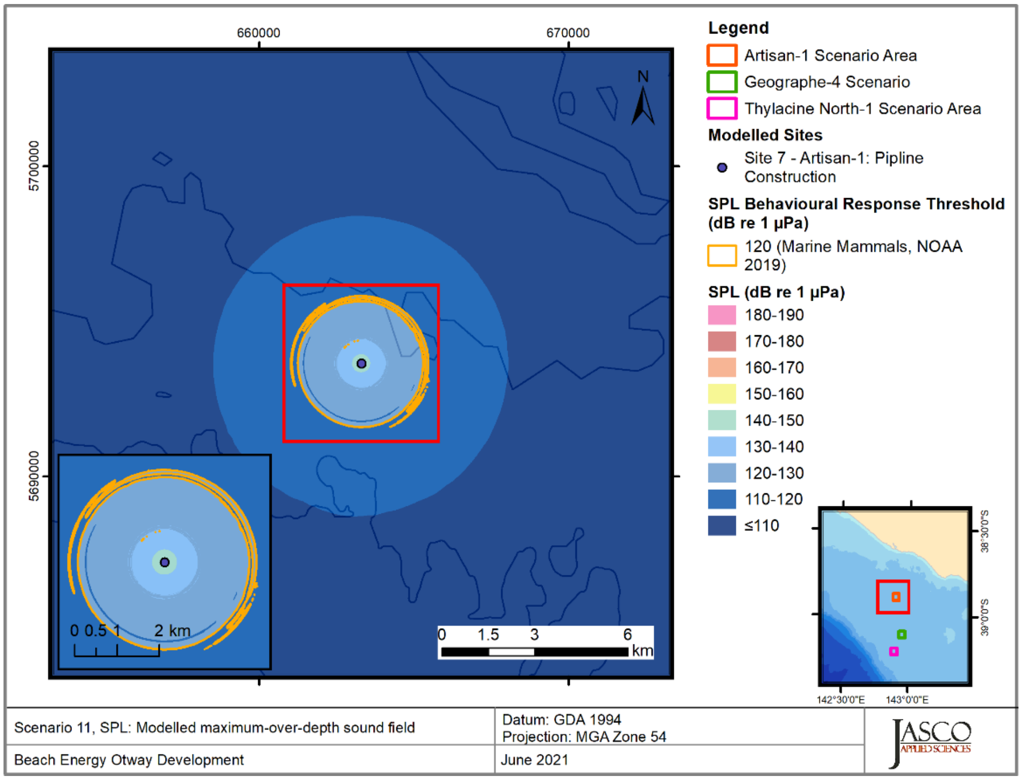


Figure 14. *Artisan-1, PLV stationary -June (Scenario 11) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

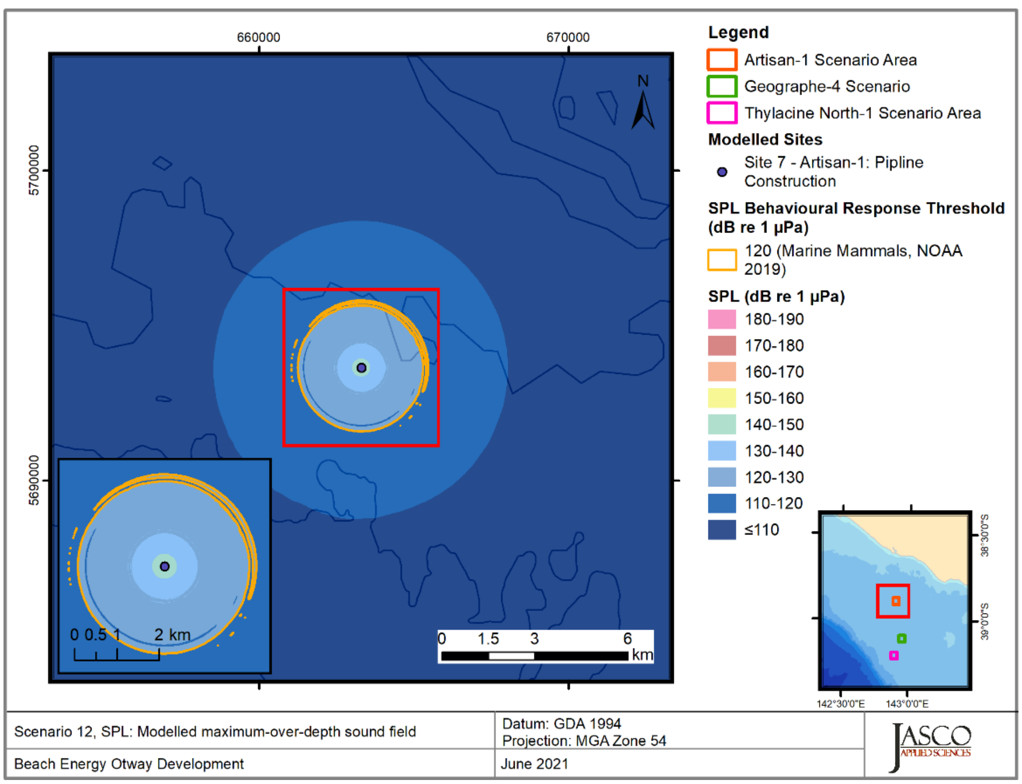


Figure 15. *Artisan-1, PLV stationary -November (Scenario 12) SPL:* S Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

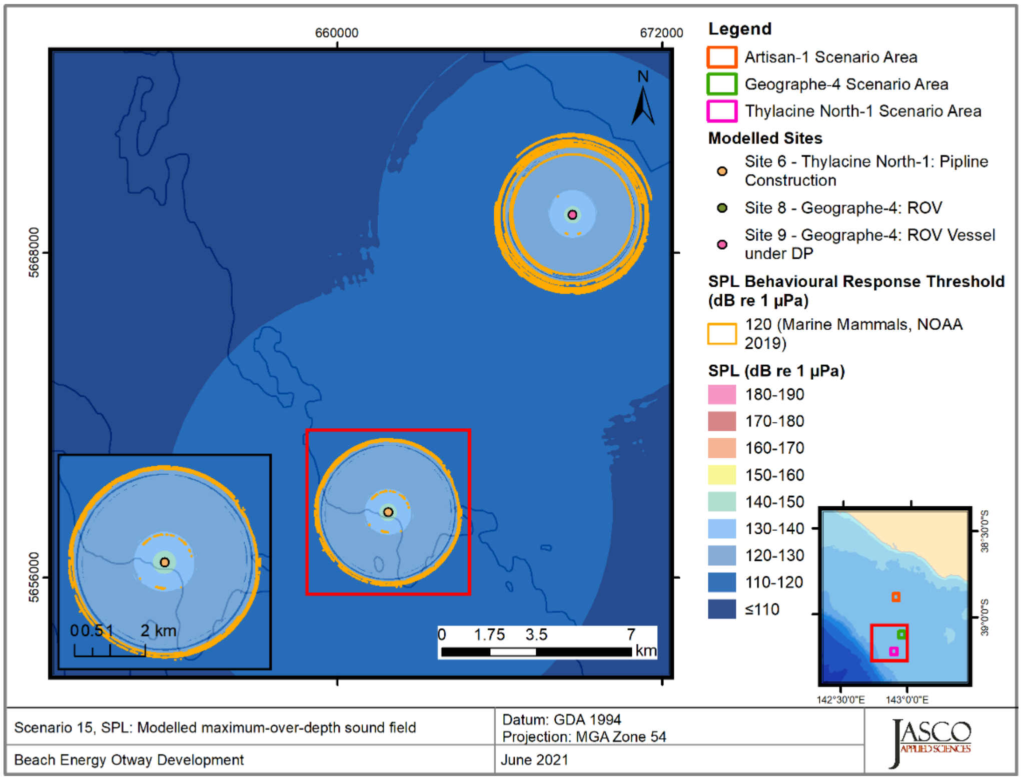


Figure 16. *Thylacine North-1, PLV stationary and ROV operations at Geographe-4 - June (Scenario 15) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

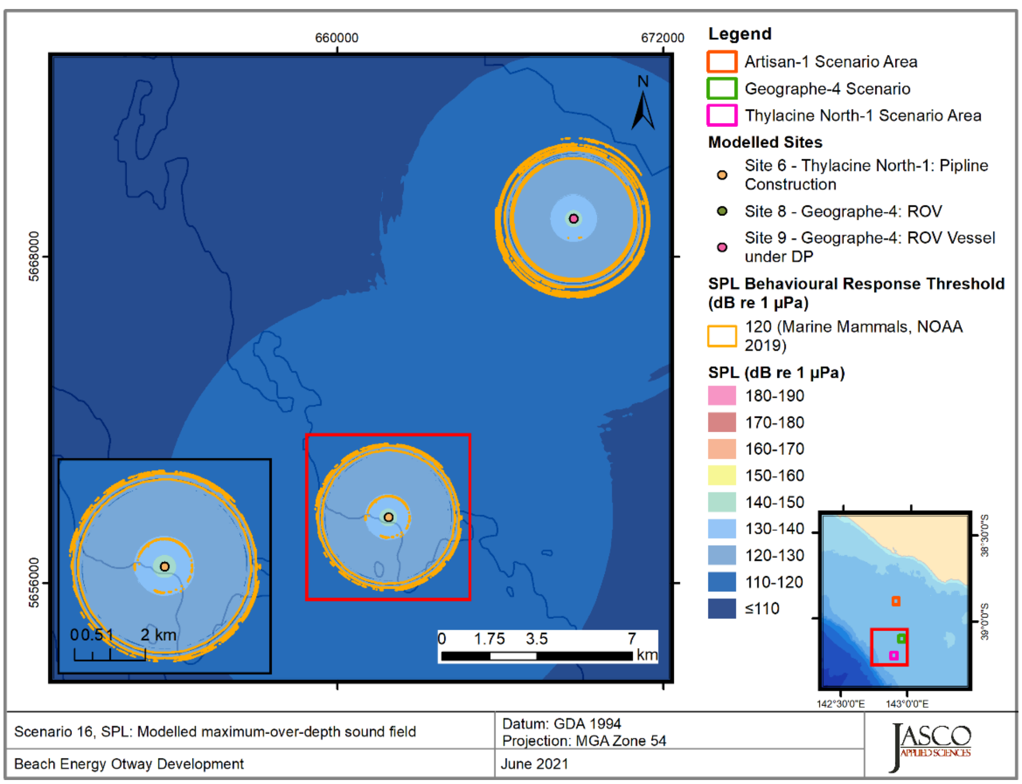


Figure 17. *Thylacine North-1, PLV stationary and ROV operations at Geographe-4 – November (Scenario 16) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

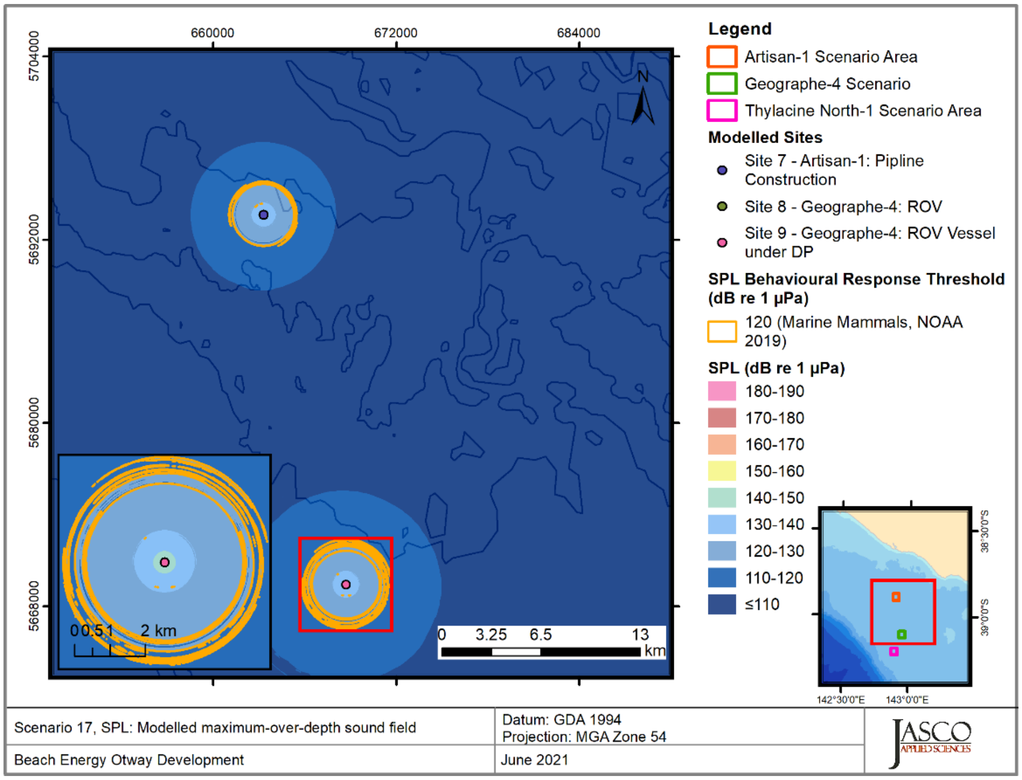


Figure 18. *Artisan-1, PLV stationary and ROV Operations at Geographe-4 – June (Scenario 17) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

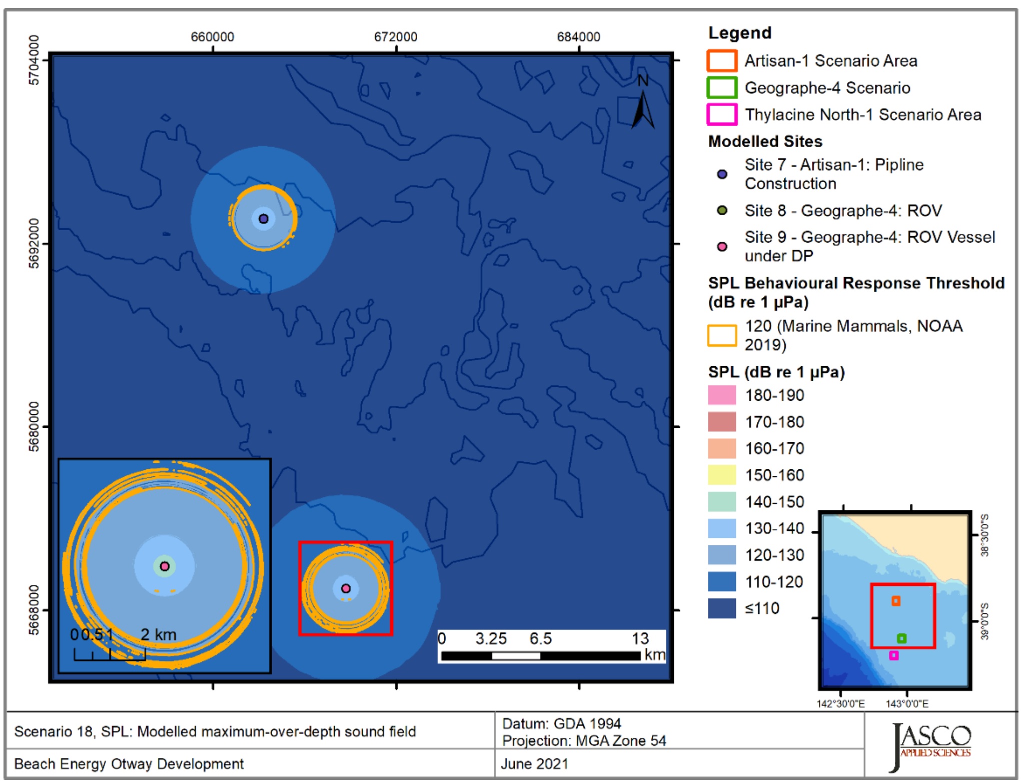


Figure 19. *Artisan-1, PLV stationary and ROV Operations at Geographe-4 – November (Scenario 18) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

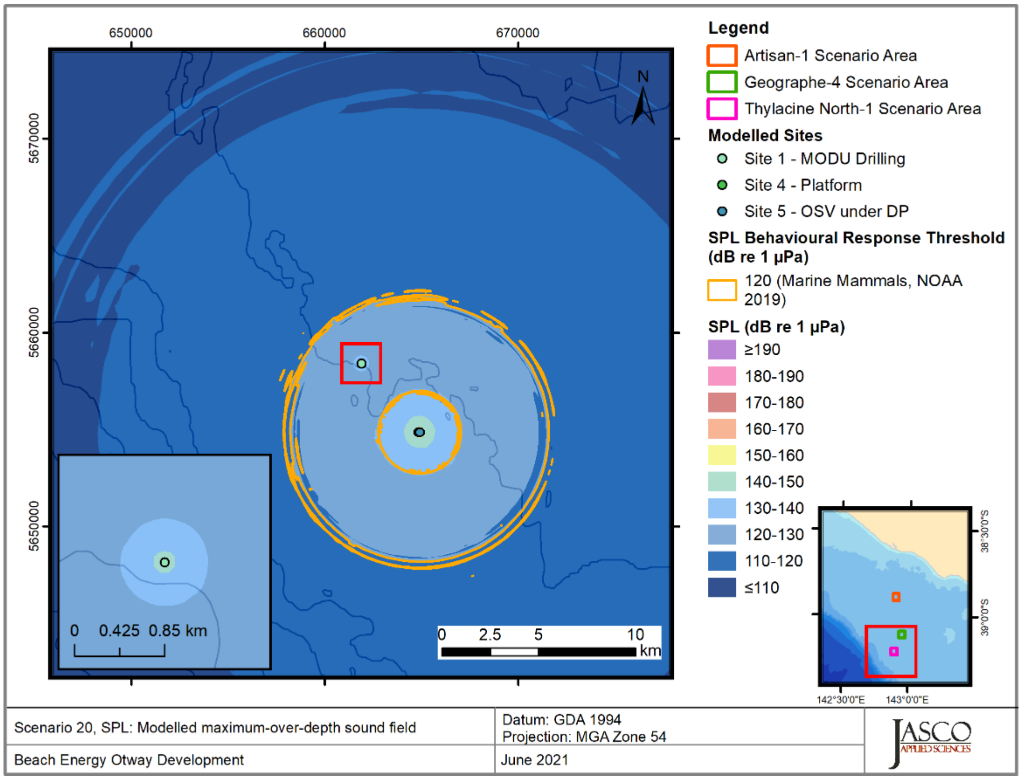


Figure 20. *Thylacine A Platform, Platform Resupply and MODU Drilling (Scenario 20) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

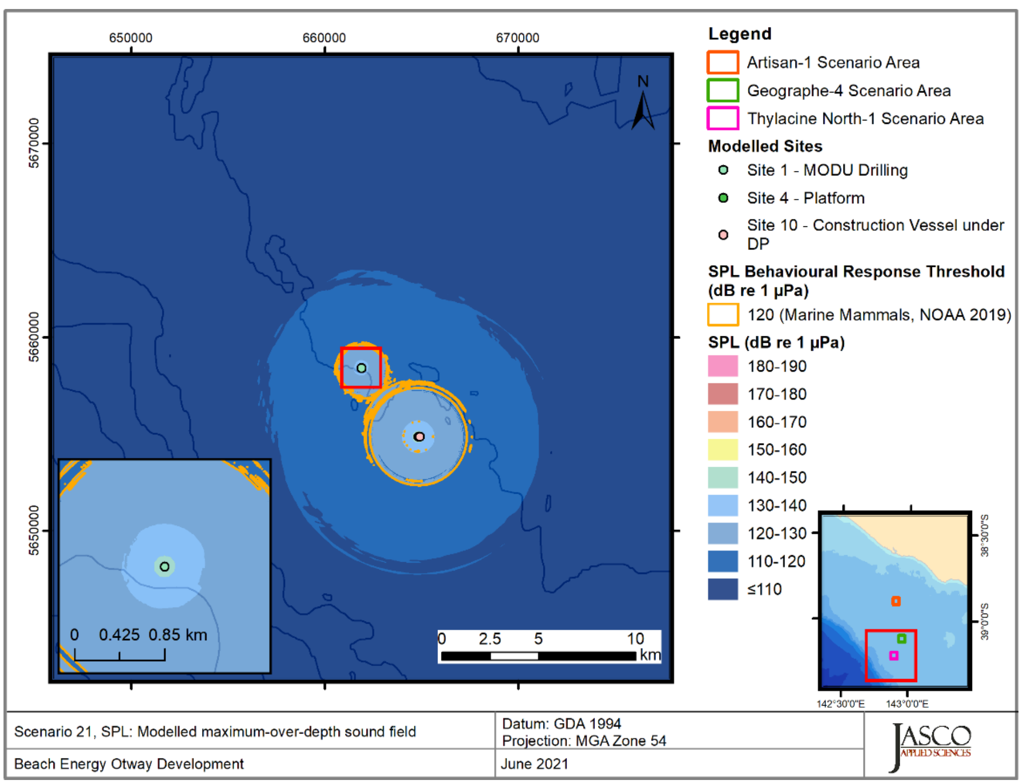


Figure 21. *Thylacine A Platform, Platform Resupply and skid installation (Scenario 20) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

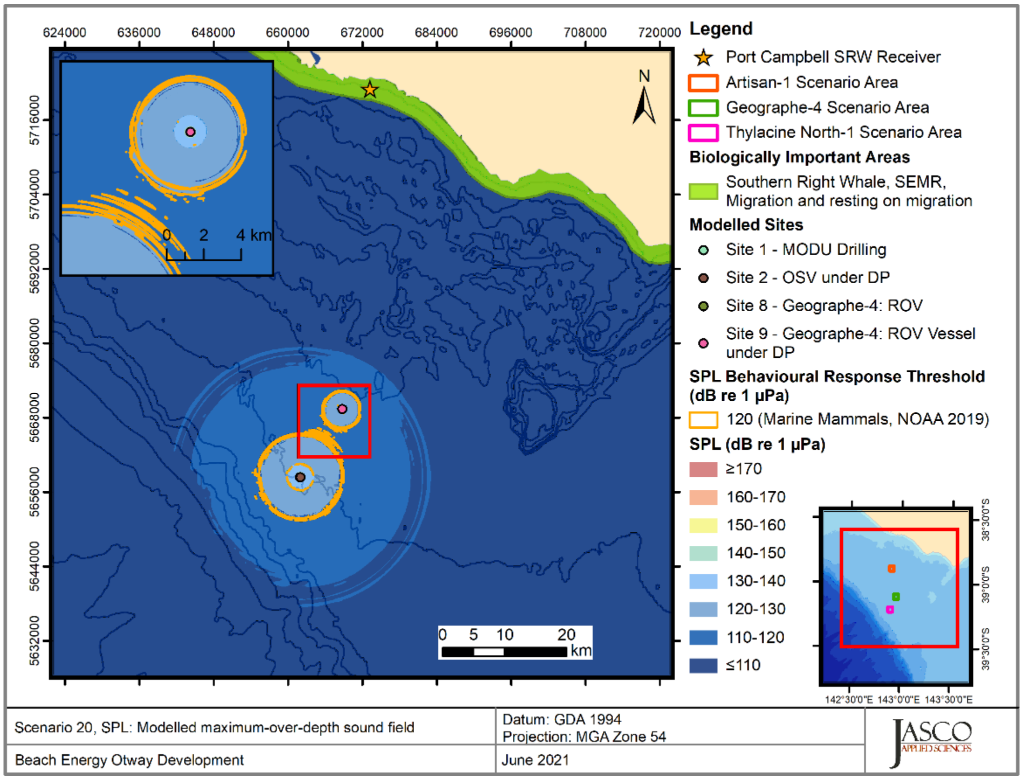


Figure 22. *Concurrent drilling operations at Thylacine North-1 and construction operations at Geographe-4 (Scenario 22) SPL:* Sound level contour map, showing unweighted maximum over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

4.2.2. Accumulated SEL_{24h} Maps

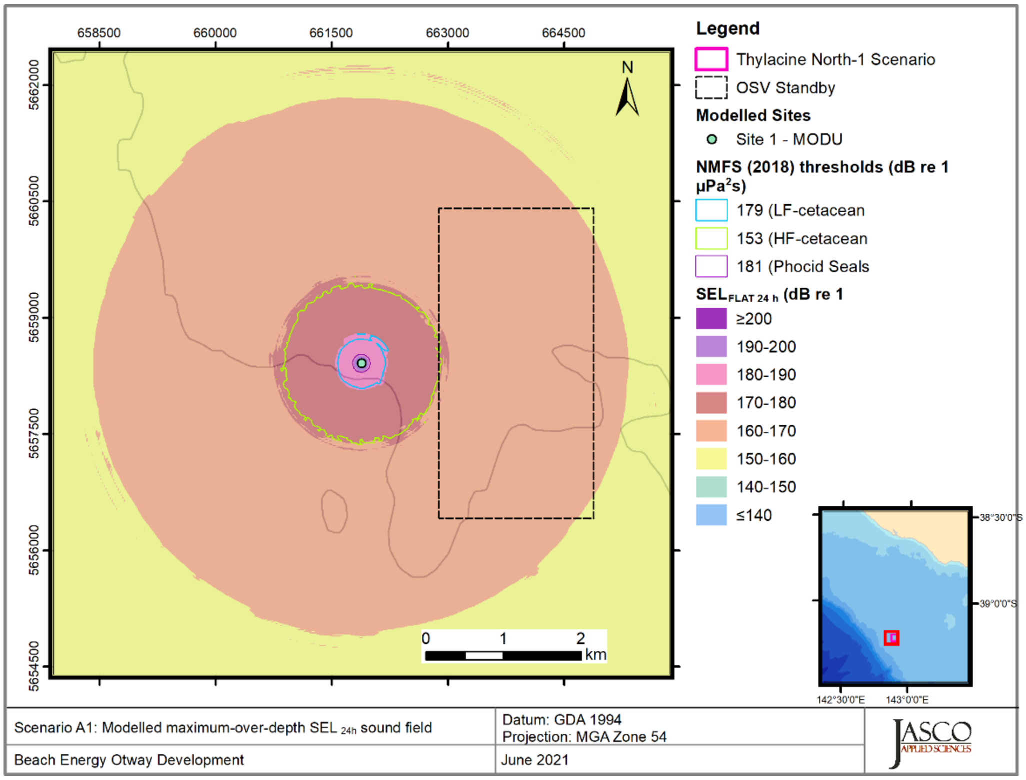


Figure 23. *Thylacine North-1, MODU Drilling (Scenario A1) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

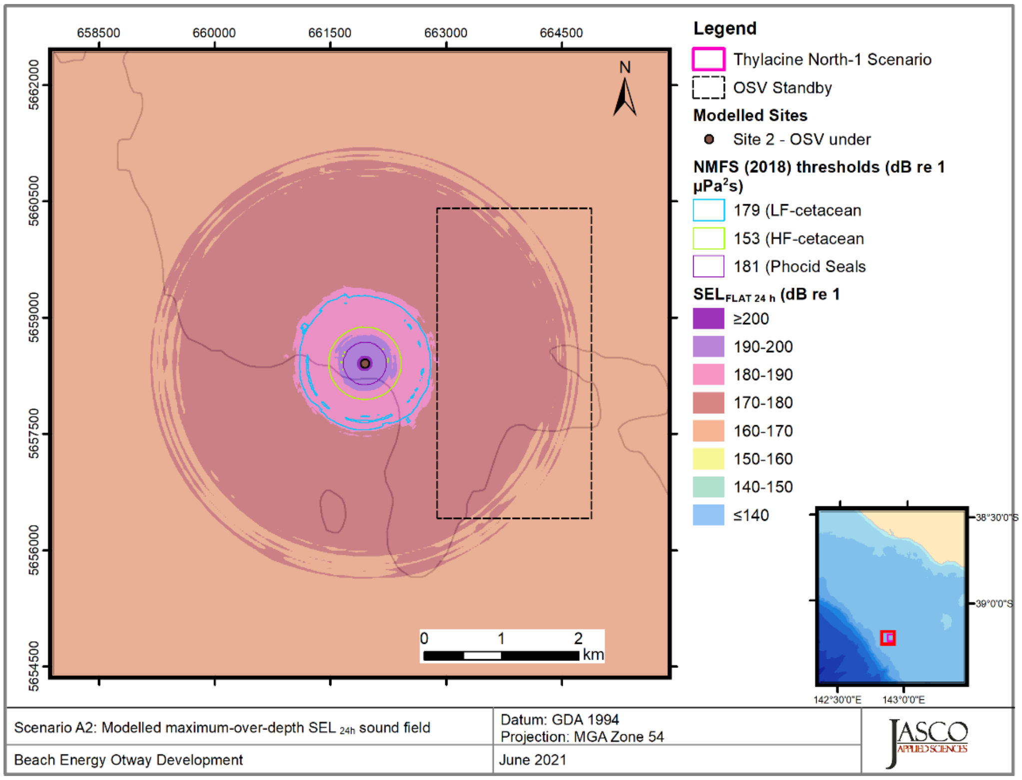


Figure 24. *Thylacine North-1, OSV on DP (4h) (Scenario A2) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

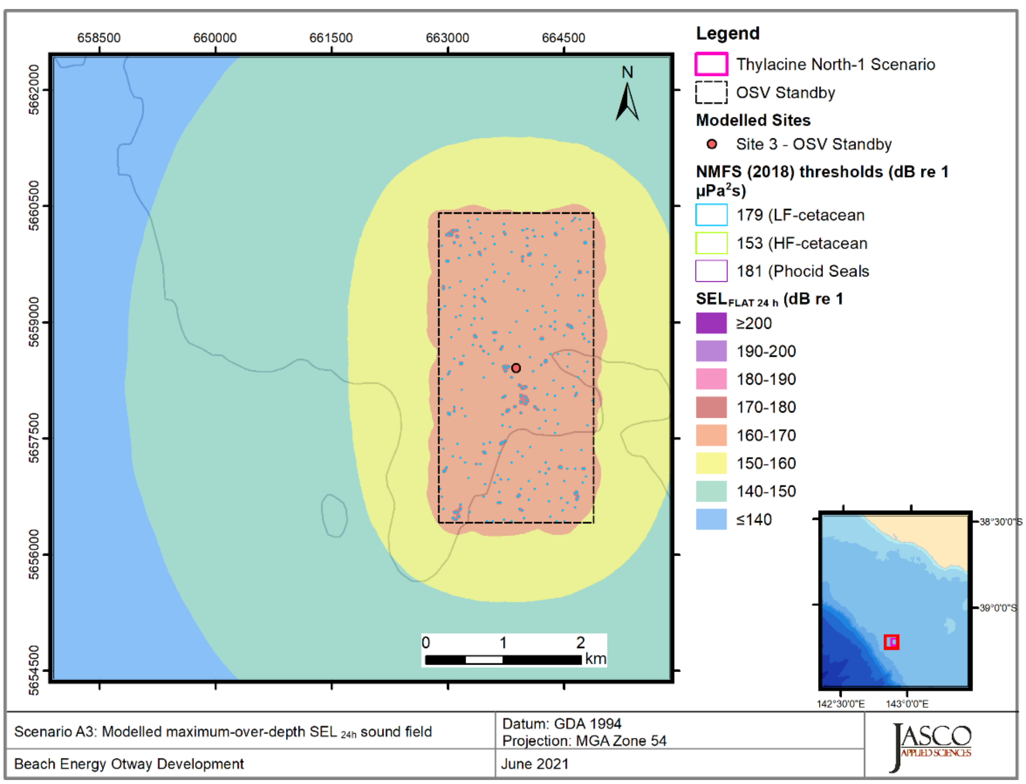


Figure 25. *Thylacine North-1, OSV Standby (Scenario A3) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

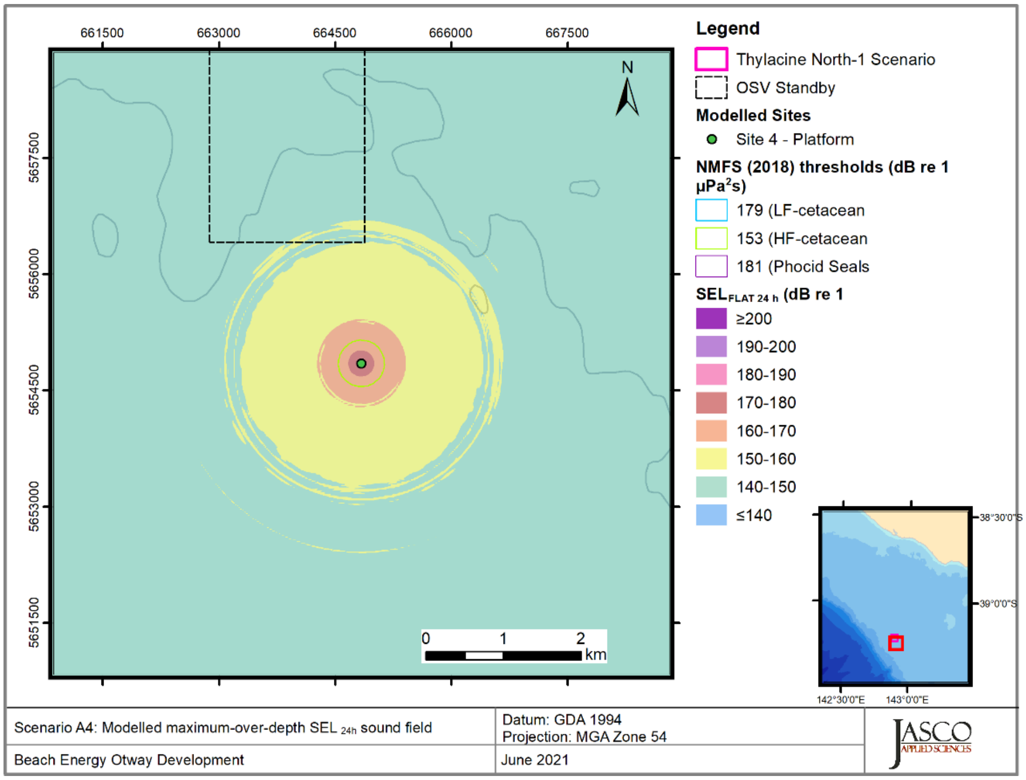


Figure 26. *Thylacine A, Platform Operations (Scenario A4) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

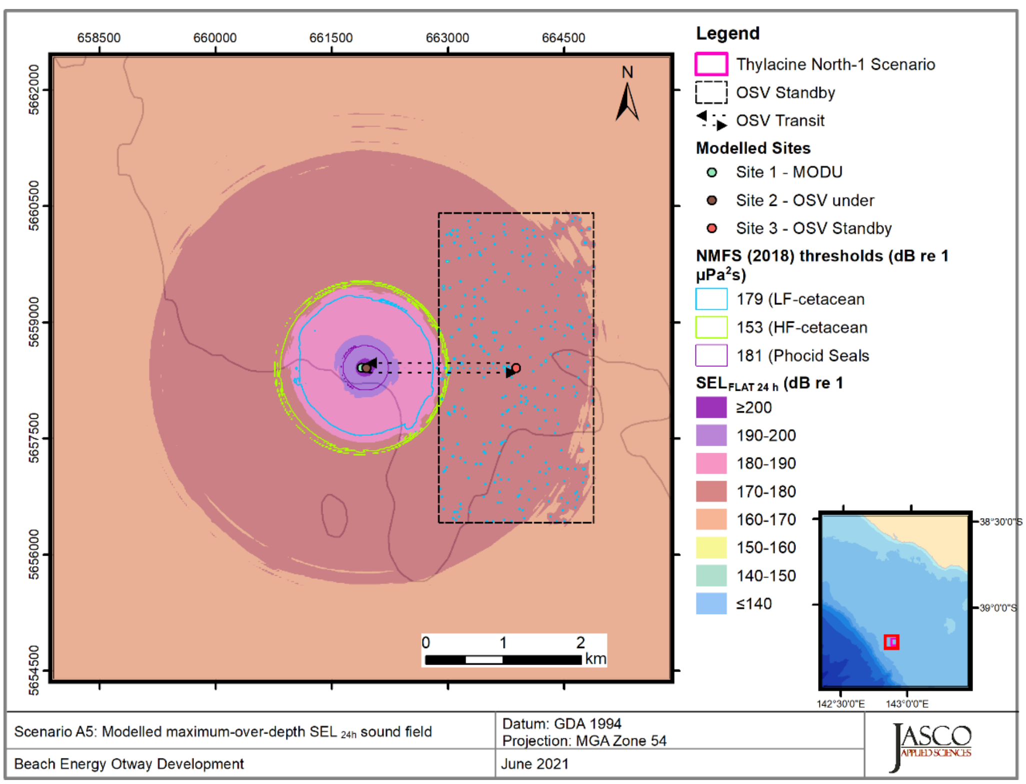


Figure 27. *Thylacine North-1, MODU 4h Resupply Operations (Scenario A5) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

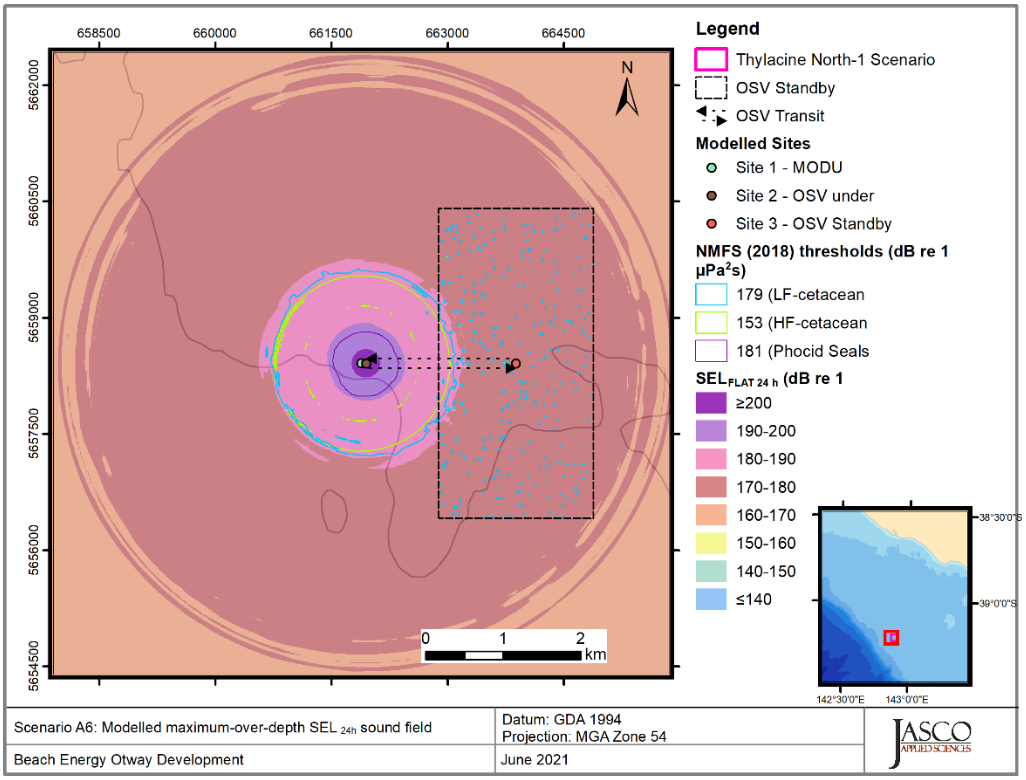


Figure 28. *Thylacine North-1, MODU 8h Resupply Operations (Scenario A6) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.*SEL24h:*

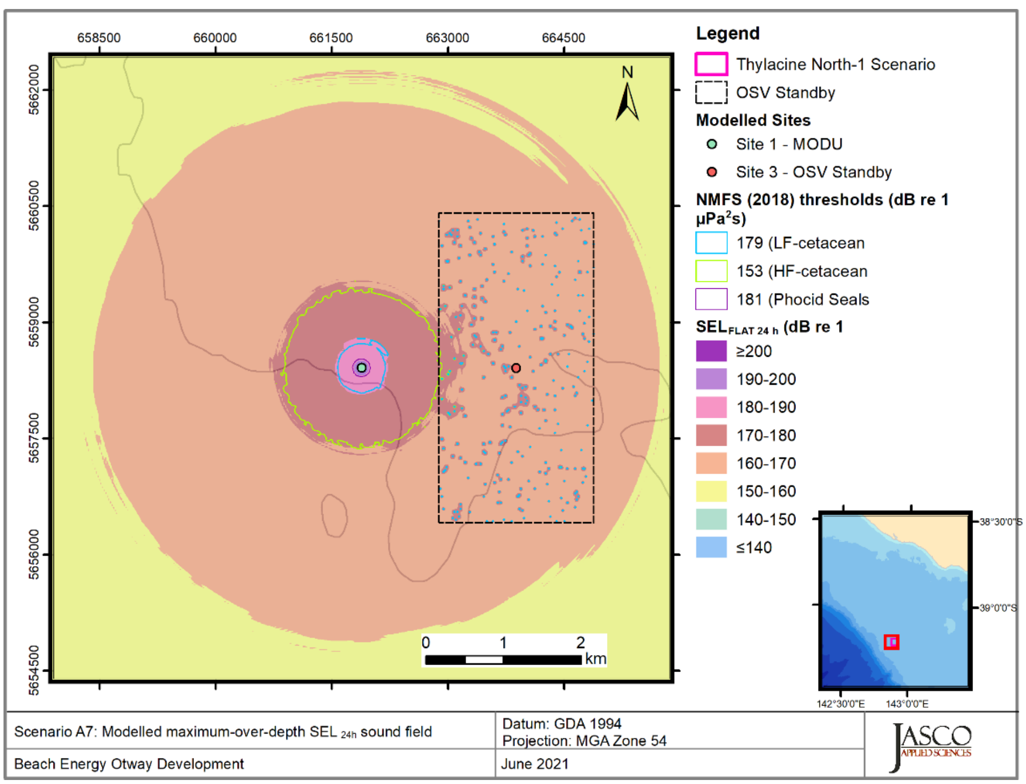


Figure 29. *Thylacine North-1, MODU Drilling and OSV standby (Scenario A7) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

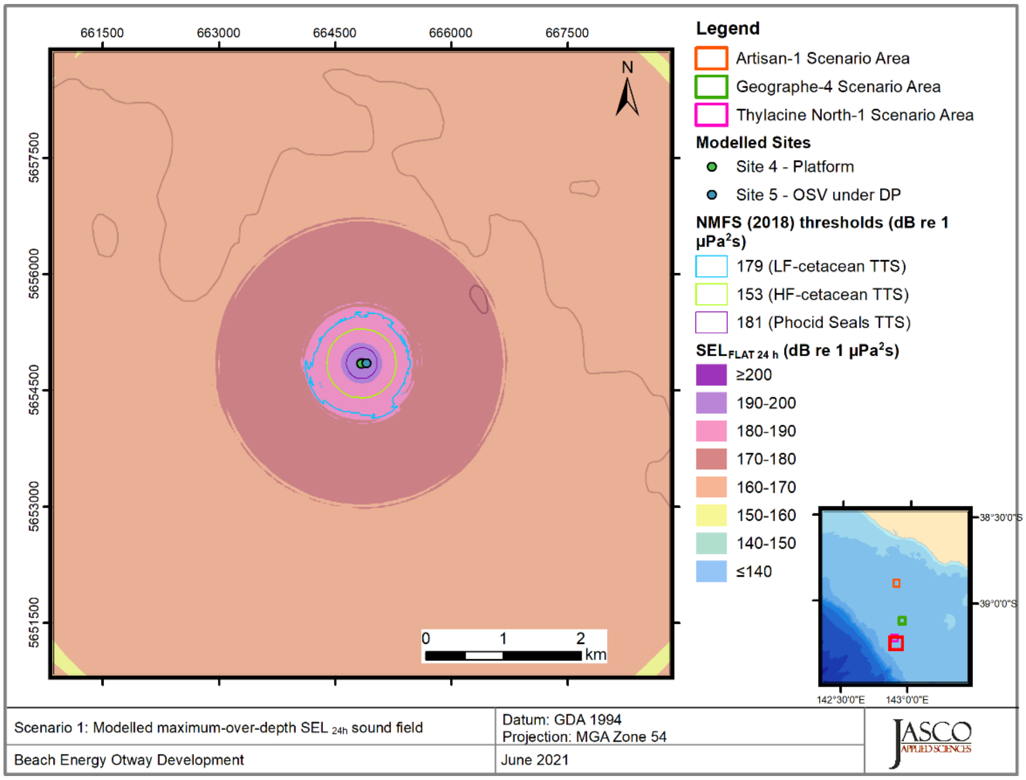


Figure 30. *Thylacine A Platform, 2 h Platform Resupply (Scenario 1) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

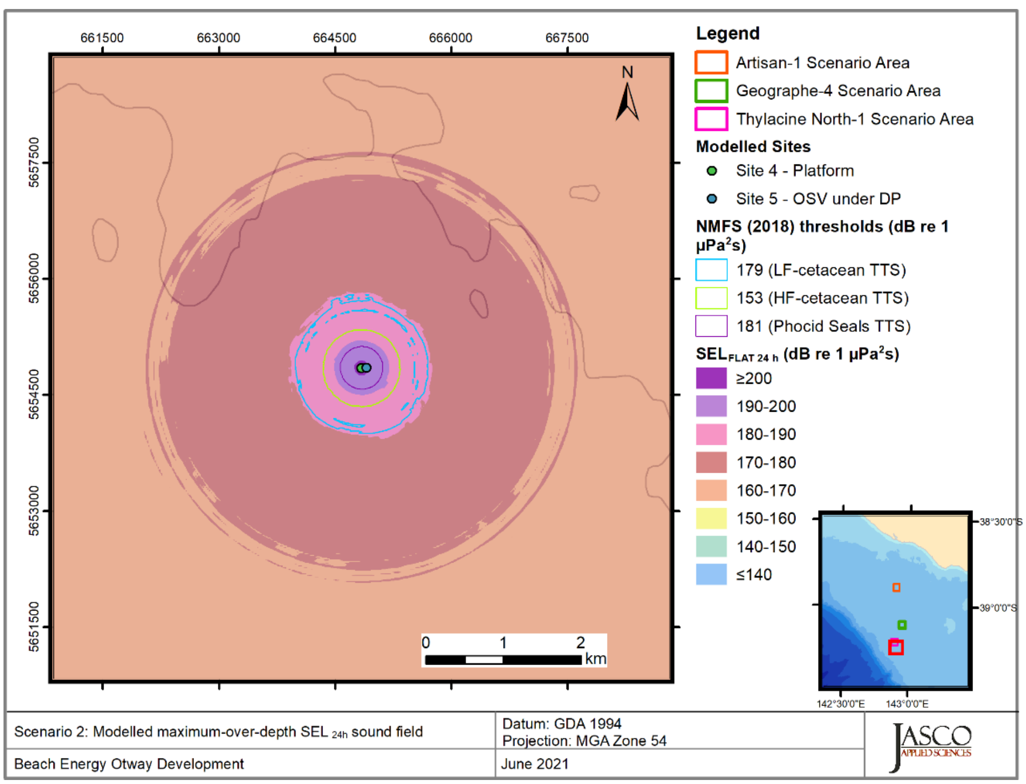


Figure 31. *Thylacine A Platform, 4 h Platform Resupply (Scenario 2) SEL$_{24h}$:* Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

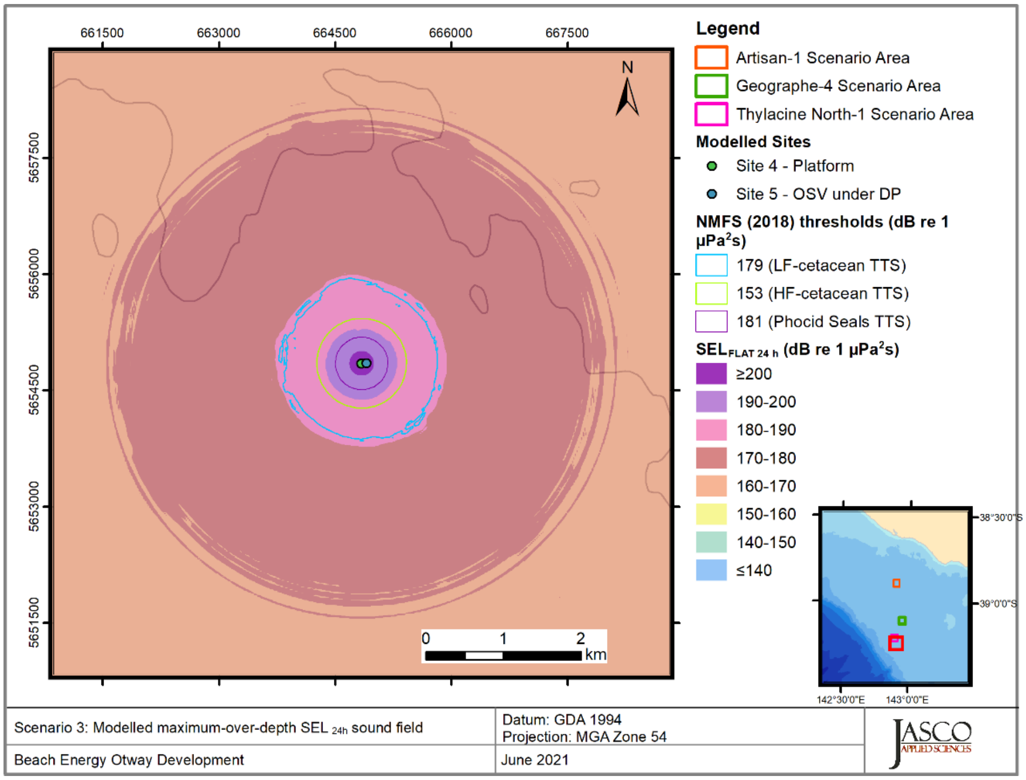


Figure 32. *Thylacine A Platform, 6 h Platform Resupply (Scenario 3) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

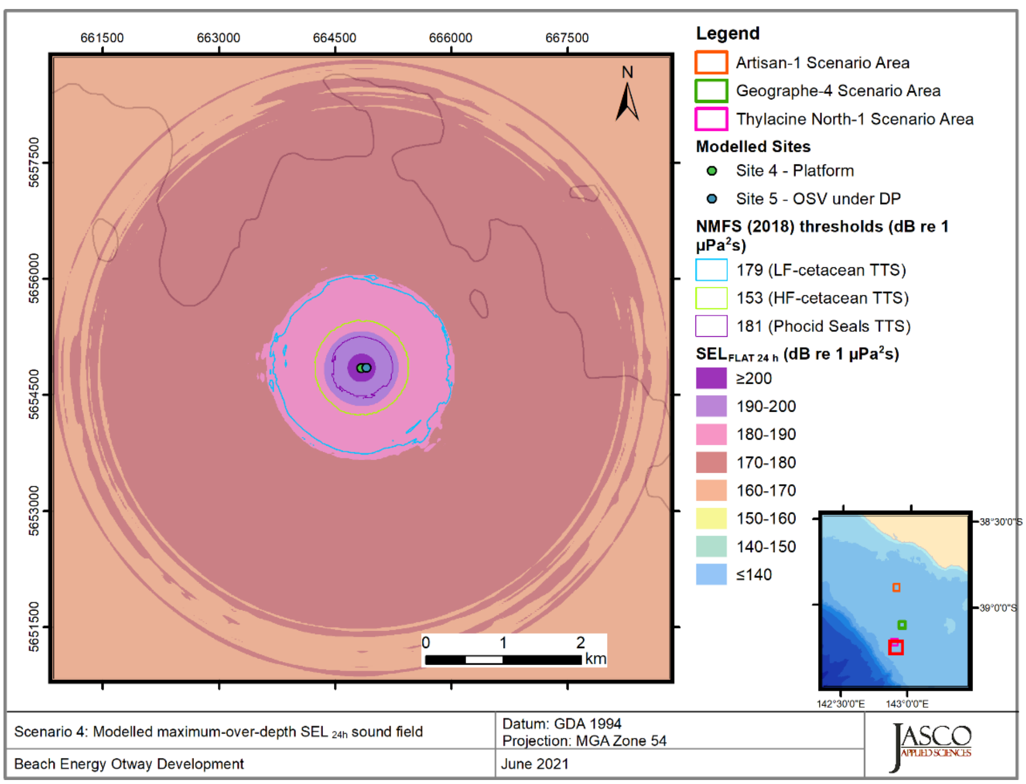


Figure 33. *Thylacine A Platform, 8 h Platform Resupply (Scenario 4) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

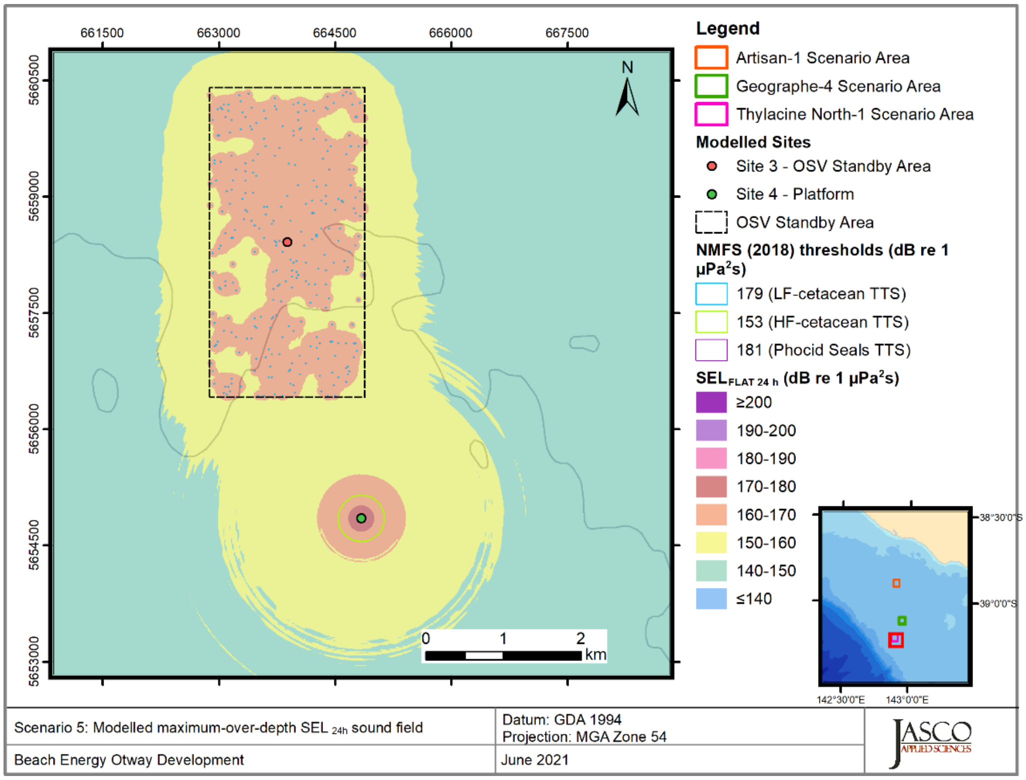


Figure 34. *Thylacine A Platform, 8h OSV standby (Scenario 5) SEL*$_{24h}$: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

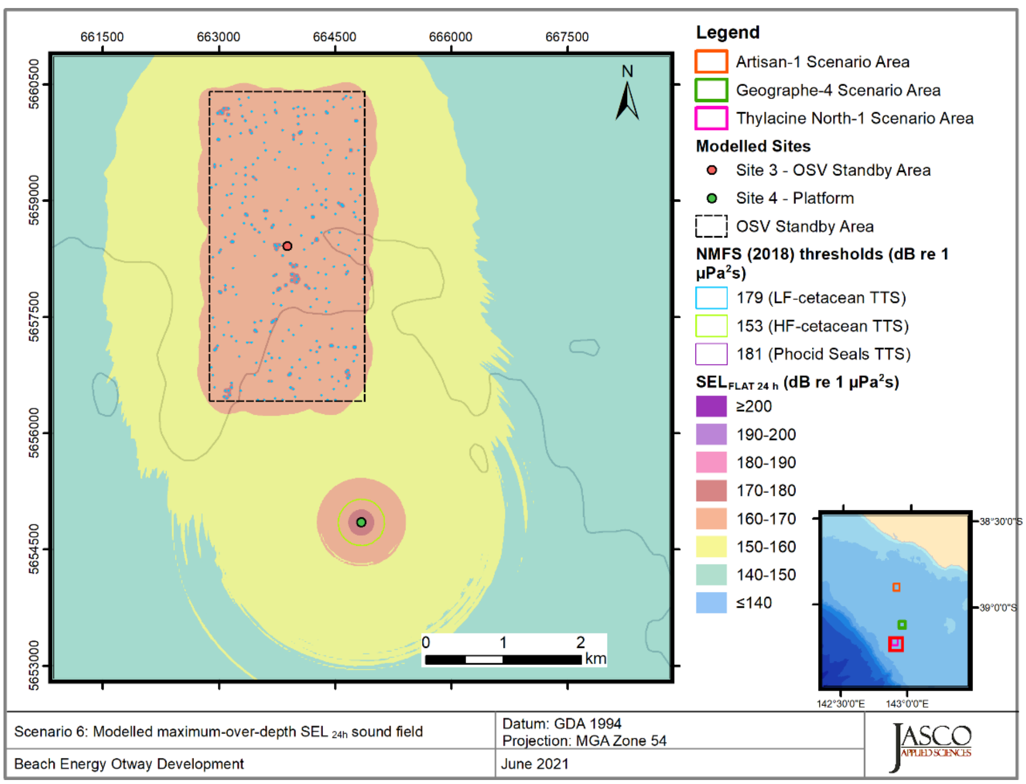


Figure 35. *Thylacine A Platform, 24h OSV standby (Scenario 6) SEL*$_{24h}$: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

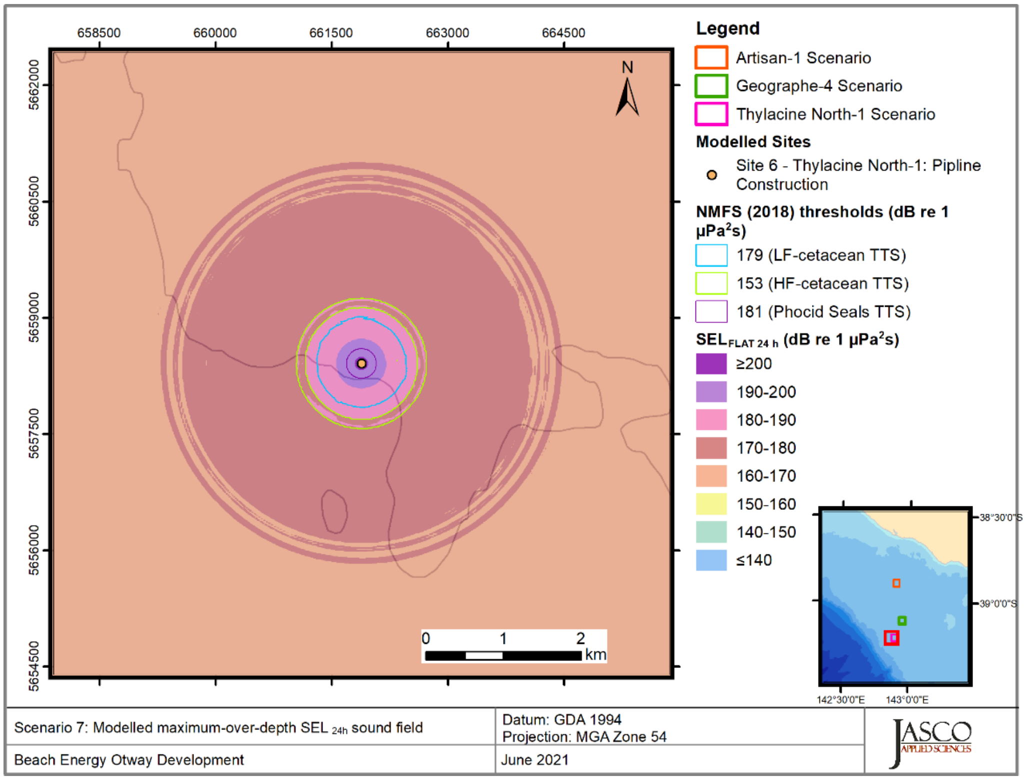


Figure 36. *Thylacine North-1, PLV stationary -June (Scenario 7) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

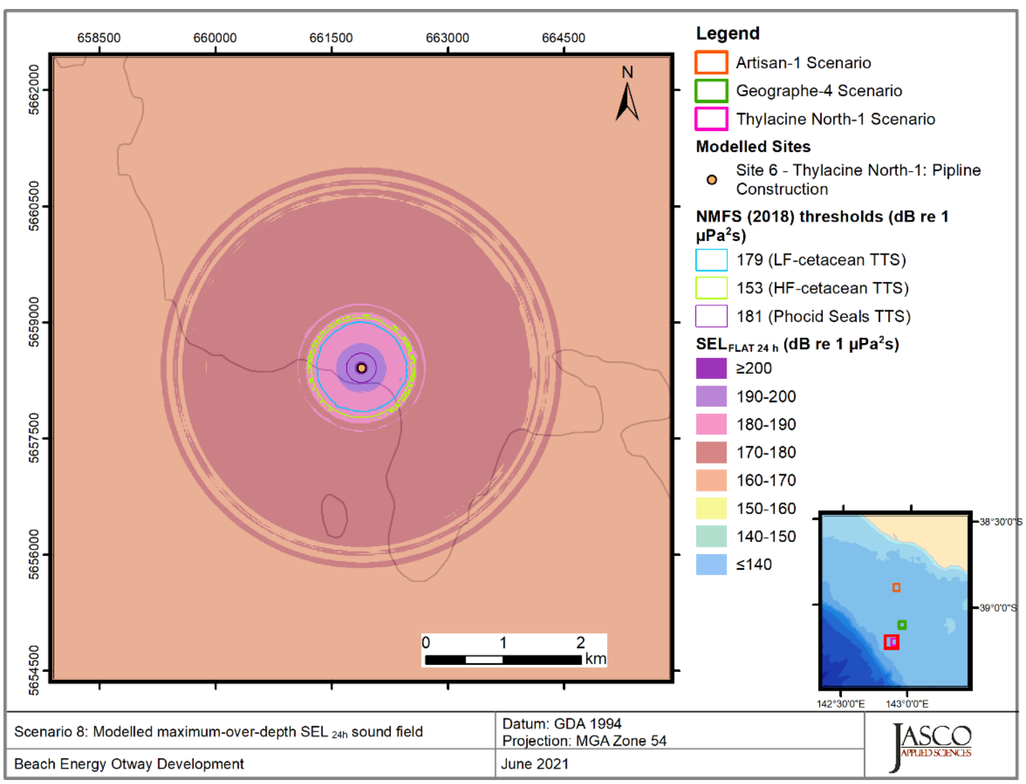


Figure 37. *Thylacine North-1, PLV stationary - November (Scenario 8) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

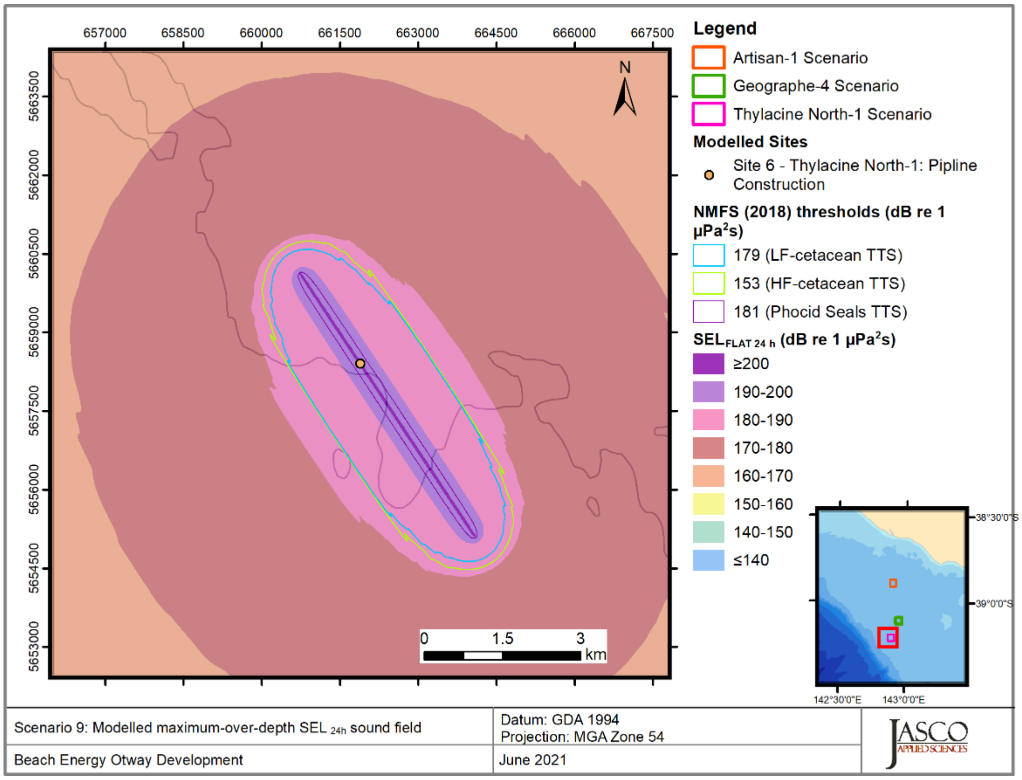


Figure 38. *Thylacine North-1, PLV pipe laying operations - June (Scenario 9) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

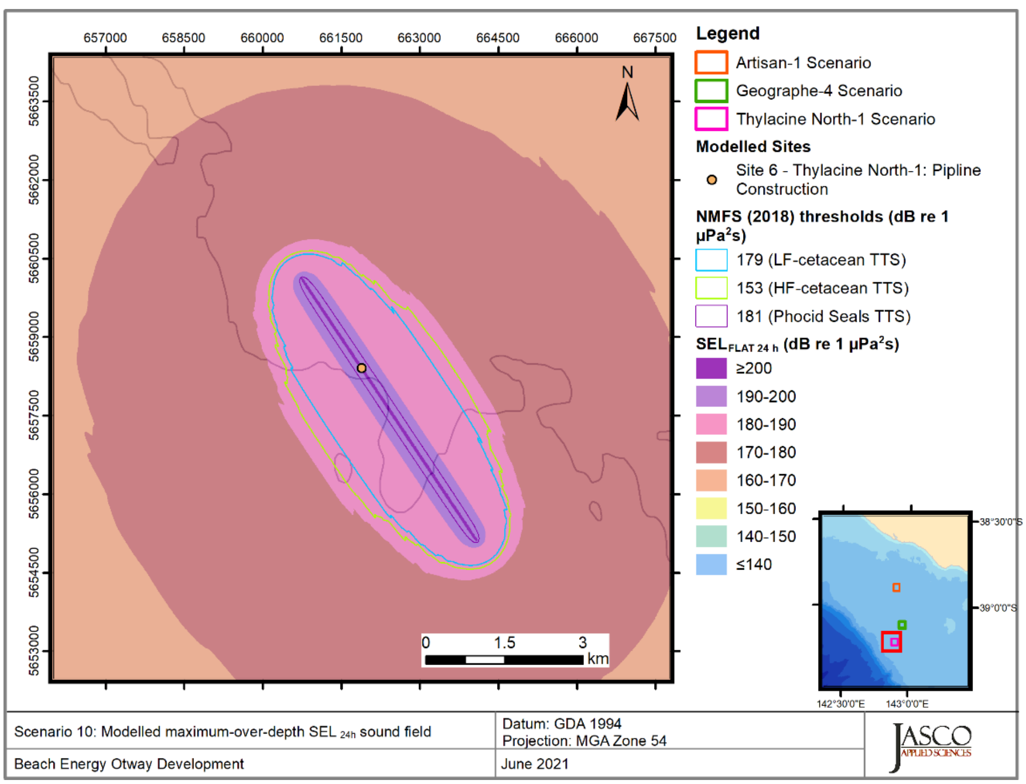


Figure 39. *Thylacine North-1, PLV pipe laying operations - November (Scenario 10) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

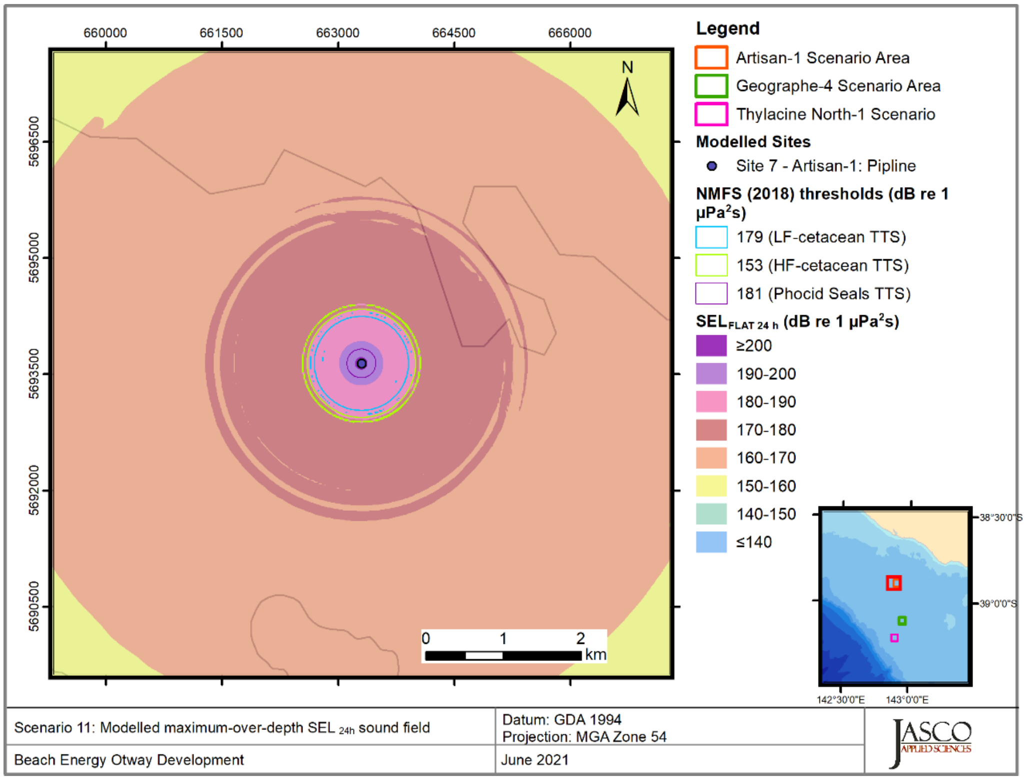


Figure 40. *Artisan-1, PLV stationary - June (Scenario 11) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

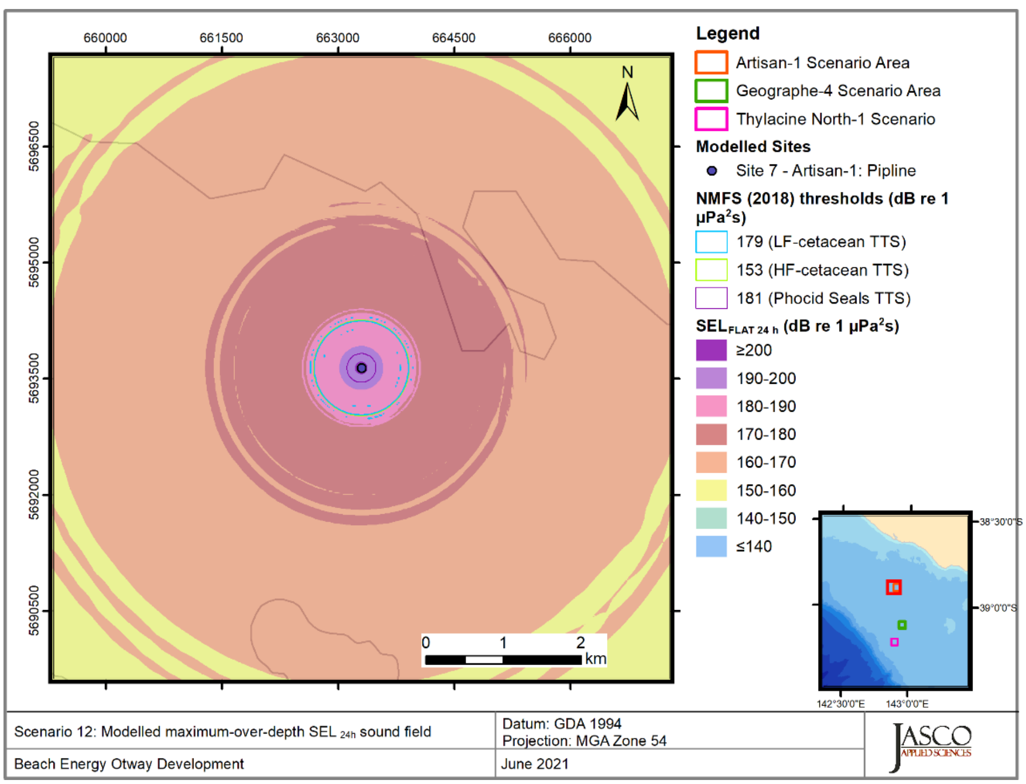


Figure 41. *Artisan-1, PLV stationary - November (Scenario 12) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

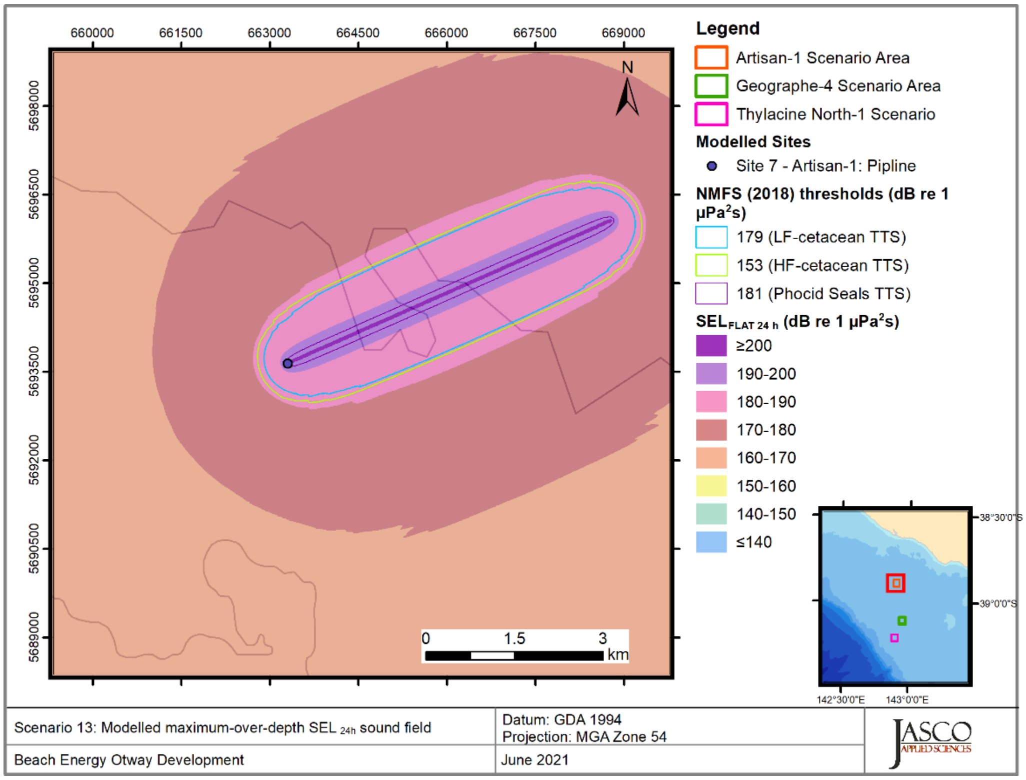


Figure 42. *Artisan-1, PLV pipe laying operations - June (Scenario 13) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

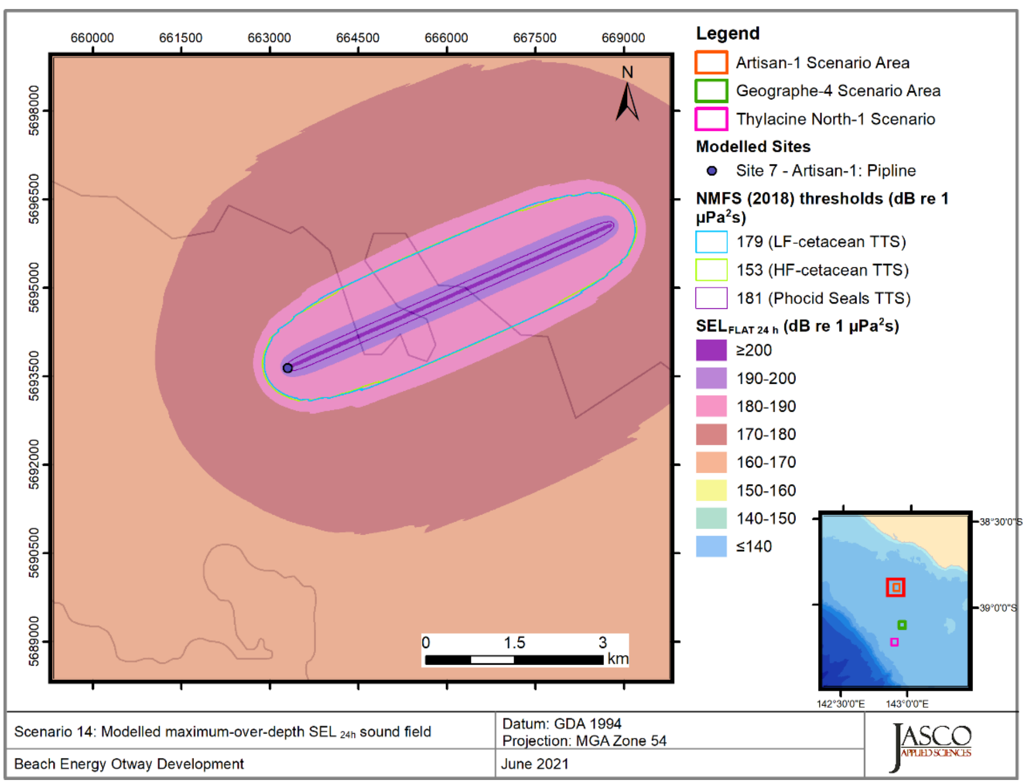


Figure 43. *Artisan-1, PLV pipe laying operations - November (Scenario 14) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

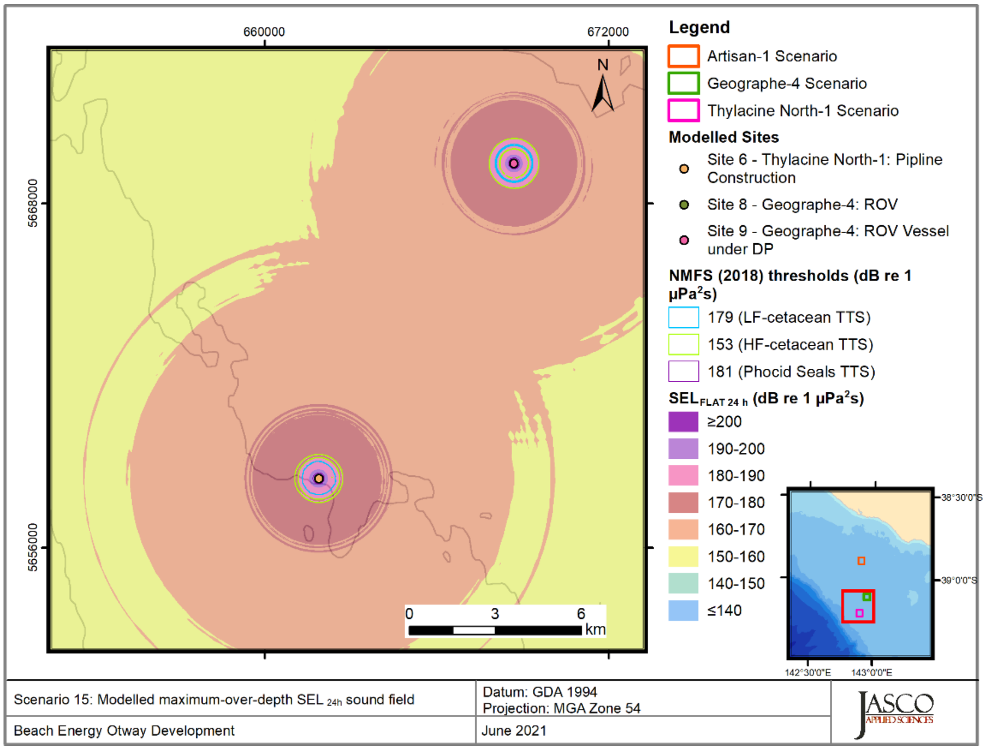


Figure 44. Thylacine North-1, PLV stationary and ROV Operations at Geographe-4 - June (Scenario 15) SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

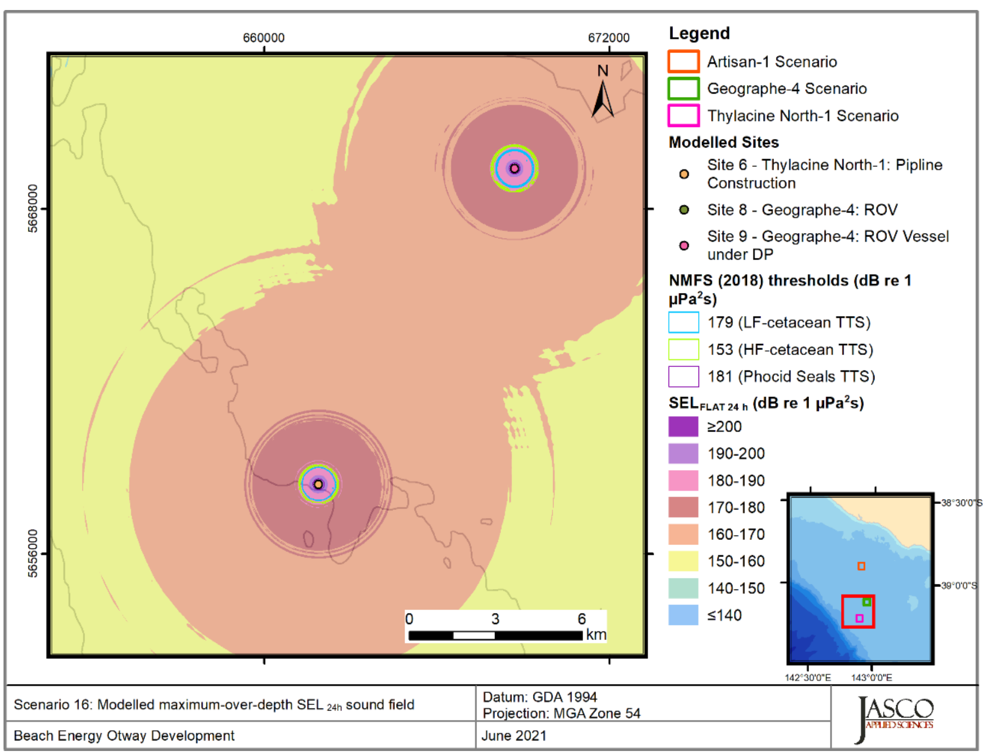


Figure 45. *Thylacine North-1, PLV stationary and ROV Operations at Geographe-4 - November (Scenario 16) SEL_{24h}:* Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

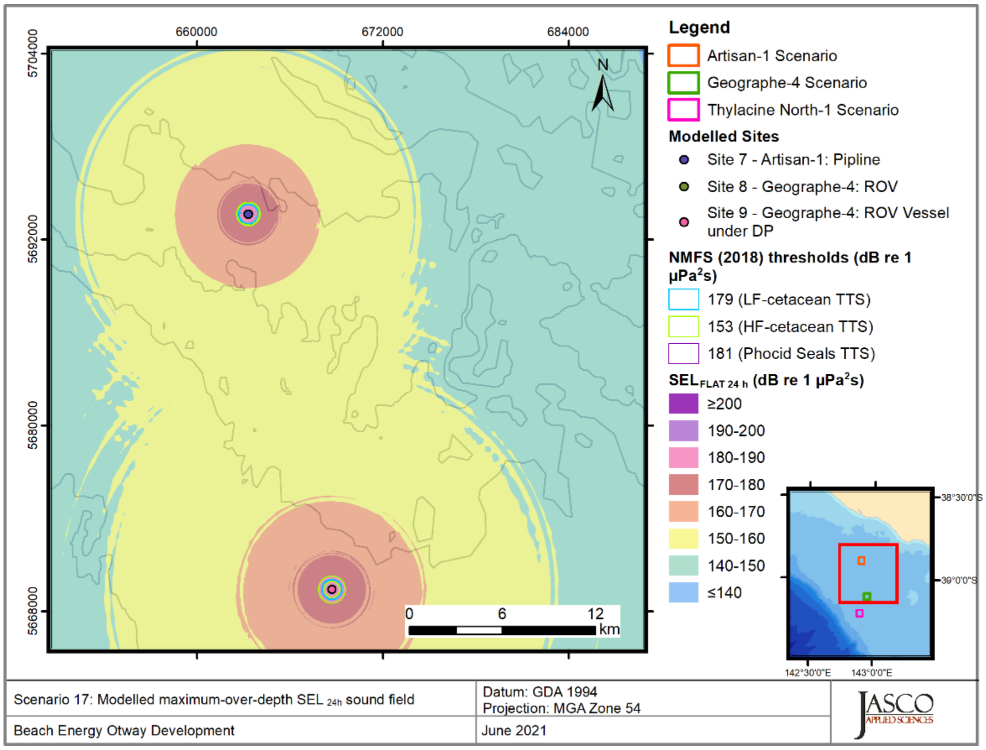


Figure 46. *Thylacine North-1, PLV stationary and ROV Operations at Geographe-4 - June (Scenario 17) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

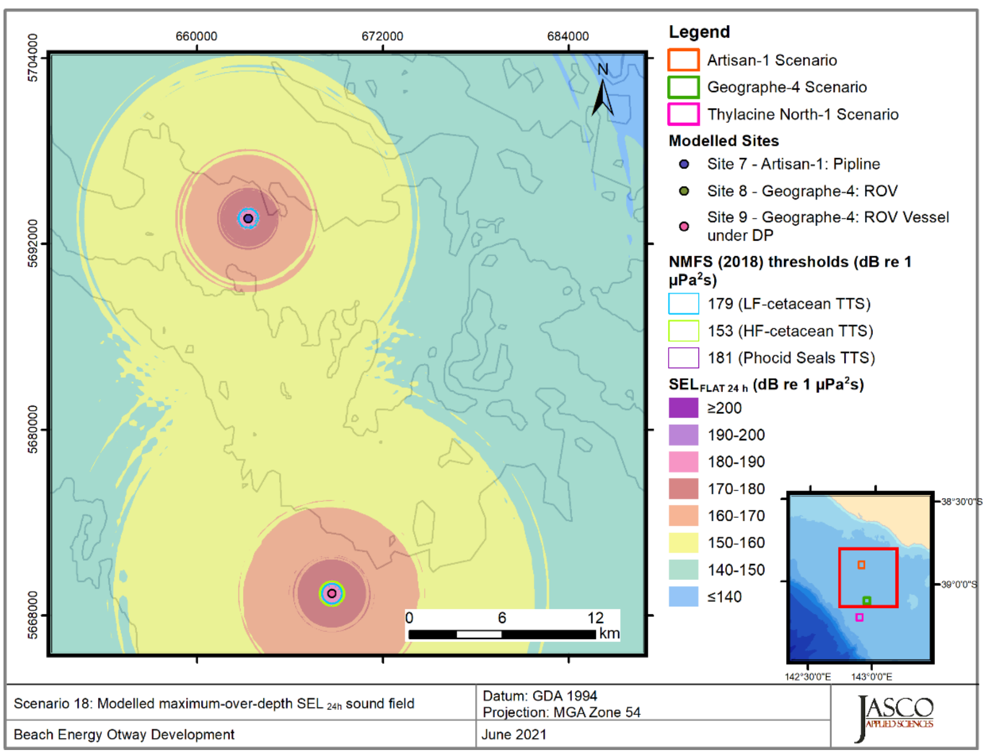


Figure 47. *Artisan-1, PLV stationary and ROV Operations at Geographe-4 - November (Scenario 18) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

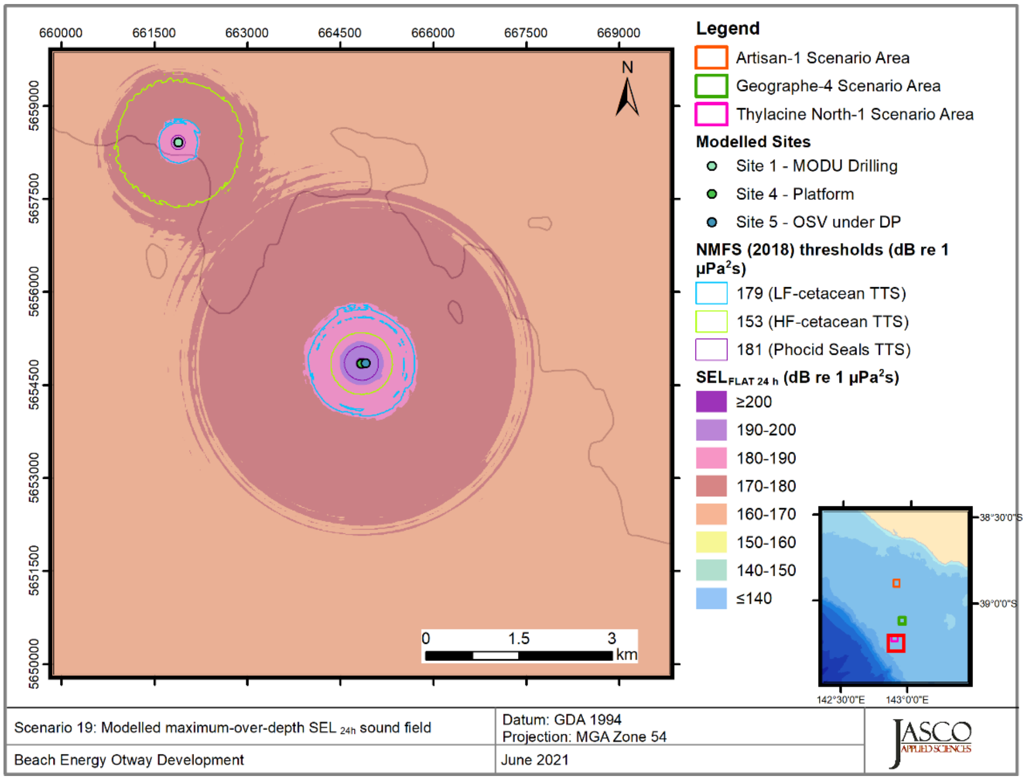


Figure 48. *Thylacine A Platform, 4h Platform Resupply and MODU Drilling (Scenario 19) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

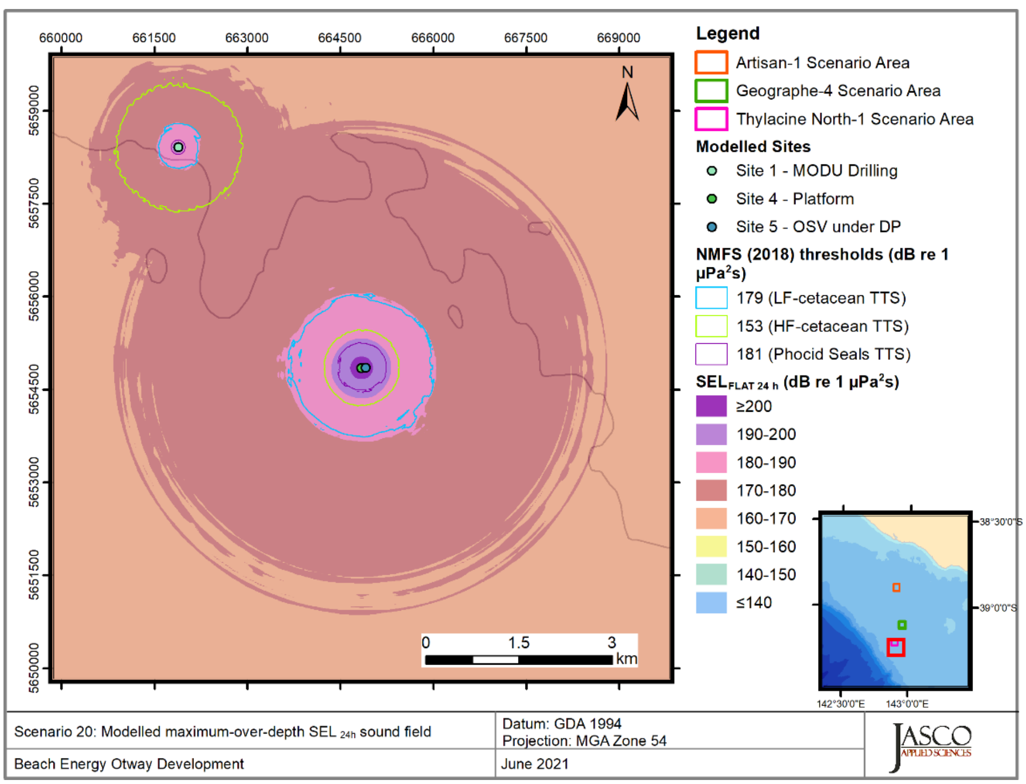


Figure 49. *Thylacine A Platform, 8h Platform Resupply and MODU Drilling (Scenario 20) SEL$_{24h}$*: Sound level contour map showing unweighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

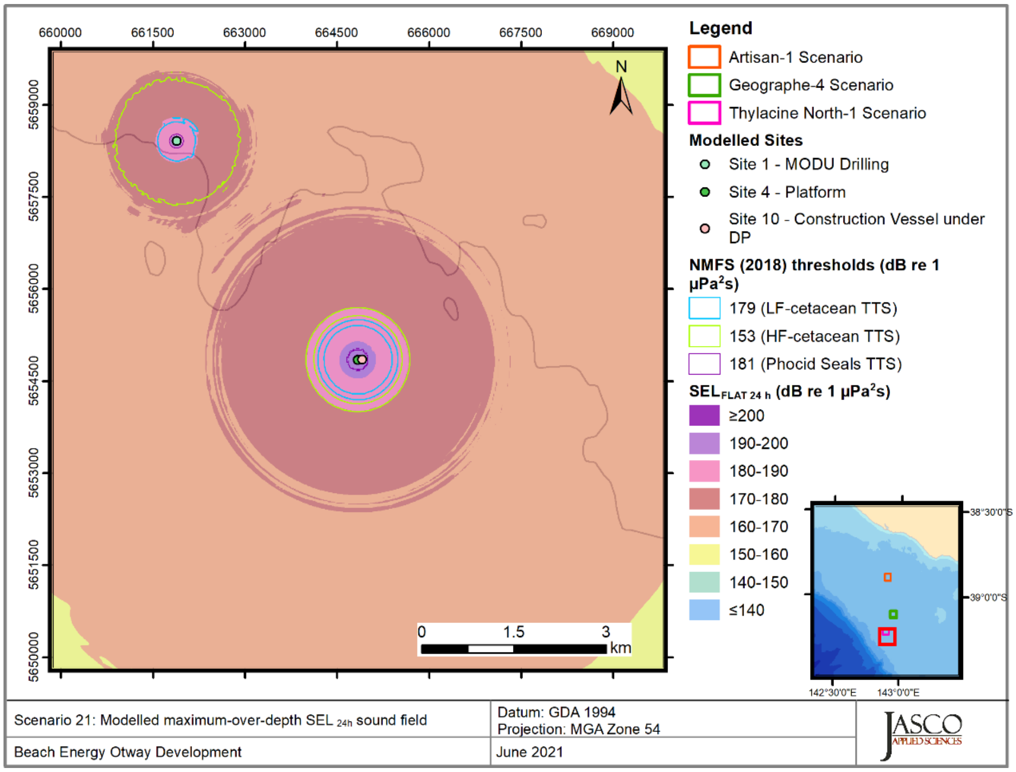


Figure 50. *Thylacine A Platform, Skid installation and MODU Drilling (Scenario 21) SEL24h:* Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

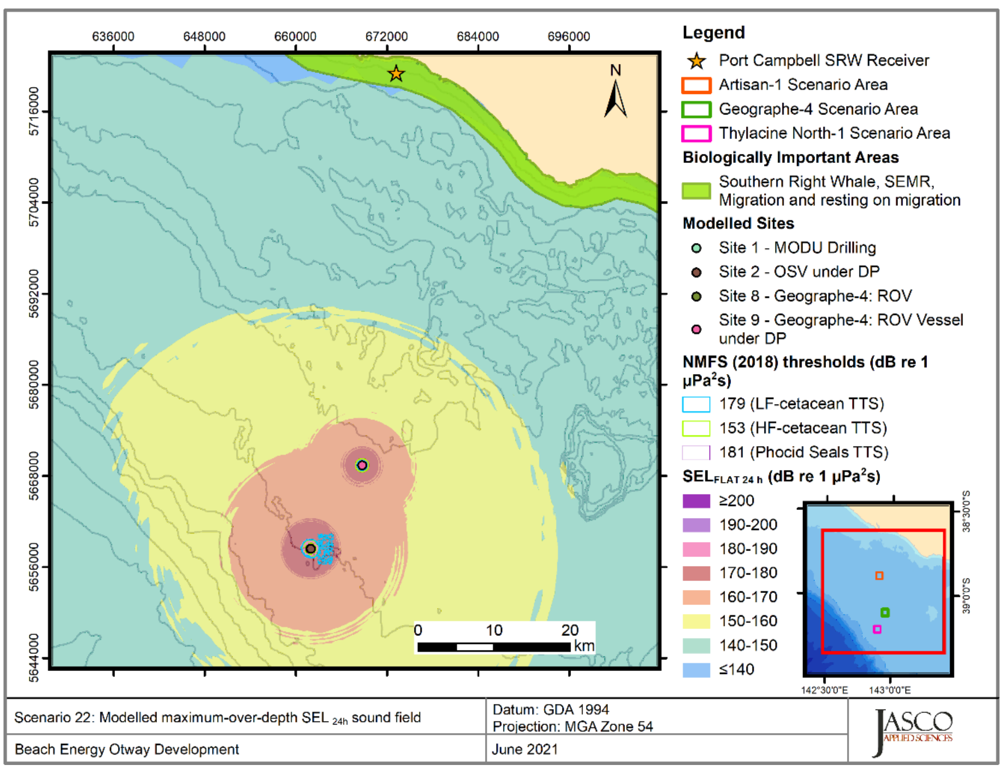


Figure 51 *Concurrent drilling operations at Thylacine North-1 and construction operations at Geographe-4 (Scenario 22) SEL24h:* Sound level contour map showing unweighted maximum-over-depth SEL24h results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map.

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 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 11–13. The seasonal differences were at most a few hundred metres. The receiver SPL level at the Port Campbell receiver locations presented in Table 8 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 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):

$$L_E = 10\log_{10}\left(\int_T p^2(t)dt \Big/ T_0 p_0^2\right) \tag{A-2}$$

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.

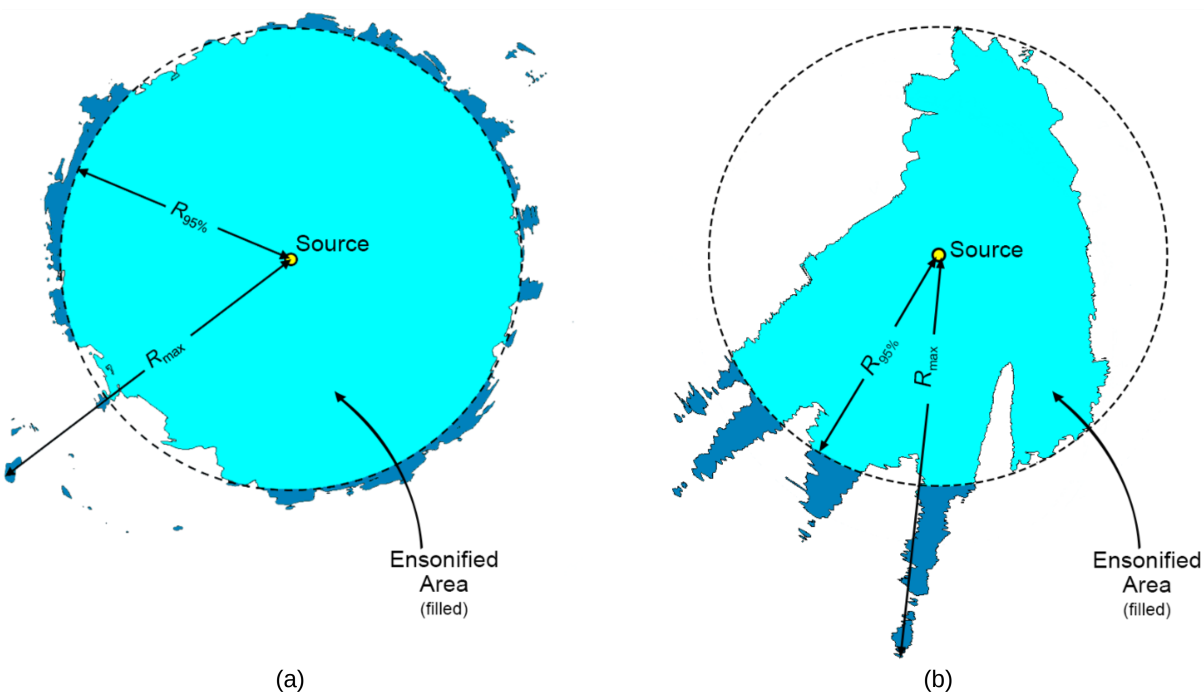


Figure B-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified 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.

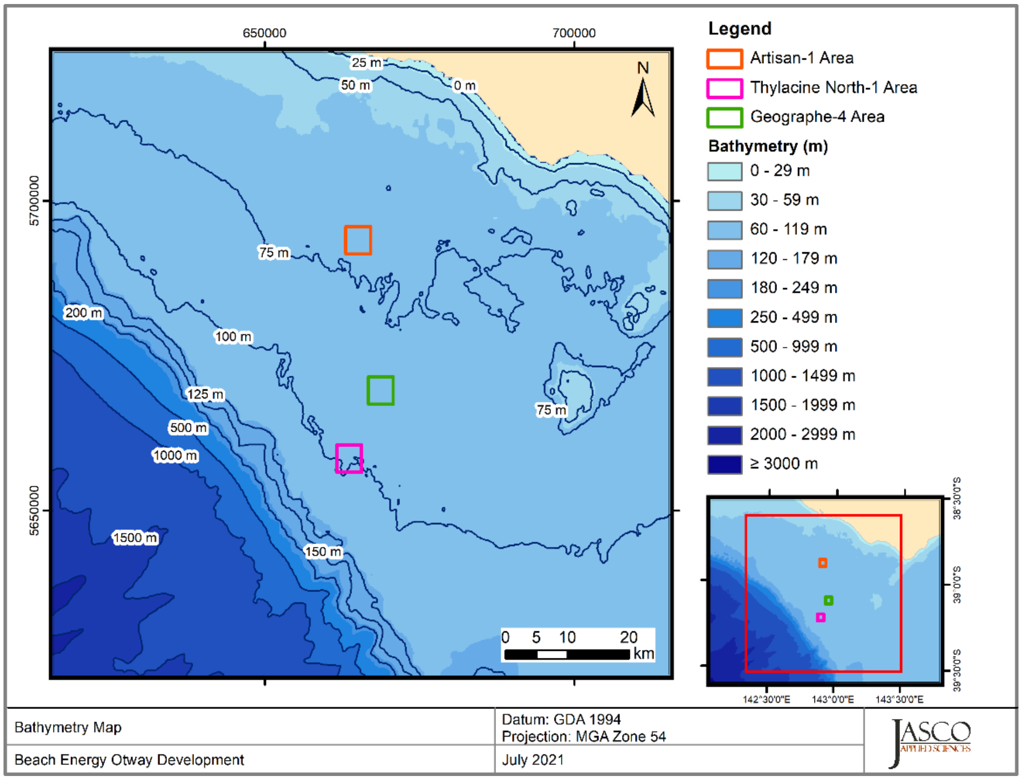


Figure B-2. Bathymetry in the modelled area.

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.

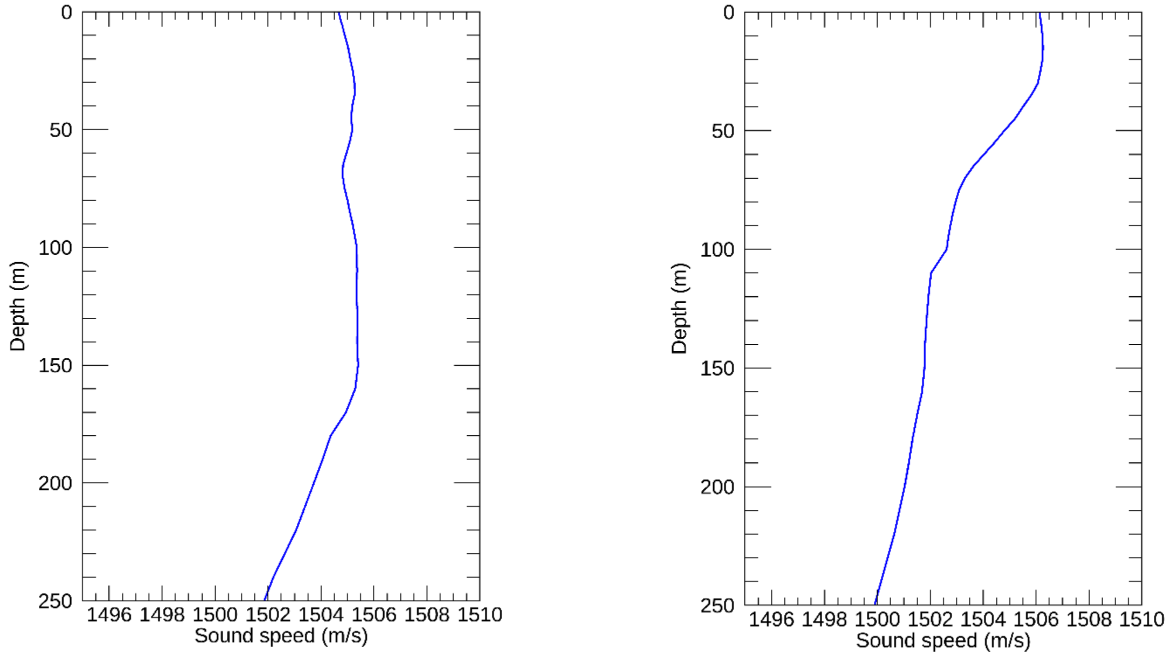


Figure B-3. The modelling sound speed profile corresponding to June (left) and November (right) Profiles are calculated from temperature and salinity profiles from *Generalized Digital Environmental Model* V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

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/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	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 Otway Offshore Stakeholder Consultation Information

Otway Offshore Project

Operations Environment Plan Revision

beach

Information Sheet | May 2021

Introduction

Beach Energy operates the Otway Gas Plant near Port Campbell which supplies natural gas to Victorian homes and businesses. The gas plant processes raw gas from several existing offshore gas reserves in State and Commonwealth waters (see map over page). Existing offshore infrastructure includes well heads, manifolds, flow lines and tie-ins, offshore platform, and offshore to onshore pipeline from the platform to the gas plant.

Offshore operations are carried out in accordance with an Environment Plan (EP) which must be reviewed at least every five years, and when there are major scope changes. The EP is assessed by the National Offshore Petroleum Safety Management Authority (NOPSEMA) and accepted when it meets regulatory requirements.

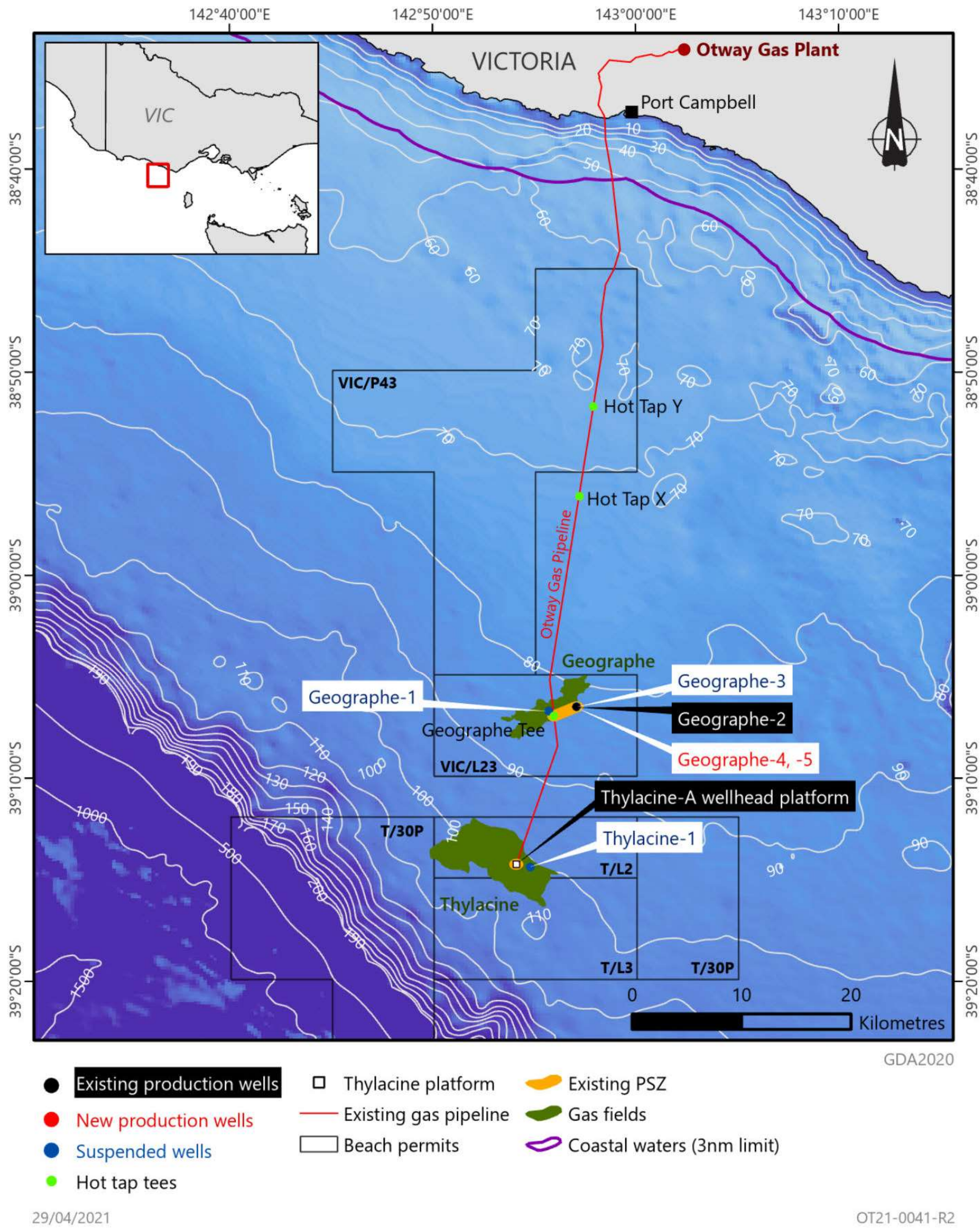
Beach is currently developing further offshore production wells to continue supply of natural gas and will be connecting new wells to the existing infrastructure. For further information see: https://www.beachenergy.com.au/vic-otway-basin/

The existing Otway Offshore Operations EP will be reviewed to include new production wells and related infrastructure and submitted to NOPSEMA for acceptance.

This information sheet provides an overview of:

- Current offshore operations, and the additional wells and infrastructure to be included in the revised EP
- Regulatory framework for safety and environment requirements, including stakeholder consultation
- Potential impacts and risks in carrying out these operations and measures to reduce and manage in accordance with regulations.

Location map for Otway Offshore Operations EP



Existing wells and infrastructure

Thylacine-A Platform

The Thylacine-A platform is a steel jacket structure with topsides consisting of an integrated deck on four levels. The platform is designed to be operated as a 'normally unattended installation'. It is remotely operated from the Otway Gas Plant central control room via duplicated communication links ensuring high availability for the control and safety shutdown systems. The platform can continue to operate safely and autonomously upon a loss of communications.

Wells and connections

The Thylacine gas field currently consists of four production wells which are connected to the platform and pipeline, and one suspended subsea well (Thylacine-1). The Geographe gas field consists of one subsea production well (Geogrpahe-2), connected to a subsea manifold with an umbilical to the Thylacine platform and a flowline to the existing offshore to onshore pipeline, and two suspended subsea wells (Geographe-1 and Geographe-3). Control and services to the Geographe production well are provided via the main umbilical from the Thylacine-A Platform.

Pipeline

The Otway Gas Offshore to Onshore Pipeline and monoethylene glycol (MEG) pipeline, which are piggybacked, run from the platform to the Otway Gas Plant. The MEG pipeline supplies MEG and chemicals for injection into the Otway Gas Offshore to Onshore Pipeline at the platform. The pipelines are approximately 80 km in total length, including the offshore section approximately 69 km long.

Maintenance

Routine maintenance of the platform is undertaken by work crews transported by helicopter from Warrnambool approximately once a fortnight during daylight hours. Regular activities include: routine operational checks; instrument and mechanical maintenance; shutdown resets, corrosion monitoring; and chemical replenishment. Specific maintenance and upgrade activities are also carried out to complete requirements identified during the routine checks.

Supply and support vessels

The platform is also visited approximately once per month by a supply vessel from Geelong for the provision of fuel, chemicals, maintenance consumables and equipment.

Vessels are also required for specific activities such as subsea inspection work using Remotely Operated Vehicles (ROVs) and/or divers.

New wells and infrastructure

Geographe wells and infrastructure

Beach's Otway Offshore Project commenced drilling in March 2021. The project includes two new production wells (Geographe-4 and Geographe-5) in the Geographe field which will be connected to the existing subsea infrastructure and flowline to the existing offshore to onshore pipeline.

The Thylacine-A platform, wells, and subsea manifold are controlled and monitored 24 hours per day by the Otway Gas Plant control room. The new wells and associated seabed infrastructure will be within the existing Geographe Petroleum Safety Zone. The new wells will be managed in the same manner as the existing Otway offshore production wells and will be included in existing inspection and maintenance schedules to ensure their ongoing integrity. The current operations EP is being reviewed to include these new wells and infrastructure.

Thylacine wells and infrastructure

Four new Thylacine production wells will also be drilled and connected with a new production manifold, flowlines and umbilicals to the Thylacine-A platform. The operations EP will undergo a further review to include the new Thylacine wells and infrastructure, after the engineering design is completed.

Location and timing

The wells, infrastructure and Thylacine-A Platform are located in Commonwealth waters approximately 55 to 80 km from Port Campbell. The map on page 2 shows the locations of the existing platform, wells, and pipeline, along with the new production wells.

Drilling of the Geographe-4 and 5 wells commenced in March 2021 and are expected to be tied into the existing infrastructure before December 2021. Drilling of the Thylacine wells will proceed after the Geographe wells have been drilled and are expected to be completed before the end of 2022. See further information: https://www.beachenergy.com.au/vic-otway-basin/

Regulatory framework

Offshore petroleum activities are regulated under the *Offshore Petroleum and Greenhouse gas Storage Act 2006 (OPGGS Act)* which requires a Safety Case, Well Operations Management Plan and an Environment Plan for each activity type. The plans are assessed by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) who regulates petroleum activities under the OPPGGS Act.

Environment Plans must include a description of the existing environment and the proposed activity, an evaluation of the impacts and risks associated with the activities, environmental performance outcomes and standards, implementation strategy, and reporting requirements. Beach must demonstrate in the Environment Plan, how it will conduct the activities to ensure that potential impacts are of an acceptable and any residual impacts are reduced to "As Low As Reasonably Practicable" (ALARP).

In developing the Environment Plans, relevant up-to date technical and scientific studies are taken into consideration, along with stakeholder feedback.

Marine environment

Beach recognises the environmental, heritage, social and economic values in the areas in which we operate.

The activities will be conducted in water depths ranging from 80 to 110 metres where there is a variety of marine fauna including the potential 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 sharks species throughout the year
- New Zealand and Australian fur seals throughout the year
- Loggerhead, green turtle and leatherback turtles throughout the year.

Commonwealth managed fisheries may operate in the region, including: southern and eastern scalefish and shark; and southern squid jig fishery. Victorian managed fisheries, including: rock lobster and giant crab may also operate in the area but tend to concentrate in the reef areas closer to shore for rock lobster and closer to the continental shelf for giant crab. There is also significant commercial shipping activity in the area.

Mitigation and management

The Environment Plan details a range of controls to reduce and manage environmental impacts and potential risks to acceptable levels as approved by regulators. These include:

- The Thylacine-A Platform and offshore pipeline are marked on navigational charts and the platform has an existing 500 metre petroleum safety zone.
- The Geographe wells and infrastructure are within an existing 500 metre petroleum safety zone.
- Vessels utilised by Beach are required to comply with all applicable marine regulations and observe the minimum approach distances to whales and dolphins set out in national guidelines.
- Gas venting at the Thylacine-A Platform is limited to the minimum required for safe operations. Fuel burning equipment on the platform and vessels is designed and maintained to reduce pollutant emissions to atmosphere.
- Beach operates in compliance with the NOSPEMA accepted Safety Cases and Well Operations Management Plans (for more information see: https://www.nopsema.gov.au/safety/safety-case/what-is-a-safety-case/).
- The risk of a loss of containment of hydrocarbons or chemicals is managed through the equipment design process and the implementation of asset integrity and maintenance programs. In addition, process parameters are monitored 24 hours per day by trained and competent personnel who must follow documented procedures.
- Contractors utilised by Beach are subject to a prequalification process and assurance over their activities to ensure compliance with the Environment Plan.

Oil pollution emergency plan

An Environment Plan must also include an Oil Pollution Emergency Plan (OPEP) for managing any hydrocarbon release.

When conducting offshore activities, there is an unlikely risk of release of hydrocarbons (which are primarily gas) or a spill from vessels in the event of an accident. Beach will review its existing OPEP to ensure it includes potential spill risks associated with the proposed activities. The OPEP forms part of the Environment Plans required to be accepted by NOPSEMA for each activity.

Preparing an OPEP involves using hydrocarbons spill modelling information for the local area using the most conservative credible case scenario. The modelling calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the volume and physical and chemical properties of possible spills event. The OPEP also assess the likelihood and consequences of any oil spill which must be reduced to ALARP through a range of control measures and include detailed response plans.

The OPEP describes the arrangements for responding to and monitoring any release of hydrocarbon and includes:

- The control measures necessary for rapid response
- Response arrangements and capability in place to ensure rapid implementation and provide for the ongoing maintenance of capability
- Response arrangements and capability in place for monitoring oil pollution to inform response activities as well as monitoring the effectiveness of these activities

These arrangements are based on the worse case spill event associated with the proposed activities to ensure that Beach has the appropriate level of response arrangement and capability.

Key matters in the EP review

Key changes and updates for the revised Environment Plan include:

- Description of Beach as the current asset owner
- Description of Beach's health, safety and environment management system
- Revised impact and risk assessment that meets NOPSEMA's various guidelines released since acceptance of the existing Operations Environment Plan, to demonstrate that the environmental impacts and risks are of an acceptable level and ALARP.
- Revised environmental performance outcomes and environmental performance standards that reflect current best practice and will allow Beach to measure and report on its environmental performance.

The OPEP is not required to be updated as there is no change in the spill risk from the addition of the new Geographe production wells.

Consultation

Beach values stakeholder consultation and feedback. The purpose of consultation is to understand how different stakeholders' functions, interests and activities may be affected by the activities included in the EP.

Beach will consider all feedback, including any concerns and objections. Measures will be explored to reduce any impacts and risks, and responses will be provided to stakeholders.

All stakeholder feedback, records of consultation and copies of correspondence, including emails, will be considered alongside technical and environmental assessments as the Environment Plan is prepared for submission, and will be communicated to NOPSEMA as required by legislation.

Traditional Custodians

Beach would like to respectfully acknowledge the Eastern Maar peoples, the Traditional Custodians of the land on which the Otway Gas Development operates. Beach respects their historical and ongoing connection to country through cultural and spiritual sites, language and ceremony, and would like to pay our respect to their Elders past, present and future.

Questions and answers

How will you ensure that you operate safely?

Safety takes precedence in everything we do. Beach has over 60 years' experience in the oil and gas industry and our marine exploration, development and operations teams have extensive local and international experience. Our gas plant and offshore personnel undertake regular competency assessments and training to ensure their knowledge and skills meet strict operational requirements. We have stringent procedures for assessing, selecting and managing specialist contractors to carry out our marine activities to ensure they will keep our operations safe, operating in accordance with the Wells Operation Management Plan and Environment Plan.

What is a Petroleum Safety Zone (PSZ)?

Petroleum Safety Zones are administered by NOPSEMA under Section 616 of the Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act). PSZs may extend for a radius of up to 500 metres 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.

PSZs are currently in place around the Thylacine-A platform and the Geographe wells and infrastructure. The new Geographe-4 and 5 wells will be within the existing Geographe PSZ.

What is a Safety Case?

A Safety Case is a document that describes the Thylacine-A facility and related infrastructure, the associated hazards and risks and the safety management system in place to control and managed these risks. The Safety Case is revised every five years and is submitted NOPSEMA for acceptance. The purpose of the Safety Case is to demonstrate that the facility complies with the relevant requirements of the *Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations, 2009*.

What is ALARP?

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 completely eliminated. For information on how NOPSEMA assesses ALARP see: https://www.nopsema.gov.au/about/our-regulatory-activities/

What are the impacts to commercial fishing?

Petroleum Safey Zones (PSZs) of 500m radius around the Thylacine-A platform and 500m radius around the existing well heads and infrastructure have been in place for many years, and are marked on marine charts. Fishing cannot occur with those areas to minimise safety risks. Throughout Beach's consultation with the fishing sector and review of fishing effort information published by State and Commonwealth fishery authorities, Beach understands there is relatively low level of fishing activity in the vicinity of the platform, current and new wells. Given the vast fishery areas, the potential for impact is very minor.

During the drilling of new wells and construction of seabed infrastructure, Beach consults extensively with the commercial fishing sector to ensure each other's operations are understood, and potential impacts are minimized.

Isn't natural gas contributing to climate change?

Natural gas is an important partner for renewable energy to ensure stability of affordable fuel supply to homes and industry whilst our economy transitions to a greater percentage from renewables. Beach's Climate Change policy commitment ensures that our practices and procedures align and integrate climate risks into project decision making. For more information on Beach's sustainability commitments, see https://www.beachenergy.com.au/sustainability-2/

We welcome your questions and feedback

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6 of 6

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