Environment Plan

Trefoil Geophysical and Geotechnical Seabed Assessment

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

Revision	Date	Reason for issue	Reviewer/s	Consolidator	Approver
0	21/02/2020	Submission to NOSPEMA	PW	SJ	ZB
1	3/04/2020	Submission to NOSPEMA	PW	SJ	ZB
1A	08/10/2021	Revision submission to NOPSEMA – change of survey dates	WM	JE	WM
2	22/11/2021	RFFWI #1	WM/RP	JE	WM

Review due	Review frequency
N/A	N/A

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

Table of contents

Table of figures

List of tables

Acronyms

Terms/acronym	Definition/expansion
ADIOS	Automated Data Inquiry for Oil Spills
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
ANSI	American National Standards Institute
APPEA	Australian Petroleum Production and Exploration Association
ASAP	as soon as practicable
Beach	Beach Energy Limited
BIA	biologically important area
BOM	Bureau of Meteorology
CHIRP	compressed high-intensity radar pulse
CMT	Crisis Management Team
COLREG	Convention on the International Regulations for Preventing Collisions at Sea
CPT	cone penetrometer test
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTD	conductivity, temperature and depth
DAWE	Department of Agriculture, Water and Environment (Commonwealth)
DAWR	Department of Agriculture and Water Resources (Commonwealth) now Department of Agriculture, Water and Environment
DELWP	Department of Environment, Land, Water and Planning (Victorian)
DPIPWE	Department of Primary Industries, Parks, Water and Environment (Tasmanian)
DJPR	Department of Jobs, Precincts and Regions (Victorian)
DotEE	Department of the Environment and Energy (Commonwealth) now Department of Agriculture, Water and Environment
DP	dynamic positioning
EEZ	Exclusive Economic Zone
EIA	environmental impact assessment
EMBA	environment that may be affected
EMT	Emergency Management Team
EP	Environment Plan
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

HFO	heavy fuel oil
HSE	Health, Safety and Environment
OEMS	Operations Excellence Management System
IC	Incident Commander
IAPP	International Air Pollution Prevention
IMO	International Maritime Organisation
IMS	invasive marine species
JASCO	JASCO Applied Sciences
JRCC	Joint Rescue Coordination Centre
KEF	Key Ecological Features
Lattice	Lattice Energy Limited
MARPOL	International Convention for the Prevention of Pollution from Ships
MBES	multi-beam echo sounder
MC	Measurement criteria
MMO	Marine Mammal Observer
MNES	Matters of National Environmental Significance
MO	Marine Order
MOC	Management of Change
NatPlan	National Plan for Maritime Environmental Emergencies
NEBA	Net Environmental Benefit Analysis
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
OGUK	Oil and Gas UK
OPEP	Oil Pollution Emergency Plan
OPGGSA	*Offshore Petroleum and Greenhouse Gas Storage Act 2006*
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Commonwealth)
Origin	Origin Energy Resources Limited
OSTM	oil spill trajectory modelling
OWR	oiled wildlife response
PK	peak pressure level
PK-PK	peak-to-peak pressure level
PMS	planned maintenance system
POLREP	Marine Pollution Report
PSZ	Petroleum Safety Zone
PTS	permanent threshold shift
RMS	Root mean square
ROV	remotely operated underwater vehicle
SBES	single beam echo sounder
SBP	sub-bottom profiler
SEEMP	Ship Energy Efficiency Management Plan
SEL	sound exposure level

SEMR	South-east Marine Region
SETFIA	South East Trawl Fishing Industry Association
SITREP	Situation Reports
SIV	Seafood Industry Victoria
SMP	Scientific Monitoring Program
SMPEP	Shipboard Marine Pollution Emergency Plan
SMS	scientific monitoring study
SPL	sound pressure level
SSS	side scan sonar
SVP	Sound Velocity Profiler
TTS	temporary threshold shift
USBL	ultra-short baseline

1 Overview of the activity

Beach Energy (Operations) Limited (Beach) propose to undertake a geophysical and geotechnical seabed assessment (seabed assessment) within the Trefoil (T/RL2) and Yolla (T/L1) permits and open acreage within the Bass Strait in Commonwealth waters (

Figure 1-1). At its closest point, the seabed assessment area is approximately 89 km from Wilsons Promontory, Victoria and 89 km from Stanley, Tasmania.

The seabed assessment consists of a geophysical survey and geotechnical survey. It is part of the evaluation of a potential development of the Trefoil field and is required to determine the placement of a rig for future drilling of a well within the Trefoil field and for surveying a potential pipeline tieback route to the Yolla platform.

The geophysical survey and geotechnical survey will be undertaken separately and take up to 25 and 30 days respectively to complete, subject to operational and weather constraints. The surveys will occur sometime between 1st November 2021 and 31st December 2023, dependant on the availability of suitable vessels, weather and the receipt of required environmental approvals.

This EP is submitted to NOPSEMA pursuant to Regulation 17(5) of the OPGGS(E)R. It is a proposed revision to the accepted EP presently in force and is submitted to extend the timeframe for the activities from 31 December 2021 (specified in the EP presently in force) to 31st December 2023, as stated above. Note also that the duration of the geotechnical survey has been reduced from 55 to 30 days and it is highly unlikely that further geophysical surveys will be undertaken under this EP as they were completed in June 2020.

It is anticipated that there will be a seamless transition between the EPs with this revised EP taking over directly from the present in force EP.

The seabed assessment consists of:

- geotechnical survey to collect information on the properties of the seabed and the underlying shallow sediments using:
  - borehole sampling
  - core sampling
  - piezo cone penetrometer test
  - sediment sampling
  - drop camera
  - towed /remote operated video (no hydraulics)
- geophysical survey (if required) to collect bathymetry data and detect seabed hazards using:
  - multibeam echo sounder
  - side-scan sonar
  - sub-bottom profiler
  - magnetometer

The seabed assessment area refers to the area where the geophysical and geotechnical surveys will be undertaken. This will cover a 6 km x 6 km area over the proposed well location and a 1 km x 40 km corridor from the proposed well location to the Yolla platform and has an area of approx. 71 km^2. As the well location has not yet been finalised the seabed assessment area will be within the operational area which covers approx. 550 km^2. Water depths within the operational area range from 64 – 82 m.

1.1 Environment Plan summary

This Trefoil Geophysical and Geotechnical Seabed Assessment Environment Plan (EP) Summary has been prepared from material provided in this EP. The summary consists of the following as required by Regulation 11(4) of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R:

EP Summary Material Requirement	Relevant Section of EP Containing EP Summary Material
The location of the activity	Section 3.1.1
A description of the receiving environment	Section 4 and Appendix B
A description of the activity	Section 3
Details of the environmental impacts and risks	Section 6
The control measures for the activity	Section 6.5
The arrangements for ongoing monitoring of the titleholder's environmental performance	Section 7.12
Response arrangements in the oil pollution emergency plan	Section 6.4 and Section 8
Consultation already undertaken and plans for ongoing consultation	Section 9
Details of the titleholders nominated liaison person for the activity	Section 1.2

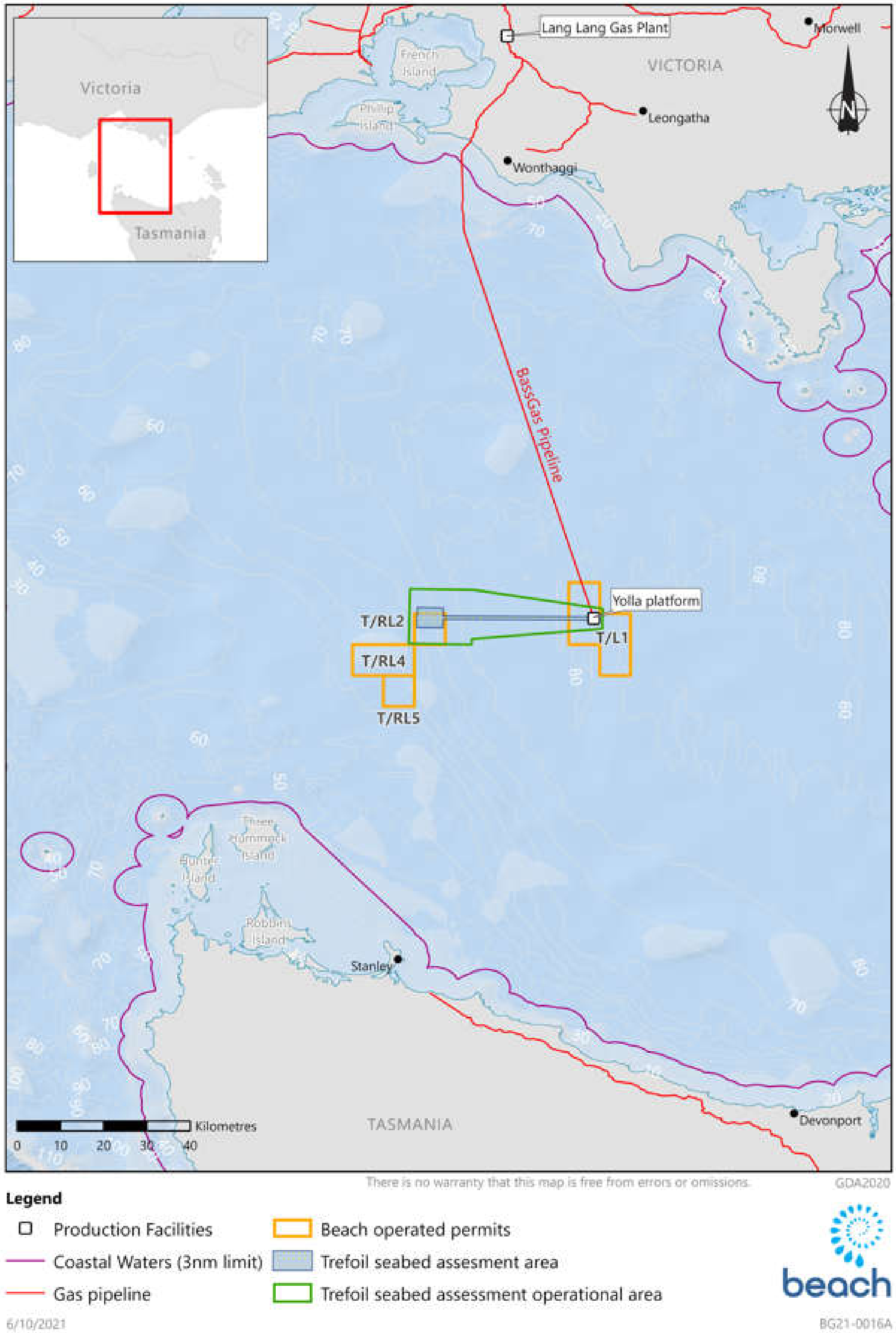


Figure 1-1: Trefoil seabed assessment area, operational area and associated permits

1.2 Titleholder and liaison person details

The titleholder is Beach Energy (Operations) Limited.

Beach is an ASX 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 from 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 Taranakiin New Zealand (Figure 1-2).

Table 1-1 details the titleholder and the liaison person for the titles applicable to the activity.

Beach shall notify the Regulator (National Offshore Petroleum Safety and Environmental Management Authority [NOPSEMA]) of a change to the 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 during the survey, in accordance with Regulation 15(3) of the OPGGS(E)R.

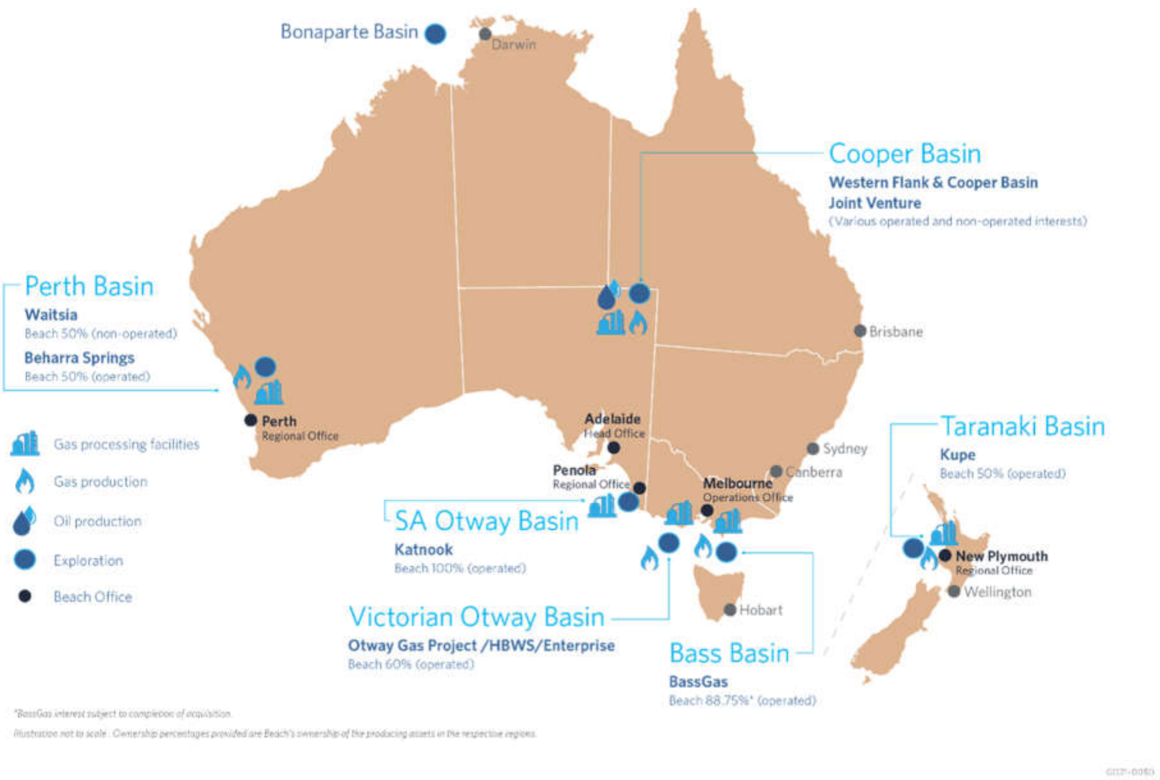


Figure 1-2: Beach operations across Australia and New Zealand

Table 1-1: Details of titleholder and liaison person

Petroleum Title(s)	**Details**	
T/L1	Titleholder(s)	Beach Energy (Operations) Limited (operator)
		AWE Petroleum Pty Ltd
		AWE (Bass Gas) Pty Ltd
		Prize Petroleum International Pty Ltd
		Beach Energy Ltd
		Beach Energy (Bass Gas) Limited
T/RL2	Titleholder(s)	Beach Energy (Operations) Limited (operator)
		AWE Petroleum Pty Ltd
		Beach Energy Ltd
		Prize Petroleum International Pty Ltd
Titleholder for the activity	Titleholder	Beach Energy (Operations) Limited
	Business address	Level 8 80 Flinders Street Adelaide South Australia 5000
	Telephone number	(08) 8338 2833
	Email address	info@beachenergy.com.au
	Australian Company Number	Beach Energy (Operations) Limited (ACN: 007 845 338)
Titleholder Liaison Person		
Wayne Mothershaw Seismic Acquisition and Survey lead	Business address	Level 8 80 Flinders Street Adelaide South Australia 5000
	Telephone number	(08) 82253465
	Email address	wayne.mothershaw@beachenergy.com.au

NB: Beach Energy (Operations) Limited has acquired AWE's interest in T/RL2 and T/L1. Transfer applications were lodged with NOPTA on 13 August 2021 (T/L1: NEATS Ref SK78B5 and T/RL2: NEATS Ref S5RB5B)

2 Environmental requirements

This section provides information on the requirements that apply to the activity, in accordance with Regulation 13(4) of the OPGGS(E)R. 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 activity is planned solely within Commonwealth waters. Commonwealth legislation (including relevant international conventions) and other requirements relevant to the seabed assessment are summarised in Table 2-1.

2.1 EPBC Act management plans

Table 2-2 details the recovery plans, threat abatement plans and species conservation advices applicable to species that may be present within environment that may be affected (EMBA) by the seabed assessment's planned and unplanned activities. This is further detailed in Section 4. Where an applicable threat or management advice has been identified relevant to the seabed assessment's planned and unplanned activities, this is addressed in Section 6.

Table 2-1: Commonwealth environmental requirements relevant to the seabed assessment

Legislation/Regulation	Scope	Related International Conventions	Administering Authority
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 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 Section 8.*	• International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 • Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000 • International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 1969 • Articles 198 and 221 of the United Nations Convention on the Law of the Sea 1982	Australian Maritime Safety Authority (AMSA)
Australian Ballast Water Management Requirements (DAWR, 2017)	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. *Table 6-2 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, Water and Environment (DAWE)
Biosecurity Act 2015 Biosecurity Regulations 2016	This Act replaced the *Quarantine Act 1908* in 2015 and is the primary legislation for the management of the risk of diseases and pests that may cause harm to human, animal or plant health, the environment and the economy. The objects of this Act are to provide for: (a) managing biosecurity risks; human disease; risks related to ballast water; biosecurity emergencies and human biosecurity emergencies;	• International Convention for the Control and Management of Ships' Ballast Water and Sediments (adopted in principle in 2004 and in force on 8 September 2017)	DAWE

Legislation/Regulation	Scope	Related International Conventions	Administering Authority
	(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 nm from the coastline. For the activity the Act regulates vessels entering Australian territory regarding ballast water and hull fouling. *Biosecurity risks associated with the activity are detailed in Table 6-2.*		
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; and • 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 describes matters protected under Part 3 of the EPBC Act.*	• 1992 Convention on Biological Diversity and 1992 Agenda 21 • Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 • Agreement between the Government and Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment 1974 • Agreement between the Government and Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 • Agreement between the Government of Australia and the Government of the Republic of Korea on The Protection of Migratory Birds 2006 • Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971 (Ramsar)	DAWE

Legislation/Regulation	Scope	Related International Conventions	Administering Authority
	The EP must assess any actual or potential impacts or risks to MNES from the activity. *Section 6 provides an assessment of the impacts and risks from the activity to matters protected under Part 3 of the EPBC Act.*	• International Convention for the Regulation of Whaling 1946 • Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979	
Environment Protection 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 if a cetacean is sighted. *Section 6 details how these requirements will be applied.*	-	DAWE
EPBC Policy Statement 2.1 Interaction between offshore seismic exploration and whales	Provide practical standards to minimise the risk of acoustic injury to whales in the vicinity of seismic survey operations and provides 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. **Application to activity**: Provides a framework for minimising acoustic disturbances to whales if geophysical activities are undertaken *Section 6 details how these requirements will be applied.*		DAWE
Marine Pest Plan 2018–2023: the National Strategic Plan for Marine Pest Biosecurity (DAWR, 2018)	The visions of the *Marine Pest Plan is*: *Maintaining Australia's healthy and resilient marine environment that is protected from the threat of marine pests, and which supports our economy and social amenity.* While the vision sets the broad direction for the future of marine pest biosecurity in Australia, *Marine Pest Plan 2018–2023* describes the steps to make this vision a reality, and the outcomes to achieve over the next five years. **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. *Sections 6 details the requirements applicable to vessel activities.*	-	DAWE
National Biofouling Management	The guidance document provides recommendations for the management of biofouling hazards by the petroleum industry.	• Certain sections of MARPOL	DAWE

Legislation/Regulation	Scope	Related International Conventions	Administering Authority
Guidelines for the Petroleum Production and Exploration Industry 2009 (Marine Pest Sectoral Committee, 2018)	**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. *Sections 6 details the requirements applicable to vessel activities.*	• International Convention for the Safety of Life at Sea 1974 • Convention on the International Regulations for Preventing Collisions at Sea (COLREG) 1972	
National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (Commonwealth of Australia, 2020)	The Guidelines outline the process to be followed where there is the potential for artificial lighting to affect wildlife. They apply to new projects, lighting upgrades (retrofitting) and where there is evidence of wildlife being affected by existing artificial light. **Application to activity**: Applying the recommendations within this document and implementing effective controls can reduce the impact of light on light sensitive species. *Sections 6 details the requirements applicable to vessel activities.*	-	DAWE
National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (Commonwealth of Australia, 2017c)	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 6 details the requirements applicable to vessel activities.*	-	DAWE
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/Regulation	Scope	Related International Conventions	Administering Authority
	Application to activity: The relevant vessels (according to class) will adhere to the relevant Marine Orders regarding navigation and preventing collisions in Commonwealth waters. *Sections 6 details the requirements applicable to vessel activities.*		
Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGSA) 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 as low as reasonably practicable (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 6.*	-	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.	• Various parts of MARPOL	AMSA

Legislation/Regulation	Scope	Related International Conventions	Administering Authority
	Several MOs are enacted under this Act relating to offshore petroleum activities, including: • MO 91: Marine Pollution Prevention – Oil. • MO 93: Marine Pollution Prevention – Noxious Liquid Substances. • MO 94: Marine Pollution Prevention – Packaged Harmful Substances. • MO 95: Marine Pollution Prevention – Garbage. • MO 96: Marine Pollution Prevention – Sewage. • MO 97: Marine Pollution Prevention – Air Pollution. *Sections 6 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. *Sections 6 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	This Act replaces the *Historic Shipwreck Act* 1976. The Act provides for the protection of Australia' underwater cultural heritage. It protects the heritage values of remains of vessels, aircraft and certain associated articles that have been in Commonwealth waters for at least 75 years. Vessels and aircraft that have been underwater less than 75 years, and other types of underwater cultural heritage, can be protected through individual declaration based on an assessment of heritage significance. **Application to activity**: Provisions under the Act are applicable to the activity in the event of removal, damage or interference to items of	• Agreement between the Netherlands and Australia concerning old Dutch Shipwrecks 1972	DAWE

Legislation/Regulation	Scope	Related International Conventions	Administering Authority
	underwater cultural heritage and/or the activity is proposed within an Underwater Protected Heritage Zone. *Section 4 details that there are no Underwater Protected Heritage Zones within the environment that may be affected (EMBA). If any remains of vessels, aircraft and associated articles are located during the seabed assessments, they will be reported as per Table 7-5.*		
Acoustic impact evaluation and management (NOPSEMA 2020c)	Advice to titleholders to assist with preparing EPs for marine seismic survey activities, and in particular the components of an EP that relate to detailing, evaluating and managing impacts from acoustic emissions. **Application to activity:** Advice regarding impact assessment. *Sections 6 details the requirements applicable to underwater acoustic emissions.*		NOPSEMA

Table 2-2: Recovery plans, threat abatement plans and species conservation advices relevant to the activity

Relevant Plan/Advice	Applicable Threats or Management Advice
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. Objective The plan provides national guidance on action to prevent and mitigate the impacts of harmful marine debris on vertebrate marine life.
Fish	
Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013)	**Objective** The overarching objective of this recovery plan is to assist the recovery of the white shark in the wild throughout its range in Australian waters. **Threats**: • none identified applicable to the activity.
Seabirds	
Draft Wildlife Conservation Plan for Seabirds (CoA 2019)	Provides a framework to guide the conservation of 76 seabird species and their habitat in Australia, and in recognition of their migratory and oceanic habits, outlines activities to support their conservation. **Objective** Seabirds and their habitats are protected and managed in Australia. **Threats**: • Habitat loss/ modification • Anthropogenic disturbance • Invasive species • Pollution (marine debris/light/water)
Wildlife Conservation Plan for Migratory Shorebirds (DoEE 2015)	**Objective:** Anthropogenic threats to migratory shorebirds in Australia are minimised or, where possible, eliminated **Threats:** • Habitat loss/ modification • Anthropogenic disturbance
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. **Objective**

Relevant Plan/Advice	Applicable Threats or Management Advice
	The overall objective of the 2011-2016 recovery plan is to ensure the long-term survival and recovery of albatross and giant petrel populations breeding and foraging in Australian jurisdiction by reducing or eliminating human related threats at sea and on land. **Threats** • **Marine pollution**: Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented. • **Marine debris**: Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented.
Gould's petrel (*Pterodroma leucoptera leucoptera)* Recovery Plan (DoEC (NSW) 2006)	Recovery plan identifies actions to be taken to ensure the long-term viability of the Gould's petrel in nature and the parties who will carry these out. **Objective** The overall objective of the Gould's petrel recovery effort is for Gould's petrel to be down listed from endangered to vulnerable by 2011. **Threats** • none identified applicable to the activity.
National Recovery Plan for the Orange-bellied Parrot (*Neophema chrysogaster*) (DELWP, 2016)	The recovery plan is a co-ordinated conservation strategy for the orange-bellied parrot. **Objective** The long-term recovery objective is to have a wild population of the orange-bellied Parrot that, with limited species-specific management, has a high likelihood of persistence in nature for 100 years. **Threats:** • Degradation and loss of habitat. • Barriers to migration and movement
Approved Conservation Advice for *Sternula nereis nereis* (fairy tern) (DSEWPaC, 2011b)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the fairy tern. **Objective** None specified. **Threats** • **Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.

Relevant Plan/Advice	Applicable Threats or Management Advice
Draft National Recovery Plan for the Australian Fairy Tern (*Sternula nereis nereis*) (Commonwealth of Australia, 2019)	Draft recovery plan for actions so species no longer qualifies for listing as threatened under any of the EPBC Act listing criteria. **Objective** The Australian Fairy Tern population has increased in size to such an extent that the species no longer qualifies for listing as threatened under any of the Environment Protection and Biodiversity Conservation Act 1999 listing criteria. **Threats** • Habitat degradation and loss of breeding habitat • Pollution
Conservation Advice *Calidris canutus* (red knot) (TSSC, 2016)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the red knot. **Objective** None specified. **Threats** • **Marine pollution**: Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.
Conservation Advice for the *Halobaena caerulea* (blue petrel) (TSSC, 2015a)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the blue petrel. **Objective** None specified. **Threats** • none identified applicable to the activity.
Conservation Advice for *Calidris ferruginea* (curlew sandpiper) (DoE, 2015a)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the curlew sandpiper. **Objectives** The objective for curlew sandpiper is to minimise disturbance at key roosting and feeding sites while maintaining and enhancing important habitats to achieve a stable or increasing habitat. **Threats** • **Marine pollution**: Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented

Relevant Plan/Advice	Applicable Threats or Management Advice
Conservation Advice for *Numenius madagascariensis* (eastern curlew) (DoE, 2015b)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the eastern curlew. **Objectives** The objective for Eastern curlew is to minimise disturbance at key roosting and feeding sites while maintaining and enhancing important habitats to achieve a stable or increasing habitat. **Threats** • none identified applicable to the activity.
Approved Conservation Advice for *Pachyptila turtur subantarctica* (fairy prion) (TSSC, 2015b)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the fairy prion. **Objective** None specified. **Threats** • none identified applicable to the activity.
Conservation Advice for *Ardenna carneipes* (flesh-footed shearwater). (TSSC, 2014)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the flesh-footed shearwater. **Objective** None specified. **Threats** • none identified applicable to the activity.
Conservation Advice for *Pterodroma mollis* (soft-plumaged petrel) (TSSC, 2015c)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the soft-plumaged petrel. **Objective** None specified. **Threats** • none identified applicable to the activity.
Marine Reptiles	
Recovery Plan for Marine Turtles in Australia, 2017-2027 (Commonwealth of Australia, 2017a)	This plan is a national plan which aims to aid in the recovery of six of the world's seven species of marine turtles; loggerhead (*Caretta caretta*), olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), flatback (*Natator depressus*) and hawksbill (*Eretmochelys imbricata*) turtles.

Relevant Plan/Advice	Applicable Threats or Management Advice
	Objective The long-term recovery objective for marine turtles is to minimise anthropogenic threats to allow for the conservation status of marine turtles to improve so that they can be removed from the EPBC Act Threatened species list. **Threats** • chemical and terrestrial discharge. • marine debris. • light pollution. • habitat modification. • vessel strike. • noise interference. • vessel disturbance. • climate change.
Approved Conservation Advice for *Dermochelys coriacea* (leatherback turtle) (DEWHA, 2008)	There is a long-term recovery objective for leatherback turtles to minimise anthropogenic threats to allow for the conservation status of marine turtles to improve so that they can be removed from the EPBC Act Threatened species list. Refer to the recovery plan for marine turtles in Australia, 2017-2027. **Objective** To minimise anthropogenic threats to allow for the conservation status of leatherback turtles to improve so that they can be removed from the EPBC Act Threatened species list. **Threats** • marine debris. • light pollution. • vessel strike. • noise interference. • vessel disturbance.

Relevant Plan/Advice	Applicable Threats or Management Advice
Marine Mammals	
Conservation Management Plan for the Blue Whale, 2015-2025 (Commonwealth of Australia, 2015)	The long-term recovery objective for blue whales is to minimise anthropogenic threats to allow for their conservation status to improve so that they can be removed from the EPBC Act threatened species list. **Objective** The long-term recovery objective for blue whales is to minimise anthropogenic threats to allow for their conservation status to improve so that they can be removed from the EPBC Act threatened species list. **Threats** • 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.
Conservation Management Plan for the Southern Right Whale 2011-2021 (DSEWPaC, 2012)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the southern right whale. **Objective** None specified. **Threats** • 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. • marine debris: evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented.
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. **Objective** None specified. **Threats** • noise Interference: evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented.

Relevant Plan/Advice	Applicable Threats or Management Advice
	• vessel disturbance: evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015e)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the humpback whale. **Objective** None specified. **Threats** • 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. • marine debris: evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented.
Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015d)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the sei whale. **Objective** None specified. **Threats** • 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.

3 Description of the activity

This section provides a description of the petroleum activity, including the details of the location in which the activities will occur, in accordance with Regulation 13(1) of the OPGGS(E)R.

The seabed assessment will compose of a geophysical survey and a geotechnical survey with the objective to:

- investigate sub-seabed geological conditions at the proposed well location for detailed soils classification and integration with other investigations for assessment of foundation conditions.
- identify potential seabed debris and obstructions.
- identify and map the nature and distribution of seabed surface types.
- accurately measure water depth and map seabed topography.

3.1 Activity location and timing

3.1.1 Activity Location

The proposed seabed assessment area and operational area are shown in Figure 3-1 with coordinates for the operational area in Table 3-1.

The seabed assessment area refers to the area where the geophysical and geotechnical surveys will be undertaken. This will cover a 6 km x 6 km area over the proposed well location and a 1 km x 40 km corridor from the proposed well location to the Yolla platform. The seabed assessment area covers approx. 71 km^2 as there is an area of overlap between the 6 km x 6 km area and the 1 km x 40 km corridor. As the well location has not yet been finalised the seabed assessment area will be within the operational area which has an area of 552 km^2.

For the purposes of this EP, activities performed by a vessel when outside the operational area is not covered by the OPGGS(E)R and therefore not addressed within this EP

Table 3-1: Geospatial coordinates of the operational area (GDA 94)

Figure 3-1 Label	Latitude	Longitude
A	39° 45.9169' S	145° 19.4006' E
B	39° 46.0565' S	145° 29.5788' E
C	39° 49.1022' S	145° 50.5330' E
D	39° 52.3522' S	145° 50.4784' E
E	39° 54.0244' S	145° 29.4045' E
F	39° 54.9139' S	145° 29.3849' E
G	39° 54.7736' S	145° 19.1849' E

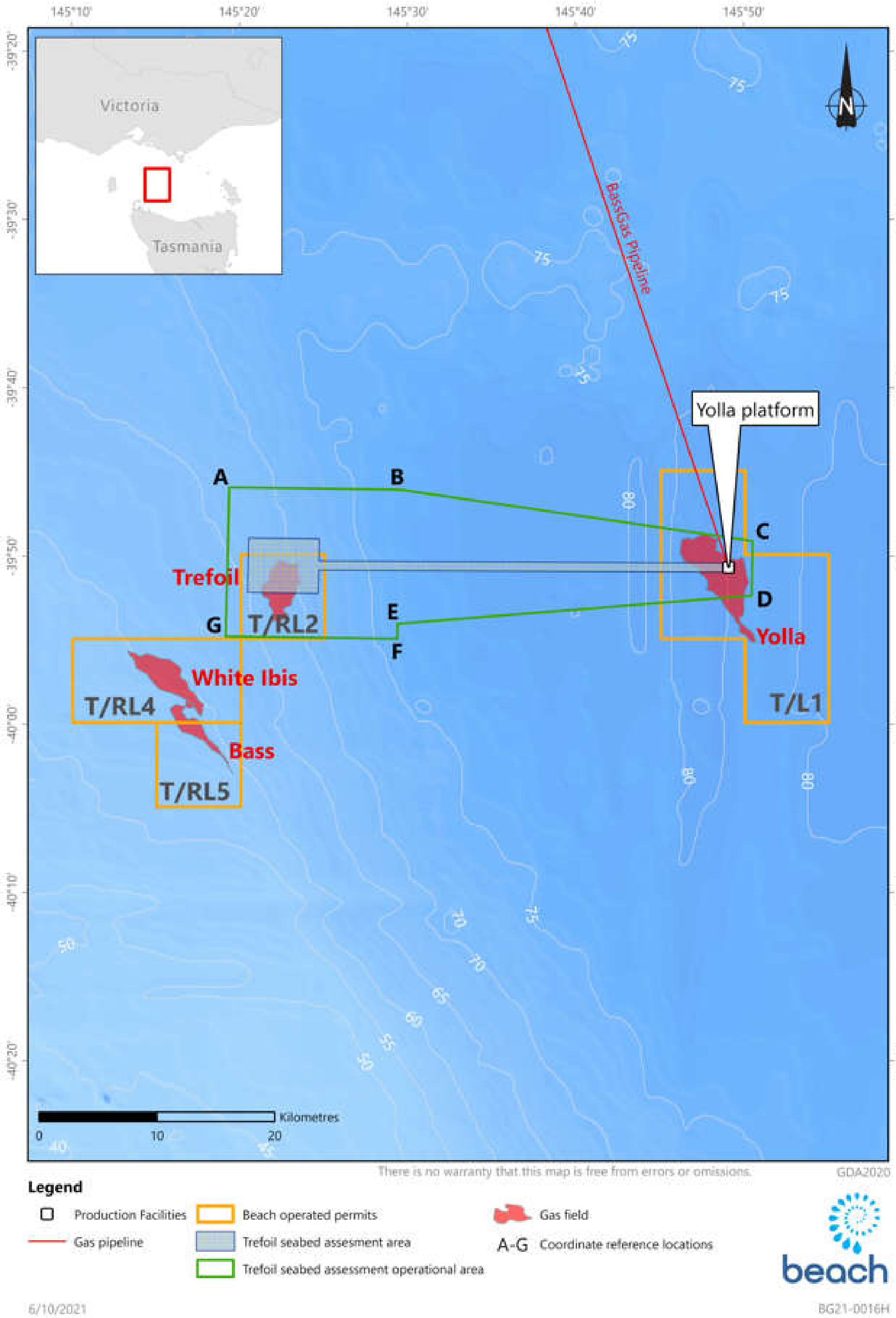


Figure 3-1: Trefoil seabed assessment area, operational area and permits

3.1.2 Activity timing

The geophysical survey and geotechnical survey may be undertaken by the same vessel or as separate surveys and take up to 25 days and 30 days respectively, between 1 November 2021 and 31 December 2023.

If the geophysical survey and geotechnical survey are undertaken as separate surveys they will not be undertaken at the same time.

Timings and durations for the geophysical and geotechnical surveys are contingent on the availability of suitable vessels, weather and the receipt of environmental approvals.

3.2 Survey activities

3.2.1 Geophysical survey

The equipment to be used for the geophysical survey is described in Table 3-2 and shown in Figure 3-2.

Within the 6 km x 6 km assessment area the line spacing will consist of nominal 100 m spaced primary lines with crosslines spaced at 500 m. For the 40 km corridor line spacing will consist of nominal 100 m spaced primary lines with crosslines spaced at 1,000 m.

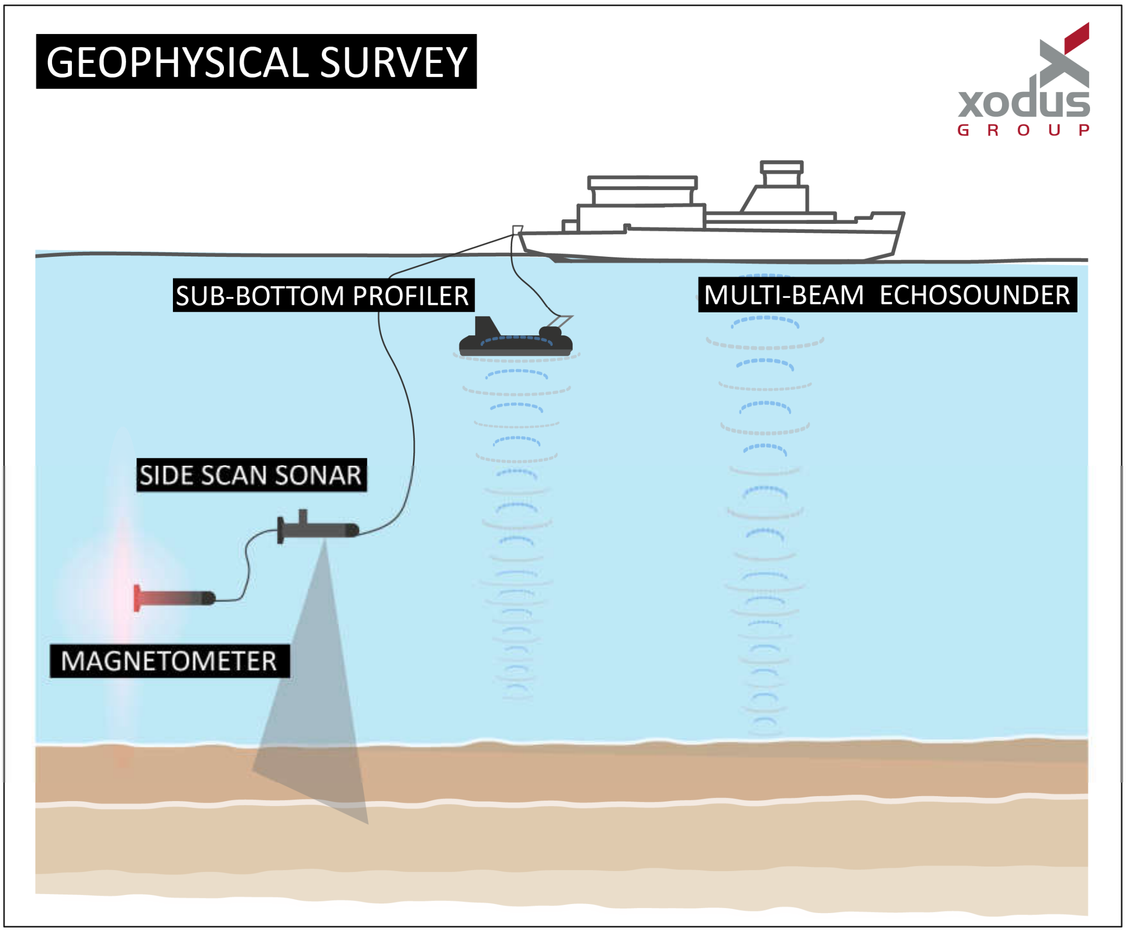


Figure 3-2: Geophysical survey equipment

3.2.2 Geotechnical survey

The scope and equipment to be used for the geotechnical survey is described in Table 3-3 and shown in Figure 3-3.

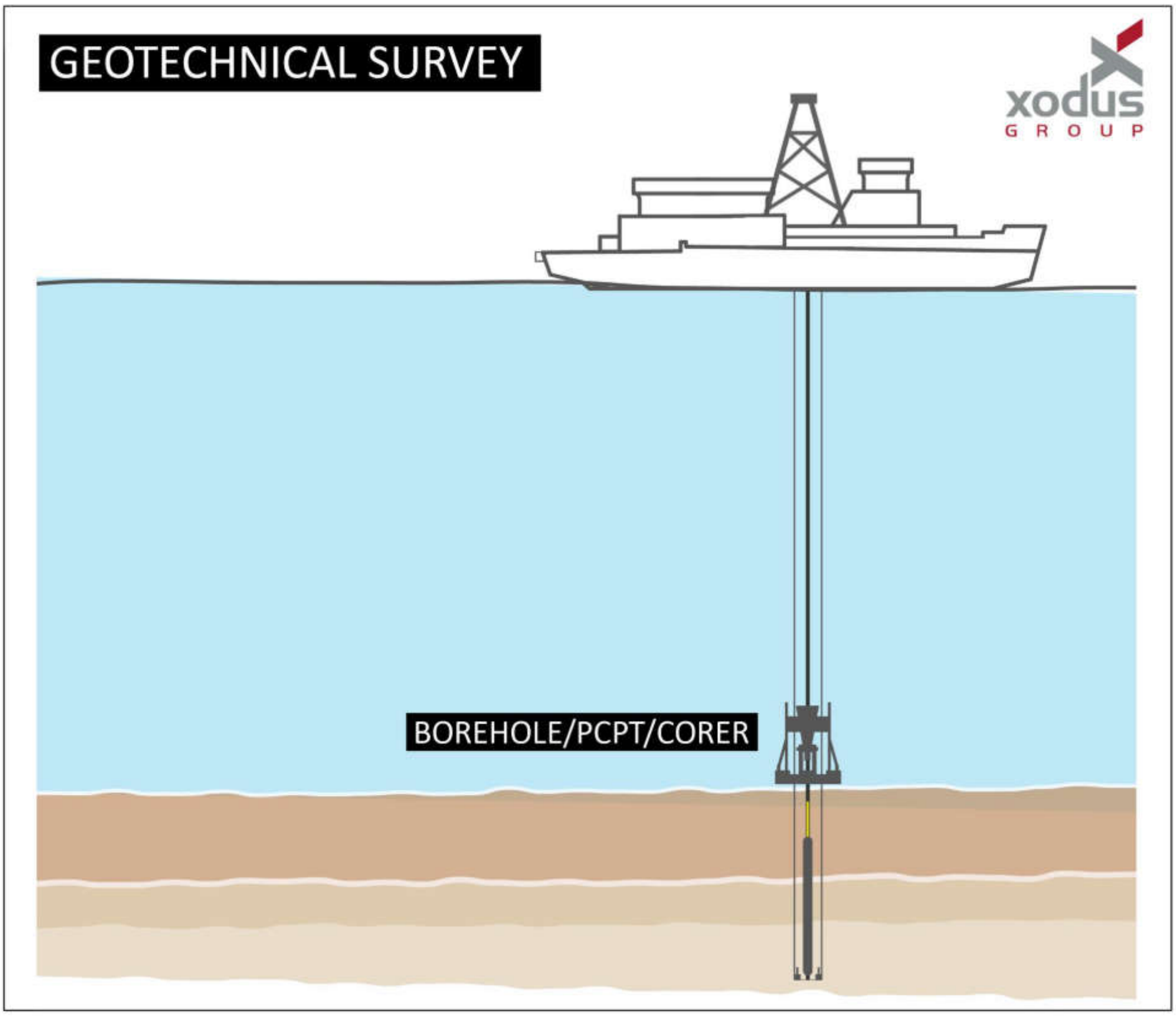


Figure 3-3: Geotechnical survey equipment

3.3 Vessel activities

The geophysical and geotechnical surveys may be undertaken from the same vessel or from separate vessels. However, there will only be one vessel undertaking a survey at a time.

While undertaking the geophysical survey the vessel will travel at approximately 4–5 knots (7–9 km/hr). For the geotechnical survey the vessel will be stationary and use dynamic positioning (DP) or propellers to maintain position as water depths are too deep for anchoring.

The use of support vessels is not required.

Vessel refuelling and crew change will occur at port.

Table 3-2: Description of geophysical survey activities

Equipment	Purpose	Activity Details
Multi-beam echosounder (MBES)	Measure bathymetry.	A MBES mounted on the vessel hull is typically used. A MBES acquires a wide swath (strip) of bathymetry data perpendicular to the vessel track and provides total seabed coverage with no gaps between vessel tracks. A MBES transmits a broad acoustic pulse from a transducer over a swath across a vessel track. The MBES then forms a series of received beams that are each much narrower and form a 'fan' (with a half-angle of 30-60°) across the seabed, perpendicular to the vessel track. The transducer(s) then 'listen' for the reflected energy from the seabed. The fans of seabed coverage produce a series of strips along each track, which are lined up side-by-side to generate two dimensional georeferenced bathymetric maps of the seabed.
Side scan sonar (SSS)	Detects hazards such as existing pipelines, lost shipping containers, boulders, debris, unmarked wrecks, reefs and craters.	The SSS method of surveying generates oblique acoustic images of the seabed by towing a sonar 'towfish.' The towfish is provided with power and digital telemetry services and towed from the vessel using a reinforced or armoured tow cable. The towfish is equipped with a linear array of transducers that emit, and later receive, an acoustic energy pulse in a specific frequency range. Typically, a dual-channel, dual-frequency SSS is used. SSS is like MBES but operates at a wider fan angle. The acoustic energy received by the towfish (backscatter) provides information as to the general distribution and characteristics of the surficial sediment and outcropping strata. Shadows result from areas of no energy return, such as shadows from large boulders or sunken ships, and aid in interpretation of the sonogram image. The towfish is constructed of stainless steel and is a cylindrical torpedo-like device. It is typically towed 10-15 m above the seabed depending on water depth and the frequency range. The SSS is operated at the same time as the MBES.
Sub-bottom profiler (SBP)	SBP is used to investigate the layering and thickness of the uppermost seabed sediments. The SBP imagery penetrates to a minimum depth of at least 30 m below the seabed.	**Compressed High-Intensity Radar Pulse (CHIRP)** Very high frequency systems including pingers, parametric echo sounding and CHIRP – produce a swept-frequency signal. CHIRP systems usually employ various types of transducers as the source. The transducer that emits the acoustic energy also receives the reflected signal. CHIRP signals typically penetrate only about 5-10 m into the seabed and provide the best resolution, but lowest penetration. A CHIRP is normally hull mounted when used for shallow water operations but may also be towed in a similar fashion to the SSS.

Equipment	Purpose	Activity Details
		High-frequency boomers High frequency boomers generate a broadband, high amplitude impulsive acoustic signal in the water column that is directed vertically downward. Boomers are mostly surface towed but may also be towed below the surface to avoid sea surface wave related noise and movement. The receiver for the boomer system is usually a hydrophone or hydrophone array consisting of a string of individual hydrophone elements. They typically contain eight to 12 hydrophone elements evenly spaced in a tube that is 2.5 to 4.5 m in length and 25 mm in diameter. The SBP system is towed and operated at the same time as the MBES and SSS. The SBP survey is likely to be undertaken in two passes in conjunction with the MBES and SSS.
Magnetometer	This equipment detects metallic objects on or below the seabed (e.g. buried pipelines, petroleum wellheads, shipwreck debris and dropped objects such as unexploded ordnance, cables, anchors, chains) that may not be identified using acoustic techniques.	A magnetometer sensor is housed in a towfish and is towed as close to the seabed as possible and sufficiently far away from the vessel to isolate the sensor from the magnetic field of the vessel. The magnetometer survey will be conducted at the same time as the MBES, SSS and SBP. The magnetometer towfish is constructed of stainless steel and is a cylindrical torpedo-like type device.
Ultra-Short Baseline (USBL)	Used for positioning the SSS and geotechnical equipment.	The side scan sonar towfish and geotechnical equipment are positioned utilising ultra-short baseline (USBL) methods. It is necessary to calibrate the transceiver, which is usually deployed on retractable pole under the vessel, or over the side. The calibration requires a transponder to be deployed on the sea floor, at working depth and the vessel; surveys a pattern around the transponder to ascertain the error (pitch, roll, heading & velocity) of the USBL transceiver. The transponder is lowered to the seabed with a sandbag fitted with an acoustic release. Once the calibration is complete, the acoustic release is triggered, and the transponder recovered. The sandbag anchor remains on the seabed. During the Otway seabed survey, a hessian bag was utilised filled with sand. As the calibration must be completed at working depth and close passes are required it is impractical to buoy the transponder/sandbag, without the risk of entanglement. The USBL sandbag will cover an area of 0.2 m^2.

Table 3-3: Description of geotechnical assessment activities

Activity	Purpose	Activity Details
Borehole sampling	Obtain core samples for geological analysis of formations below the seabed.	Borehole sampling involves drilling through seabed sediments with an open-centred drill bit used to recover the seabed core sample. Drilling will either be undertaken from the survey vessel or using a sea floor drilling system. The seafloor drilling systems is lowered to the seabed for the survey vessel. Both techniques require a guide base on the seafloor ~ 2.5 m x 2.5 m with a footprint of ~ 6.25 m^2. Borehole sampling generates minimal cuttings as the aim of the sample is to recover the core. Based on experience cuttings are typically generated in the top 5 m of the borehole with the rest of the borehole material trapped within the core tube. Thus, for a 0.35 m diameter borehole the estimated volume of cuttings is 0.48 m^3. Bentonite and/or seawater will be used to lubricate and cool the drill bit. 6 km x 6 km area: 7 x 150 m boreholes 1 x 40 km corridor: 2 x 150 m boreholes Total footprint: 56.25 m^2.
Piezo Cone Penetration Test (PCPT)	Determine soil strength and helps to delineate soil stratigraphy.	PCPT involves the in-situ measurement of the resistance of ground to continuous penetration. This process involves lowering a frame to the seabed and pushing the PCPT unit into the sediment at a steady penetration rate (usually 2 cm per second). A frame is lowered to the seabed with the PCPT unit integrated into it and operated remotely. When the required penetration depth is reached, all equipment is withdrawn from the seabed. A small hole will remain in the seabed, which will eventually collapse and infill with the movement of seabed sediments. The PCPT frame is ~ 5 m x 1 m with a footprint of ~ 5 m^2. The piezo cone is ~ 10 cm in diameter and penetrates the seabed from 10 to 60 m. 6 km x 6 km area: 28 PCPTs 1 x 40 km corridor: 48 PCPTs Total footprint: 380 m^2.

Activity	Purpose	Activity Details
Box core	Obtain core samples for geological analysis.	A box core is used to collect core samples from soft, unconsolidated sediment. The corer is lowered to the seabed and then the instrument is triggered by a trip as the main coring stem passes through its frame. The stem has a weight of up to 800 kg to aid penetration. While pulling the corer out of the sediment a spade swings underneath the sample to prevent loss of the core. The box core is ~ 0.8 m x 0.8 m with a footprint of ~0.64 m^2. The box core penetrates the seabed to ~ 1m. 6 km x 6 km area: 10 box cores 1 x 40 km corridor: 20 box cores Total footprint: 19.2 m^2.
Vibro core	Obtain core samples for geological analysis.	Vibrocoring is a technique for collecting core samples in unconsolidated sediments by using a vibrating device to drive a coring tube into the seabed. Typically, two large electrical motors power two concentric weights, which produce the necessary vibration. Once the unit is on the seabed, the high-power vibrator motors are engaged and drive the core barrel with PVC liner into the seabed. The vibro core frame is ~ 5 m x 5 m with a footprint of ~25 m^2. The vibro core has a diameter of ~ 15 cm and penetrates the seabed to ~ 4 m. 6 km x 6 km area: 10 vibro cores 1 x 40 km corridor: 20 vibro cores Total footprint: 750 m^2.
Gravity core	Obtain core samples for geological analysis.	Gravity coring is normally used on soft, unconsolidated sediment. A gravity corer is a general-purpose tool that relies on its weight for penetration into the seafloor. It is lowered to a predetermined height above the seabed using a wire rope before being allowed to freefall. The resulting core enters the internal sleeve and is held in place by a core catcher. The gravity core has a diameter of ~15 cm with a footprint of ~0.018 m^2. The gravity core penetrates the seabed to ~ 4 m. 6 km x 6 km area: 10 gravity cores 1 x 40 km corridor: 20 gravity cores Total footprint: 0.54 m^2.

Activity	Purpose	Activity Details
Van veen grab	Collecting small samples of surface sediments from the seafloor.	A Van Veen grab sampler is a light weight sampler designed to take samples in soft seabed sediments. It has long lever arms and sharp cutting edges on the bottom of the scoops (like a set of jaws) which enable it to cut into the seabed. The sampler is lowered to the seabed via a winch. Only surface sediments are collected and the sampler has no ability to penetrate to depth. Up to 100 samples may be collected along the pipeline route. Other samples may be obtained at areas of interest as identified visually by the camera (up to 40 to be conservative) The grab sample can leave a hole 0.4 m x 0.4 m (footprint ~0.16 m^2) and be up to 20 cm deep. 6 km x 6 km area: 40 samples 1 x 40 km corridor: 100 samples Total footprint: 22.4 m^2.
Tow camera Drop camera	To visually observe the physical and biological environment	Cameras will be operated off the back of the survey vessel. No impacts.

4 Existing environment

In accordance with Regulation 13(2) of the OPGGS(E)R, this section provides a description of the physical, ecological and social receptors of the environment that may be affected (EMBA) (Figure 4-1). A detailed description of the environment is provided in Appendix B for the physical, ecological, social receptors identified.

4.1 Environment that may be affected (EMBA)

The largest EMBA for the activity has been identified from a maximum credible hydrocarbon spill event. The EMBA is based on hydrocarbon exposure for the unplanned release of marine diesel oil from a vessel collision (Section 6.3). This was modelled using the Automated Data Inquiry for Oil Spills (ADIOS II) and reached 5 km from the seabed assessment operational area (Section 6.3). Figure 4-1 shows the EMBA and seabed assessment operational area.

An EPBC Protected Matters Report was generated for the EMBA (5 km around the operational area) (See Appendix A.1; accessed September 2021).

Threatened species recovery plans, threat abatement plans and species conservation advices relevant to identified receptors are detailed in Table 2-2.

4.1.1 Physical, ecological, socio-economic and cultural receptors

The EMBA and operational area are in the South-East Marine Region (SEMR), which extends from the south coast of New South Wales to Kangaroo Island in South Australia and around Tasmania.

The following tables list the presence of physical (Table 4-1), ecological (Table 4-2) and socio-economic and cultural (Table 4-3) receptors that may occur within the EMBA and operational area.

4.2 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.

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:

  a. Commonwealth marine area within the meaning of that Act; or

  b. 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) or habitat critical to survival – as they are spatially defined areas where aggregations of individuals of a regionally significant species are known to display biologically important behaviours such as breeding, foraging, resting or migration.

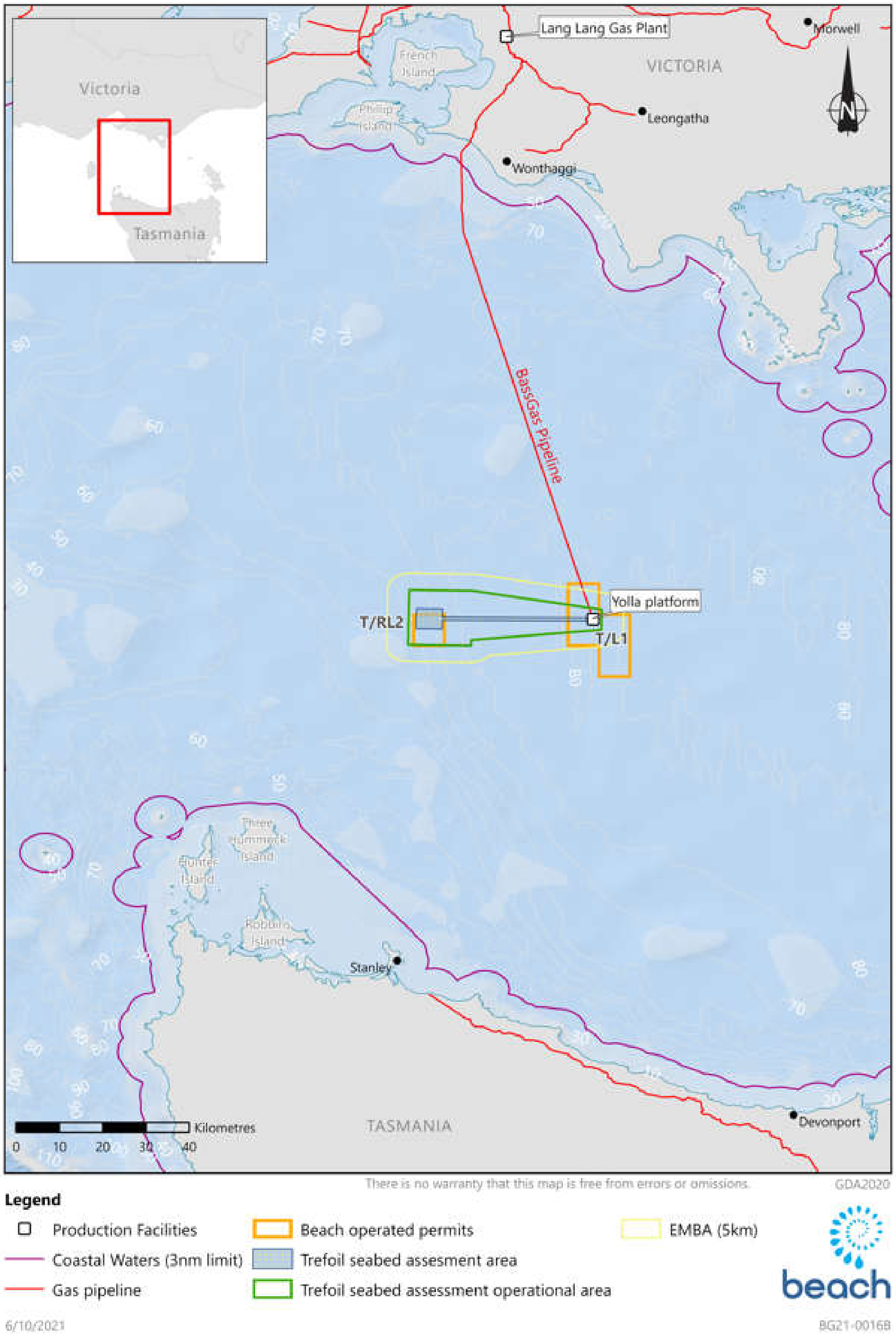


Figure 4-1: Environment that may be affected

Table 4-1: Presence of physical receptors within the EMBA and operational area

Receptor Type	Receptor Description	Values and Sensitivities	Present EMBA and Operational Area	Description
Shoreline	Rocky	• foraging habitat (e.g. birds) • nesting or breeding habitat (e.g. birds, pinnipeds) • haul-out sites (e.g. pinnipeds)	-	The EMBA and operational area do not include the onshore/nearshore environment.
	Sandy	• foraging habitat (e.g. birds) • nesting or breeding habitat (e.g. birds, pinnipeds) • haul-out sites (e.g. pinnipeds)	-	
	Artificial structure	• sessile invertebrates	-	
Mangroves	Intertidal/subtitle habitat, mangrove communities	• nursery habitat (e.g. crustaceans, fish) • breeding habitat (e.g. fish)	-	The EMBA and operational area do not include the onshore/nearshore environment.
Saltmarsh	Upper intertidal zone, saltmarsh habitat, habitat for fish and benthic communities	• nursery habitat (e.g. crustaceans, fish) • breeding habitat (e.g. fish)	-	The EMBA and operational area do not include the onshore/nearshore environment.

Receptor Type	Receptor Description	Values and Sensitivities	Present EMBA and Operational Area	Description
Soft sediment	Predominantly unvegetated soft sediment substrates	• key habitat (e.g. benthic invertebrates)	✓	The EMBA and operational area are situated over seabed that is flat and featureless along with very soft to soft alternating layers of silty carbonate clay and silty sands containing fragile white shell fragments. *See Appendix B.2.1 for more detail.*
Seagrass	Seagrass meadows	• nursery habitat (e.g. crustaceans, fish) • food source (e.g. fish, turtles)	-	Not present within the EMBA and operational area due to water depth >64 m.
Algae	Macroalgae	• nursery habitat (e.g. crustaceans, fish) • food source (e.g. birds, fish)	✓	Algae are widespread throughout oceanic environments. *See Appendix B.3.1 for more detail.*
Coral	Soft coral communities	• nursery habitat (e.g. crustaceans, fish) • breeding habitat (e.g. fish)	✓	Sparsely scattered clumps of solitary sponges may be present within the EMBA and operational area. *See Appendix B.3.1 for more detail.*

Table 4-2: Presence of ecological receptors within the EMBA and operational area

Receptor Type	Receptor Description	Values and Sensitivities	Present EMBA and Operational Area	Description
Plankton	Phytoplankton and zooplankton	• food source (e.g. fish, cetaceans, marine turtles)	✓	Phytoplankton and zooplankton are widespread throughout oceanic environments. *See Appendix B.3.2 for more detail.*
Marine invertebrates	Benthic and pelagic invertebrates	• food source (e.g. fish)	✓	A variety of invertebrate species may occur within the EMBA and operational area including sponges, mollusc and arthropods. *See Appendix B.3.1 for more detail.*
		• commercial species	✓	Commercially important species such as squid may occur in the EMBA and operational area. No catch effort was identified within the EMBA or operational area for other invertebrate fisheries such as scallop, rock lobster or giant crab. *See Appendix B.3.1 and B4.6 for more detail.*
Seabirds	Birds that live or frequent the ocean	• listed marine species • listed threatened species • listed migratory species • BIA	✓	32 seabird and shorebird species (or species habitat) may occur within the EMBA; with foraging and migratory behaviours identified. The EMBA and operational area intersects foraging BIAs for several albatross (black-browed albatross, Buller's albatross, Campbell albatross, Indian yellow-nosed albatross, shy albatross, wandering albatross); common diving-petrel, short-tailed shearwater and white-faced storm-petrel. *See Appendix B3.4.1 for more detail.*

Receptor Type	Receptor Description	Values and Sensitivities	Present EMBA and Operational Area	Description
Fish	Sharks	• listed marine species • listed threatened species • Listed migratory species • BIA	✓	Three shark species (or species habitat) may occur within the EMBA and operational area: • porbeagle shark • shortfin mako shark • white shark The EMBA and operational area is within a distribution BIA for the white shark. No habitat critical to the survival of the species or behaviours were identified. *See Appendix B3.4.2 for more detail.*
	Pipefish, seahorse, seadragons	• listed marine species	✓	11 syngnathid species (or species habitat) may occur within the EMBA and operational area. No important behaviours or BIAs have been identified. It is unlikely that these species will be present in the EMBA and operational as water depths are greater than 50 m. *See Appendix B3.4.2 for more detail.*
Marine reptiles	Marine turtles	• listed marine species • listed threatened species • listed migratory species	✓	Three marine turtle species (or species habitat) may occur within the EMBA and operational area: • loggerhead turtle • green turtle • leatherback turtle No BIAs or habitat critical to the survival of the species occur within the EMBA and operational area. *See Appendix B3.4.5 for more detail.*

Receptor Type	Receptor Description	Values and Sensitivities	Present EMBA and Operational Area	Description
Pinnipeds	Fur-seals	• listed marine species	✓	Two pinniped species (or species habitat) may occur within the EMBA and operational area: • New Zealand fur-seal • Australian fur-seal. No BIAs or habitat critical to the survival of the species occur within the EMBA and operational area. *See Appendix B3.4.4 for more detail.*
Cetaceans	Whales	• listed marine species • listed threatened species • listed migratory species • BIA	✓	Nine whale species (or species habitat) may occur within the EMBA and operational area. Foraging behaviours were identified for some species (sei, fin and pygmy right whales); no other important behaviours were identified. The EMBA and operational area intersects a foraging BIA for the pygmy blue whale and a distribution BIA for the southern right whale. *See Appendix B3.4.3 for more detail.*
	Dolphins	• listed marine species • listed migratory species	✓	Four dolphin species (or species habitat) may occur within the EMBA and operational area: • Risso's dolphin; • dusky dolphin; • common dolphin; and • bottlenose dolphin. No important behaviours or BIAs have been identified. *See Appendix B3.4.3 for more detail.*

Table 4-3: Presence of socio-economic and cultural receptors within the EMBA and operational area

Receptor Type	Receptor Description	Values and Sensitivities	Present EMBA and Operational Area	Description
Commonwealth Marine Area	KEF	• high productivity • aggregations of marine life	-	As per the PMST Reports the EMBA and operational area do not overlap any KEFs.
	AMP	• aggregations of marine life	-	As per the PMST Reports the EMBA and operational area do not overlap any AMPs.
State Parks and Reserves	Marine Protected Areas	• aggregations of marine life	-	The EMBA and operational area do not overlap any State marine protected areas.
Wetlands of International Importance	Ramsar Wetlands	• aggregation, foraging and nursery habitat for marine life	-	As per the PMST Reports the EMBA and operational area do not overlap any Ramsar Wetlands.
Commercial Fisheries	Commonwealth-managed	• economic benefit	✓	Present. The Commonwealth-managed fisheries that overlap the EMBA are: • Bass Strait Central Zone Scallop Fishery; • Eastern Tuna and Billfish Fishery; • Eastern Skipjack Fishery; • Small Pelagic Fishery; • Southern and Eastern Scalefish and Shark Fishery; • Southern Bluefin Tuna Fishery; and • Southern Squid Jig Fishery. Based on data from AFMA (Stakeholder Record AFMA_10) and ABARES data the following potentially have catch effort within the seabed assessment area: • Southern and Eastern Scalefish and Shark Fishery. • Squid Jig Fishery. *See Appendix B.4.6 for more detail.*

Receptor Type	Receptor Description	Values and Sensitivities	Present EMBA and Operational Area	Description
	Tasmanian State-managed	• economic benefit	-	DPIPWE initially confirmed there was no Tasmanian fishery catch effort within the seabed assessment area. See stakeholder record TDPIPWE_26. However, in subsequent engagement between Beach and DPIPWE in relation to the Beach Energy Prion Seismic Survey, it was confirmed that there may be Tasmanian managed octopus fishery activity in the seabed assessment area
	Victorian State-managed	• economic benefit	-	VFA have confirmed there is no Victorian fishery catch effort within the seabed assessment area. See stakeholder record VFA_53.
Recreational Fisheries	State-managed	• community • recreation	-	Recreational fishing is popular in Victoria largely centred within Port Phillip Bay and Western Port, outside of the EMBA and operational area. *See Appendix B.4.5 for more detail.*
Recreation and Tourism	Various human activities and interaction	• community • recreation • economic benefit	-	The sailing vessel Albert and motor vessel Will Watch are both in the surrounding area, but not within the EMBA and operational area. The depth and prevailing sea state of the area is not conducive to offshore vessel-based tourism. *See Appendix B.4.3Appendix B.4.4 and Appendix B.4.5 for more detail.*
Industry	Shipping	• community • economic benefit	✓	The SEMR is one of the busiest shipping regions in Australia and Bass Strait is one of Australia's busiest shipping routes. Commercial vessels use the route when transiting between ports on the east, south and west coasts of Australia, and there are regular passenger and cargo services between mainland Australia and Tasmania. *See Appendix B.4.1 for more detail.*
	Petroleum exploration and production	• economic benefit	-	There are no petroleum production activities within the EMBA and operational area. *See Appendix B.4.2 for more detail.*
	Subsea Cables	• economic benefit		The Telstra Bass Strait 2 Cable overlaps with the EMBA and operational area.

Receptor Type	Receptor Description	Values and Sensitivities	Present EMBA and Operational Area	Description
				See Appendix B.4.7 for more detail
Heritage	Maritime	• underwater Protected Heritage Zones • underwater cultural heritage	-	Not present.
	Cultural	• World Heritage Properties • Commonwealth Heritage Places • National Heritage Places	-	Not present.

5 Environmental impact and risk assessment methodology

5.1 Overview

This section outlines the environmental impact and risk assessment methodology used for the assessment of the seabed assessment 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 5-1 outlines this risk assessment process.

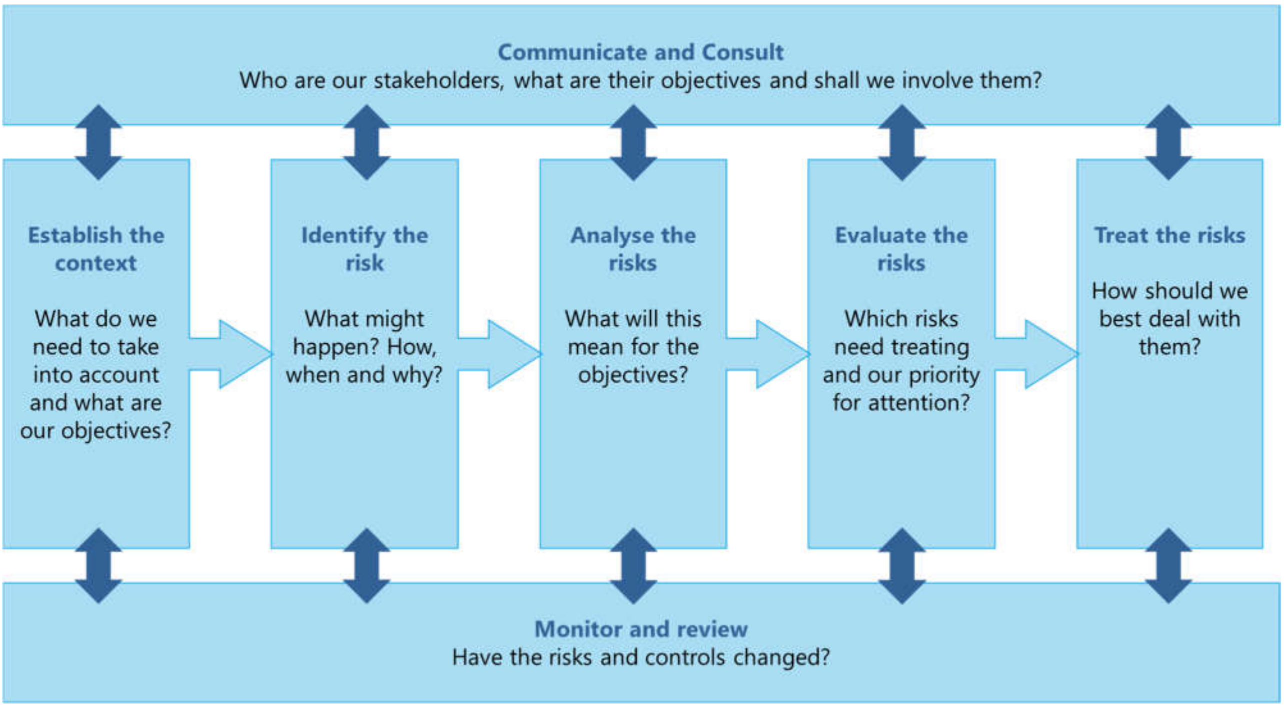


Figure 5-1: Risk assessment process

5.1.1 Definitions

Definitions of the term used in the risk assessment process are detailed in Table 5-1.

Table 5-1: 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: ◦ exercising a right conferred on a petroleum titleholder under the Act by a petroleum title; or ◦ discharging an obligation imposed on a petroleum titleholder by the Act or a legislative instrument under the Act.
Consequence	The consequence of an environmental impact is the potential outcome of the event on affected receptors (particular values and sensitivities). Consequence can be positive or negative.
Control measure	Defined under the OPGGS(E)R as a system, an item of equipment, a person or a procedure, that is used as a basis for managing environmental impacts and risks.
Emergency condition	An unplanned event that has the potential to cause significant environmental damage or harm to MNES. An environmental emergency condition may, or may not, correspond with a safety incident considered to be a Major Accident Event.
Environmental aspect	An element or characteristic of an operation, product, or service that interacts or can interact with the environment. Environmental aspects can cause environmental impacts.
Environmental impact	Defined under the OPGGE(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 is the chance of the impact occurring.
Measurement criteria	A verifiable mechanism for determining control measures are performing as required.
Operation	Refers to a component or task undertaken to facilitate a petroleum activity. Each operation is likely to have one or more associated environmental aspects.
Residual risk	The risk remaining after control measures have been applied (i.e. after risk treatment).

5.2 Communicate and consult

In alignment with Regulation 11A(2) of the OPGGS(E)R, during the development of this EP, Beach has consulted with relevant person(s) (stakeholders) to obtain information in relation to their activities within the seabed assessment 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.

5.3 Establish the context

Context for the risk assessment process is established by:

- understanding the regulatory framework in which the activity takes place (described in the Section 2, 'Environmental 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 3);
- identifying the environment that may be affected, either directly or indirectly, by the activity (based upon the 'Existing Environment' as described in Section 4); and
- understanding the concerns of stakeholders and incorporating those concerns into the design of the activity where appropriate (outlined in Section 8, 'Stakeholder Consultation').

5.4 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 seabed assessment area and 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 6-1 details the aspects identified for the activity.

5.5 Analyse the potential impacts and risks

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.

5.6 Establish environmental performance outcomes

Environmental performance outcomes 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.

5.7 Evaluate and treat the potential impacts and risks

The following steps are undertaken using the environmental risk assessment matrix (Table 5-2) to evaluate the potential impacts and risks:

- identify the consequences of each potential environmental impact, corresponding to the maximum credible impact;
- for unplanned events, identify the likelihood (probability) of potential environmental impacts (i.e., the probability of the event 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 5.9) and an acceptable level (Section 5.10); and
- establish environmental performance standards for each of the identified control measures.

5.8 Monitor 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 hazard. Additional aspects of monitoring and review are described in the Implementation Strategy (Section 7).

Table 5-2: Environmental risk assessment matrix

Environmental Risk Assessment Matrix								
Consequence Rating	Natural Environment	Reputational and/or Community damage / impact / social / cultural heritage	Likelihood of Occurrence					
			Remote (1)	Highly Unlikely (2)	Unlikely (3)	Possible (4)	Likely (5)	Almost Certain (6)
			<1% chance of occuring within the next year. Occurance requires exceptional circumstances. Exceptionally unlikely event in the long-term future. Only occur as a 100 year event.	>1% chance of occuring within the next year. May occur but not anticipated. Could occur years to decades.	>5% chance of occuring in the next year. May occur but not for a while. Could occur within a few years.	>10% chance of occuring within the next year. May occur shortly but a ditict probability iot won't. Could occur within months to years.	>50% chance of occuring within the next year. Balance of probability that it will occur. Could occur within weeks to months.	99% chance of occuring within the next year. Impact is occuring now. Could occur within days to weeks.
Catastrophic (6)	Long-term destruction of highly valued ecosystem or very significant effects on endangered species or habitats (formally managed).	Irreparable damage or highly valued items or structures of great cultural significance. Negative international or prologed national media (e.g. 2 weeks)	High	High	Severe	Severe	Extreme	Extreme
Critical (5)	Significant impact on highly valued (formally managed) species or habitats to the point of eradication or impairment of ecosystem. Widespread long-term impact.	Major irreparable damage to highly valued structures / items of cultural significance. Negative national media for 2 days or more. Significant public outcry.	Medium	Medium	High	Severe	Severe	Extreme
Major (4)	Very serious environmental effects, such as dosplacement of species and partial impairment of ecosystem (formally managed). Widespread medium and some long-term impact.	Significant damage to items of cultural significance. Negative national media for 1 day. NGO adverse attention.	Medium	Medium	Medium	High	Severe	Severe
Serious (3)	Moderate effects on biological or physical environment (formally managed) and serious short-term effects but not affecting ecosystem functions.	Permanent damage to items of cultural significance. Negative State media. Heightened concern from local community. Criticism by NGOs.	Low	Medium	Medium	Medium	High	Severe
Moderate (2)	Minor short-term damage to area of limited significance (not formally managed). Short-term effects but not affecting ecosystem functions.	Some damage to items of cultural significance. Minor adverse local public or media attention and complaints.	Low	Low	Medium	Medium	Medium	High
Minor (1)	No lasting effects. Low-level impacts on biological and physical environment to an area of low significance (not formally managed).	Low level repairable damage to commonplace structures. Public concern restricted to local complaints.	Low	Low	Low	Medium	Medium	Medium

5.9 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.

There is no universally-accepted guidance to applying the ALARP principle to environmental assessments. For this EP, the guidance provided in NOPSEMA's EP decision making guideline (NOPSEMA, 2019) guideline has been applied, and augmented where deemed necessary.

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).

5.9.1 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 (Table 5-2), 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 ・) is sufficient to manage the risk.

Higher-order environmental impacts and risks

NOPSEMA defines higher-order environmental impacts and risks as those that are not lower order risks or impacts (i.e., where the environment or receptor is formally managed, vulnerable, restricted in distribution, protected or threatened and there is little confidence in the effectiveness of adopted control measures).

Impacts and risks are considered to be higher-order when, using the environmental risk assessment matrix (Table 5-2), 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 Section5.9.3 and 5.9.4.

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 5-3.

Table 5-3: 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		

5.9.2 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 enough 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 5-2). Specifically, the framework considers impact severity and several guiding factors:

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

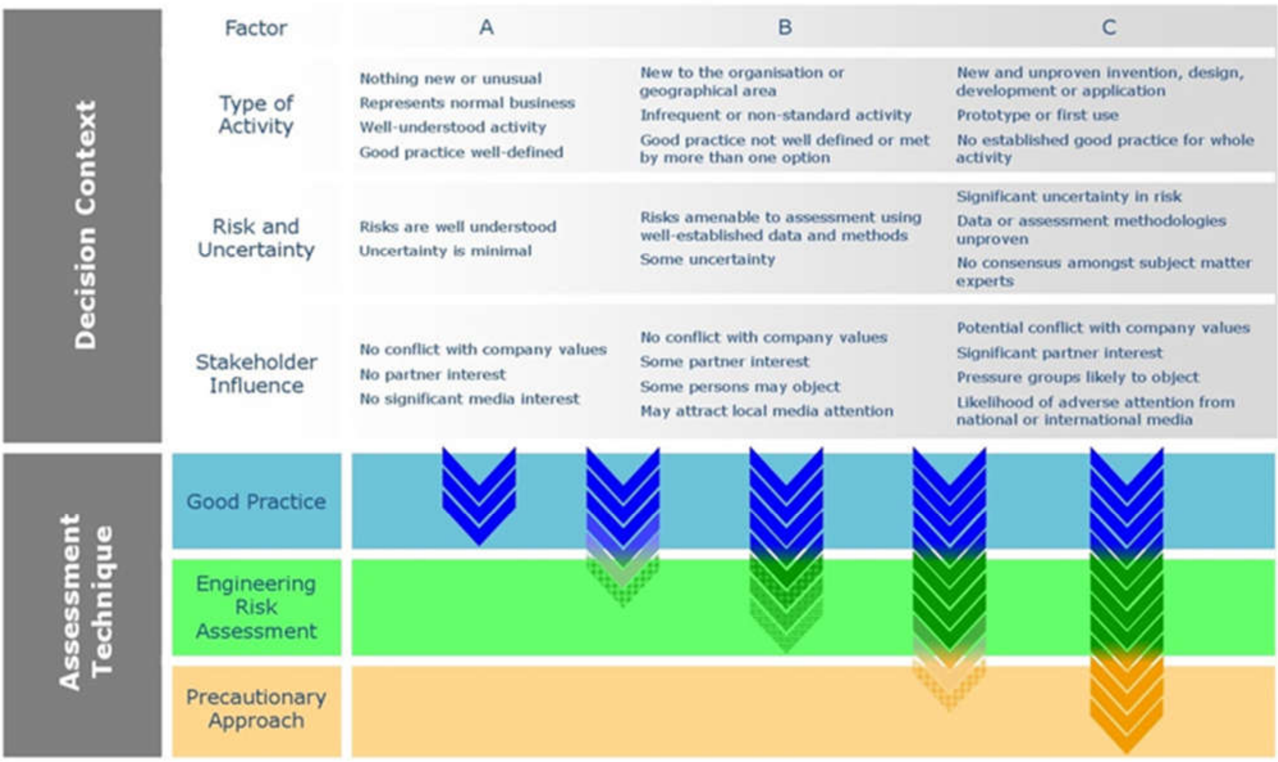


Figure 5-2: OGUK (2014) decision support framework

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.
- 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 hazards 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.

5.9.3 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.

5.9.4 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.

5.10 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 Table 5-4, which is based on Beach's interpretation of the NOPSEMA EP content requirements (NOPSEMA, 2019).

Table 5-4: Acceptability criteria

Test	Question	Acceptability demonstration
Policy compliance	Is the proposed management of the impact or risk aligned with Beach's Environmental Policy?	The impact or risk must be compliant with the objectives of the company policies.
Management system compliance	Is the proposed management of the impact or risk aligned with the Operations Excellence Management System (OEMS)?	Where specific procedures, guidelines, expectations are in place for management of the impact or risk in question, acceptability is demonstrated.
Stakeholder engagement	Have stakeholders raised any concerns about activity impacts or risks, and if so, are measures in place to manage those concerns?	Stakeholder concerns must have been adequately responded to and closed out.
Laws and standards	Is the impact or risk being managed in accordance with existing Australian or international laws or standards?	Compliance with specific laws or standards is demonstrated.
Industry practice	Is the risk being managed in line with industry practice?	Management of the impact or risk complies with relevant industry practices.
Environmental context	Is the impact or risk being managed pursuant to the nature of the receiving environment (e.g. sensitive or unique environmental features generally require more management measures to protect them than environments widely represented in a region)?	The proposed impact or risk controls, environmental performance objectives and standards must be consistent with the nature of the receiving environment.
Environmentally Sustainable Development (ESD) Principles	Is the impact or risk being managed such that the activity can be carried out in a manner consistent with the principles of ESD?	Activity must be carried out in a manner consistent with the relevant ESD principles.

5.10.1 Ecologically sustainable development

Section 3A of the EPBC Act defines ecologically sustainable development (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 principle 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.

6 Environmental impact and risk assessment

6.1 Overview

In accordance with Regulation 13(5)(6) of the OPGGS(E)R, this section presents the impact and risk assessment for the environmental hazards identified for the seabed assessment using the methodology described in Section 5. Potential impacts (planned) and risks (unplanned) associated with the environmental aspects of the activity are identified in Table 6-1 with lower order impacts and risks assessed in Table 6-2 and higher order impacts and risks assessed in 6.2, 6.3 and 6.4.

Table 6-1: Activity and aspect relationship

	Seabed disturbance	Underwater acoustic emissions	Atmospheric emissions	Light emissions	Planned marine discharges	Physical presence – collision with fauna	Physical presence – displacement of other users	Unplanned release - waste	Invasive marine species	Minor spill	Loss of diesel – vessel collision
Geotechnical survey	X	X									
Geophysical survey	X	X									
Vessel operations		X	X	X	X	X	X	X	X	X	X

Table 6-2: Seabed assessment environmental impact and risk ratings, control identification, ALARP and acceptability assessment

Activity	Aspect	Potential Impact or risk	Receptor	Evaluation of Impact or Risk	Consequence Rating	ALARP Decision Context	Good Practice Control Measure	Additional Control Measures	Likelihood of Occurrence	Residual Risk	Acceptability Assessment	Acceptability Outcome
Geotechnical and geophysical survey	Seabed disturbance	Change in habitat	Benthic habitat (soft sediment, macroalgae, soft corals) Marine invertebrates	The vessel will hold station using DP or propellers as water depths are too deep for anchoring. Seabed disturbance will occur from physical disturbance and from the discharge of borehole cuttings. Physical disturbance will occur from the following: • Borehole sampling total footprint: 56.25 m^2 • PCPT total footprint: 380 m^2 • Box core total footprint: 19.2 m^2 • Vibro core total footprint: 750 m^2 • Gravity core total footprint: 0.54 m^2. • USBL sandbag total footprint 0.2 m^2. • Van Veen grab total footprint 22.4 m^2. Thus, the extent of impact is 1228.6 m^2 or 0.0012 km^2. Borehole cuttings will be less than 0.48 m^3 at nine locations within the operational area and will be discharged within the borehole sampling footprint. As described in Appendix B.2.1and Appendix B.3.1 surveys of the seabed near the Yolla-A platform showed that the seabed is flat and featureless with sparsely scattered clumps of solitary sponges, sea cucumbers, sea squirts and predatory snails (whelk) (Thales GeoSolutions, 2001). As the operational area is in a similar area and water depths it is likely that the seabed is of a similar nature to that at the Yolla platform. There are no KEFs located within the operational area. The extent of the area of impact is predicted to be 0.0012 km^2 for a duration of up to months to years while the disturbed areas recolonise. The severity is assessed as minor based on: • the nature of the benthic habitat within the operational area is likely to consist of a flat and featureless seabed with sparse clumps of solitary sponges, sea cucumbers, sea squirts and predatory snails. • the extent of seabed disturbance will occur over an area of 0.0012 km^2. • the discharge of borehole cuttings will be less than 0.48 m^3 at up to nine locations with the discharge within the borehole sampling footprint. • drill fluids (bentonite and/or seawater) have no toxic components.	Minor (1)	A	CM#1: Geotechnical Scope of Work CM#2: Offshore Environmental Chemical Assessment Process	None identified	N/A	**Low**	• the proposed management of the impact is aligned with the Beach Environment Policy. • the proposed management of the impact is aligned with the OEMS and/or procedural requirements. • no stakeholder objections or claims have been raised. • the impact is being managed in accordance with legislative requirements. • good practice controls have been defined. • the predicted level of impact will not modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results. • the Environmental Impact Assessment (EIA) demonstrates consistency with the principles of ESD.	Acceptable

Activity	Aspect	Potential Impact or risk	Receptor	Evaluation of Impact or Risk	Consequence Rating	ALARP Decision Context	Good Practice Control Measure	Additional Control Measures	Likelihood of Occurrence	Residual Risk	Acceptability Assessment	Acceptability Outcome
				• no sensitive or protected benthic habitat or species, including commercial invertebrate species, have been identified in the operational area. • results of previous surveys of seabed disturbances from oil and gas activities indicating that recovery of benthic fauna in soft sediment substrates occurs within six to 12 months of cessation of the activity (URS, 2001). • re colonisation and recovery will occur from the undisturbed surrounding area (Ingole et al. 2013 and Bluhm 2001).								
Geophysical survey Geotechnical survey Vessel operations	Underwater acoustic emissions	Behavioural changes Auditory impairment	Further assessment required (Section 6.2).									
Vessel operations	Atmospheric emissions	Change in air quality	Air quality Seabirds	Minor emissions are predicted from the vessel due to the use of diesel combustion engines. The operational area foraging BIAs for the several albatross species, common diving-petrel, short-tailed shearwater and white-faced storm-petrel. No habitat critical to the survival of seabirds occur within the operational area. Atmospheric emissions are not identified as a threat in the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a). Vessel emissions would not be significant enough to impact on climate change. The extent of the area of impact is predicted to be localised to the emission point as offshore winds will rapidly disperse atmospheric emission to background levels close to the source for a duration of up to 55 days while the seabed assessment is undertaken. The severity is assessed as minor based on emissions will rapidly disperse to background levels close to the emission source and it is unlikely that seabirds would be this close to the emission source.	Minor (1)	A	CM#3: MO 97: Marine Pollution Prevention – Air Pollution	None identified	N/A	**Low**	• the proposed management of the impact is aligned with the Beach Environment Policy. • the proposed management of the impact is aligned with the OEMS and/or procedural requirements. • no stakeholder objections or claims have been raised. • the impact is being managed in accordance with legislative requirements. • good practice controls have been defined. • the predicted level of impact will not result in a substantial change in air quality which may adversely impact on biodiversity, ecological integrity; social amenity or human health. • activity will not 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). • the EIA demonstrates consistency with the principles of ESD.	Acceptable

Activity	Aspect	Potential Impact or risk	Receptor	Evaluation of Impact or Risk	Consequence Rating	ALARP Decision Context	Good Practice Control Measure	Additional Control Measures	Likelihood of Occurrence	Residual Risk	Acceptability Assessment	Acceptability Outcome
			Coastal settlements	There are no coastal settlements within the operational area or at a distance where impacts from air emissions would occur.	N/A							
Vessel operations	Light emissions	Change in fauna behaviour	Seabirds Shorebirds Turtles	As the seabed assessment will be undertaken 24 hours a day, lighting is required at night for navigation and to ensure safe operations when working on the vessel. Light sensitive species have been identified by reviewing the National Light Pollution Guidelines for Wildlife (the guidelines) (Commonwealth of Australia, 2020). 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. A change in ambient light levels could result in a localised light glow. This can lead to changes in fauna behaviour, through attraction of light-sensitive species such as seabirds and in turn affecting predator-prey dynamics. Light glow from the vessel is likely to be limited to the operational area and temporary in nature as the vessel moves through the water. Three Hummock Island is the closest land to the operational area where shorebirds maybe present. The island is ~ 65 km from the operational area, thus impacts to shorebirds are not predicted. There are also no turtle nesting beaches within Victorian and Tasmania coasts, thus impacts to turtles are not predicted. The operational area overlaps foraging BIAs for several albatross species, common diving-petrel, short-tailed shearwater and white-faced storm-petrel. The migratory route for the orange-bellied parrot is likely to occur over the operational area. The extent of the area of impact is predicted to be within the operational area for a duration of up to 55 days while the seabed assessment is undertaken. The severity is assessed as minor based on: • light emissions are not identified as a threat in National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011a).	Minor (1)	A	CM#4: National Light Pollution Guidelines	None identified	N/A	**Low**	• the proposed management of the impact is aligned with the Beach Environment Policy. • the proposed management of the impact is aligned with the OEMS and/or procedural requirements. • no stakeholder objections or claims have been raised. • vessel lighting will meet safety and navigation legislative requirements in relation to lighting. • Vessel lighting will be managed in accordance with the National Light Pollution Guidelines (Commonwealth of Australia, 2020). • relevant good practice controls have been identified. • the predicted level of impact will not lead to a long-term decrease in the size of a Threatened or Migratory listed seabird population or have a substantial adverse effect on a population of seabirds including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution. • The EIA demonstrates consistency with the principles of ESD.	Acceptable

Activity	Aspect	Potential Impact or risk	Receptor	Evaluation of Impact or Risk	Consequence Rating	ALARP Decision Context	Good Practice Control Measure	Additional Control Measures	Likelihood of Occurrence	Residual Risk	Acceptability Assessment	Acceptability Outcome
				• 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). • Brooke (2004) cited on Animal Diversity Web (2020) details that common diving-petrel spends 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. The operational rea overlaps 0.13% of the common diving-petrel foraging BIA (437,406 km^2). • the white-faced storm-petrel when not breeding spends the rest of the year at sea. It is strictly nocturnal at the breeding sites to avoid predation (ALA, 2020). The operational rea overlaps 0.4% of the white-faced storm-petrel foraging BIA (129,070 km^2). • the short-tailed shearwater returns to the colonies at dark after feeding at sea during the day (AAD, 2019). • the orange-bellied parrot recovery plan identifies illuminated structures and illuminated boats as a potential barrier to migration and movement (DELWP, 2016). The operational area overlaps 1% of the probable migration route (53,734 km^2). • these foraging BIAs are very large typically covering the whole of the SEMR thus it is not predicted that a large number of birds would be present in the operational area.								
Vessel operations	Planned discharges: Cooling water Brine Treated bilge Sewage and greywater	Change in water quality	Water quality Plankton Fish Marine turtles Marine mammals	Wastewater discharges can result in localised impacts to water quality from increased temperature, salinity, nutrients, chemicals and hydrocarbons leading to a change in water quality and potentially toxic effects to marine fauna. Vessel wastewater discharges will be of low volume during the seabed assessment and of an intermittent nature. 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 thus it is expected that any wastewater discharges would disperse quickly over a small area. Discharges with the potential to contain toxic components such as bilge and sewage will be treated prior to discharge. The extent of the impact is predicted to be within the operational area for a duration of up	Minor (1)	A	CM#2: Offshore Environmental Chemical Assessment Process CM#5: *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* CM#6: Preventative Maintenance System	None identified	N/A	**Low**	• the proposed management of the impact is aligned with the Beach Environment Policy. • the proposed management of the impact is aligned with the OEMS and/or procedural requirements. • no stakeholder objections or claims have been raised. • the impact is being managed in accordance with legislative requirements. • good practice controls have been defined. • the predicted level of impact will not result in a substantial change in water quality which may adversely impact on biodiversity, ecological integrity, social amenity or human health	Acceptable

Activity	Aspect	Potential Impact or risk	Receptor	Evaluation of Impact or Risk	Consequence Rating	ALARP Decision Context	Good Practice Control Measure	Additional Control Measures	Likelihood of Occurrence	Residual Risk	Acceptability Assessment	Acceptability Outcome
				to 55 days. The severity is assessed as minor 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 area of open water of the operational area. • discharges will be intermittent and of a low volume and rapidly disperse in the marine environment. • the operational area does not overlap any marine parks, KEFS or threatened ecological communities. • the overlap with BIAs is small: southern right whale distribution 0.3% (217,825 km^2), white shark distribution 0.3% (215,260 km^2), pygmy blue whale foraging 0.3% (181,409 km^2).							• the EIA demonstrates consistency with the principles of ESD.	
Vessel operations	Planned discharge: Food waste	Change in fauna behaviour	Seabirds Fish	Periodic discharge of macerated food scraps 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 vessel during the seabed assessment. The operational area overlaps foraging BIAs for several albatross species, common diving-petrel, short-tailed shearwater and white-faced storm-petrel. 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, for survey vessel food waste the discharge would be sporadic and for a short duration, thus would not result in seabirds habituating to this food source. Fish may also become attracted to the food scraps but as for seabirds the sporadic nature of vessel survey food scraps would not lead to fish habituating to this food source. The extent of the impact is predicted to be 500 m from the vessel with a duration of up to 55 days. The severity is assessed as minor 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.	Minor (1)	A	CM#7: MO 95: Marine Pollution Prevention - Garbage	None identified	N/A	**Low**	• the proposed management of the impact is aligned with the Beach Environment Policy. • the proposed management of the impact is aligned with the OEMS and/or procedural requirements. • no stakeholder objections or claims have been raised. • the impact is being managed in accordance with legislative requirements. • good practice controls have been defined. • the predicted level of impact will not lead to a long-term decrease in the size of a threatened or migratory listed seabird or fish population or have a substantial adverse effect on a population of seabirds or fish including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution. • the EIA demonstrates consistency with the principles of ESD.	Acceptable

Activity	Aspect	Potential Impact or risk	Receptor	Evaluation of Impact or Risk	Consequence Rating	ALARP Decision Context	Good Practice Control Measure	Additional Control Measures	Likelihood of Occurrence	Residual Risk	Acceptability Assessment	Acceptability Outcome
Vessel operations	Planned Discharges: Food waste Sewage and greywater	Change in aesthetic value	Recreation and tourism	Sewage and food discharges will be rapidly diluted, with impacts limited to within the operational area. No recreation or tourism has been identified within the operational area due to lack of features.	N/A							
Vessel operations	Physical presence: collision with marine fauna	Injury/mortality to fauna	Marine turtles Whales Dolphins	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; and • 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, 2017c) 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 (Commonwealth of Australia, 2017a) 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. Nine whale species 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 a distribution BIA for the southern right whale. The Conservation Management Plan for the blue whale (Commonwealth of Australia, 2015) and for the southern right whale (DSEWPaC, 2012) and Conservation Advice for the sei, fin and humpback whales identify vessel strike as a threat (TSSC, 2015d; TSSC, 2015f; TSSC, 2015e) 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 (January through to April (Gill et	Moderate (2)	A	CM#8: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans CM#9: Vessel speed restrictions	None identified	Highly Unlikely (2)	**Low**	• the proposed management of the impact is aligned with the Beach Environment Policy. • the proposed management of the impact is aligned with the OEMS and/or procedural requirements. • no stakeholder objections or claims have been raised. • the impact is being managed in accordance with legislative requirements. • good practice controls have been defined. Vessel collision with 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, 2017a). • impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015). 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, 2012). • impact sei, fin whale or humpback whales, covered by conservation advice, at a population level. Actions from the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015) 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	Acceptable

Activity	Aspect	Potential Impact or risk	Receptor	Evaluation of Impact or Risk	Consequence Rating	ALARP Decision Context	Good Practice Control Measure	Additional Control Measures	Likelihood of Occurrence	Residual Risk	Acceptability Assessment	Acceptability Outcome
				al., 2011) which overlaps the period of the seabed assessment. 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. The National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna 2017 (Commonwealth of Australia, 2017a) identifies that speed is a concern when considering collision risk and that slower moving vessels provide greater opportunity for fauna and vessels to avoid collision. The National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna 2017(Commonwealth of Australia, 2017a) does not make any recommendations in relation to a maximum vessel speed, but case studies within the strategy have implemented a 10 knot speed limit in sensitive areas. Based on this information vessel speeds within the operational area will be restricted to 10 knots. The extent of the area of where the risk of a vessel collision with fauna may occur is within the operational area and the risk could occur during the 25 days that the geophysical survey is undertaken. It less likely to occur during the geotechnical survey as the vessel will be stationary while undertaking sampling. The severity is assessed as moderate and likelihood as highly unlikely based on: • within the operational area the survey vessel 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. • if an incident occurred, it would be restricted to individual fauna and be unlikely to have an impact at a population level or impeded the recovery of a protected species.							to be reported as detailed in Section 7.10.1 • 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. This EP details the impact assessment and mitigation measures (controls) to be implemented to ensure impacts are of an acceptable level and ALARP. • the EIA demonstrates consistency with the principles of ESD.	
Vessel operations	Physical presence	Displacement of other marine users	Recreation and tourism	Due to the distance offshore of the operational area (89 km at the mainland and > 60 km to the nearest island) and the lack of emergent features	Minor (1)	A	CM#10: Ongoing consultation	CM#11: Commercial Fishery	N/A	**Low**	• the proposed management of the impact is aligned with the Beach Environment Policy.	Acceptable

Activity	Aspect	Potential Impact or risk	Receptor	Evaluation of Impact or Risk	Consequence Rating	ALARP Decision Context	Good Practice Control Measure	Additional Control Measures	Likelihood of Occurrence	Residual Risk	Acceptability Assessment	Acceptability Outcome
			Recreational fisheries Commercial fisheries Telstra cables	within the operational area, recreational fishing and tourism is unlikely. Based on data within the ABARES Fishery Status Reports 2014 to 2019 and AFMA (see Appendix B.4.6) the Southern and Eastern Scalefish and Shark Fishery and Southern Squid Jig Fishery has potential catch effort within the operational area. The Tasmanian fisheries have no catch effort within the operational area as per the stakeholder reference TDPIPWE_26. The Victorian fisheries have no catch effort within the operational area as per the stakeholder reference VFA_53. The seabed assessment overlaps the Telstra Bass Strait 2 Cable. The cable is within the corridor between the potential well location and the Yolla platform. Consultation with Telstra resulted in implementing a 1 km buffer either side of the cable known location where no borehole or Piezo Cone Penetration Test sampling can be undertaken (Stakeholder Record TELS_02). The extent of displacement is the seabed assessment area of approx 71 km^2 for a duration of up to 55 days. The severity is assessed as minor based on: • small area of displacement for a period of up to 55 days. • both the Southern and Eastern Scalefish and Shark Fishery and Southern Squid Jig Fishery fish over a large area and are not restricted in the area where they can fish. • fishery stakeholders have not raised any objections or claims. • The Telstra cable will be protected by implementation a 1 km buffer either side of the cable known location for borehole and Piezo Cone Penetration Test sampling. • permanent exclusion zones not required. Stakeholder engagement will be ongoing, and any displacement impacts can be managed by: • providing look-ahead information to fishers allowing them to plan their fishing activity to avoid when the seabed assessment is being undertaken. • the implementation of Beach's Commercial Fisher Operating Protocol to potentially impacted fishers, whereby fishers should not suffer an economic loss as a result of Beach's activities. Should a fisher incur additional costs in order to work around Beach's activities, or if they have lost catch				Operating Protocol CM#12: Telstra cable buffer			• the proposed management of the impact is aligned with the OEMS and/or procedural requirements. • stakeholder objections or claims raised have been addressed. • the impact is being managed in accordance with legislative requirements. • good practice and additional controls have been identified in consultation with stakeholders. • the predicted level of impact is that the activity will not interfere with other marine users to a greater extent than is necessary for the exercise of right conferred by titles granted. • the EIA demonstrates consistency with the principles of ESD.	

Activity	Aspect	Potential Impact or risk	Receptor	Evaluation of Impact or Risk	Consequence Rating	ALARP Decision Context	Good Practice Control Measure	Additional Control Measures	Likelihood of Occurrence	Residual Risk	Acceptability Assessment	Acceptability Outcome
				or have damaged equipment Beach will assess the claim and ask for evidence including past fishing history and the loss incurred and, where the claim is genuine, will provide compensation. Beach will also ensure that the evidence required is not burdensome on the fisher while ensuring genuine claims are processed.								
			Shipping	The operational area includes major shipping routes; however, vessel activities associated with the Bass Gas Development have been ongoing for over 10 years and to date there has been no interactions or incidents.	Minor (1)	A	CM#10: Ongoing consultation	None identified	N/A	**Low**	• the proposed management of the impact is aligned with the Beach Environment Policy. • the proposed management of the impact is aligned with the OEMS and/or procedural requirements. • no stakeholder objections or claims have been raised. • the impact is being managed in accordance with legislative requirements. • good practice controls have been defined to alert relevant stakeholders of the seabed assessment activities. • the predicted level of impact is that the activity will not interfere with other marine users to a greater extent than is necessary for the exercise of right conferred by titles granted. • the EIA demonstrates consistency with the principles of ESD.	Acceptable
Vessel operations	Unplanned release: waste	Injury/mortality to fauna	Seabirds Marine turtles Pinnipeds Cetaceans (whales, dolphins)	Transfer of waste will only occur in port. Waste accidently released to the marine environment may lead to injury or death to individual marine fauna through ingestion or entanglement. The Threat Abatement Plan for the Impacts of Marine Debris on Vertebrate Marine Life (DEWHA, 2009) 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	Minor (1)	A	CM#7: MO 95: Marine Pollution Prevention - Garbage	None identified	Remote (1)	**Low**	• the proposed management of the impact is aligned with the Beach Environment Policy. • the proposed management of the impact is aligned with the OEMS and/or procedural requirements. • no stakeholder objections or claims have been raised. • the impact is being managed in accordance with legislative requirements. • good practice controls have been defined. Marine fauna injury or death from unplanned discharge of waste if occurred will not: • impact on the recovery of marine turtles as per the Recovery Plan for	Acceptable

Activity	Aspect	Potential Impact or risk	Receptor	Evaluation of Impact or Risk	Consequence Rating	ALARP Decision Context	Good Practice Control Measure	Additional Control Measures	Likelihood of Occurrence	Residual Risk	Acceptability Assessment	Acceptability Outcome
				and ship-sourced, solid non-biodegradable floating materials lost or disposed of at sea. The operational area overlaps foraging BIAs for several albatross, common diving-petrel, short-tailed shearwater and white-faced storm-petrel. 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 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, 2017a) identified marine debris 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. Nine whale species 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 a distribution BIA for the southern right whale. The Conservation Management Plan for the blue whale and for the southern right whale (Commonwealth of Australia, 2015; DSEWPaC, 2012) and Conservation Advice for the sei whale, fin whale and humpback whale (TSSC, 2015d, TSSC, 2015f, TSSC, 2015e) do not identify marine debris as threat. Four dolphin species may occur within the operational area. No important behaviours or BIAs have been identified. 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 during the 55 days while the seabed assessment is undertaken. 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 which is unlikely to have an impact at a population levels.							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 sei, fin whale or humpback whales, covered by conservation advice, at a population level. • the EIA demonstrates consistency with the principles of ESD.	

Activity	Aspect	Potential Impact or risk	Receptor	Evaluation of Impact or Risk	Consequence Rating	ALARP Decision Context	Good Practice Control Measure	Additional Control Measures	Likelihood of Occurrence	Residual Risk	Acceptability Assessment	Acceptability Outcome
Vessel operations	Introduction of invasive marine species (IMS)	Change in ecosystem dynamics	Marine ecology Fisheries	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 mostly likely to occur in shallow waters in areas where large numbers of vessels are present and are stationary for an extended period. The introduction of IMS can occur from: • Discharge of ballast water from the vessel containing foreign species; and • Translocation of foreign species through biofouling on vessel hulls, niches (e.g., thruster tunnels, sea chests) or in-water equipment Vessels that are not local to Victorian waters would have exchanged their ballast prior to entry to Australian and/or Victorian waters as per legislative requirements. Vessels entering Australian and/or Victorian waters are required to have a low risk of biofouling as per legislative requirements. The operational area does not present a location conducive to marine pest survival due to its distance from shore (89 km from mainland and > 60 km from the nearest island) and water depths are greater than 64 m; in addition.	Serious (3)	A	CM#13: MO 98: Marine pollution – anti-fouling systems CM#14: Australian Ballast Water Management Requirements CM#15: National Biofouling Management Guidance for the Petroleum Production and Exploration Industry CM#16: Beach Domestic IMS Biofouling Risk Assessment Process	None identified	Remote (1)	**Low**	• the proposed management of the impact is aligned with the Beach Environment Policy. • the proposed management of the impact is aligned with the OEMS and/or procedural requirements. • no stakeholder objections or claims have been raised. • the impact is being managed in accordance with legislative requirements. • good practice controls have been defined. • the predicted level of impact will not result in a known or potential pest species becoming established. • the activity will be managed to meet the objective of the National Strategic Plan for Marine Pest Biosecurity (2018-2023) (DAWR, 2018) to minimise the risk of marine pest introductions, establishment and spread. • the EIA demonstrates consistency with the principles of ESD.	Acceptable
Vessel operations	Unplanned release: Minor spill (hydrocarbon or chemical)	Change in water quality	Water quality Plankton Marine fauna	Minor spills <200 L may occur from the vessel equipment, bulk storage or package chemical leak (deck spill). Given the small volumes and the low-toxicity hydrocarbons and chemicals that could be discharged, minor spills are expected to rapidly dissipate and dilute in the high energy environment of the Bass Strait region. The extent of the area of where the risk of minor spills to the marine environment is within the operational area and the risk could occur during the 55 days while the seabed assessment is undertaken. The severity is assessed as minor based on: • impacts to water quality are expected to be temporary and localised. • Minor spills will rapidly disperse in the marine environment. • receptor exposure would be short term.	Minor (1)	A	CM#17: Spill containment CM#18: SMPEP, or equivalent		Remote (1)	**Low**	• the proposed management of the impact is aligned with the Beach Environment Policy. • the proposed management of the impact is aligned with the OEMS and/or procedural requirements. • no stakeholder objections or claims have been raised. • the impact is being managed in accordance with legislative requirements. • good practice controls have been defined. • the predicted level of impact would not result in a substantial change in, water quality which may adversely impact on biodiversity, ecological integrity; social amenity or human health. • the predicted level of impact will not lead to a long-term decrease in the size of a threatened or migratory	Acceptable

Activity	Aspect	Potential Impact or risk	Receptor	Evaluation of Impact or Risk	Consequence Rating	ALARP Decision Context	Good Practice Control Measure	Additional Control Measures	Likelihood of Occurrence	Residual Risk	Acceptability Assessment	Acceptability Outcome
											listed population or have a substantial adverse effect on a population including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution. • the EIA demonstrates consistency with the principles of ESD.	
Vessel operations	Loss of marine diesel from vessel collision	Change in water quality	Further assessment required (Section 6.3).									
Vessel operations	Spill response	Disturbance to benthic habitat Waste generation, disposal and management Displacement of other marine users	Further assessment required (Section 6.4).									

6.2 Underwater acoustic emissions

6.2.1 Hazards

Underwater acoustic emissions from the seabed assessment may impact biological receptors such as:

- marine invertebrates, including commercially important species.
- fish (with and without swim bladders) including commercial species such as sharks.
- marine reptiles.
- marine mammals.

6.2.2 Known and potential environmental impacts

Potential impacts of underwater acoustic from the geophysical survey, geotechnical survey and vessel to receptors are:

- behavioural changes
- auditory impairment, permanent threshold shift (PTS) and temporary threshold shift (TTS).

6.2.3 Impact evaluation and risk assessment

Underwater acoustic emissions associated with the vessel and geotechnical survey will be continuous while the underwater acoustic emissions associated with the geophysical survey will be impulsive.

To assess potential impacts to receptors from underwater acoustic emissions associated with the geophysical seabed assessment acoustic modelling was used to predict received underwater sound levels. The modelled received sound levels where then compared to defined noise effect criteria, as determined by scientific research and academic papers, for the identified receptors.

To assess potential impacts to receptors from underwater acoustic emissions associated with the vessel and geotechnical survey published literature was used.

6.2.3.1 Sound metric terminology

Sound travels as a wave with the amplitude of the wave related to the amount of acoustic energy it carries, or how loud the sound will appear to be. Figure 6-1 shows a representative sound wave and the sound measures used in this assessment. Table 6-3 provides definitions of the sound measures and other sound related terms used in this assessment.

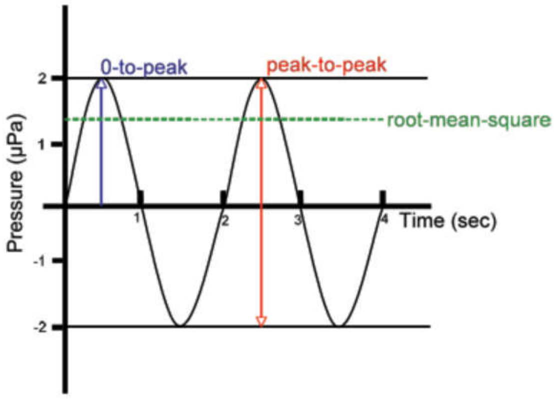


Figure 6-1: Representative sound wave and sound measures

Table 6-3: Sound terminology

Term	Definition
0-to-peak or Peak sound pressure level (PK)	The peak pressure, also called the 0-to-peak pressure, is the range in pressure between zero and the greatest pressure of the signal. It is represented by PK and the unit dB re 1 µPa and summarised as dB PK.
Peak-to-peak sound pressure level (PK-PK)	The peak-to-peak pressure is the range in pressure between the most negative pressure and the most positive pressure of the signal. It is represented by PK-PK and the unit dB re 1µPa or dB re 1 $\mu Pa^2 m^2$ and summarised as dB PK-PK.
Permanent threshold shift (PTS)	Permanent loss of hearing sensitivity caused by excessive noise exposure.
Received sound levels	The sound level measured at a receiver.
Root mean square sound pressure level (RMS)	The root-mean-square pressure is the square root of the average of the square of the pressure of the sound signal over a given duration. It is represented by sound pressure level (SPL) and the unit dB re 1 µPa and summarised as dB SPL.
Sound exposure level (SEL)	A measure of the sound energy that considers both received level and duration of exposure. SEL is specified in terms of either single pulse (SEL) or a defined accumulation period (SEL_{cum}). For this assessment 24hrs has been used for the accumulation period and is shown as SEL_{24h}. Units are dB re 1 $\mu Pa^2 \cdot s$ or dB re 1 $\mu Pa^2 m^2 s$.
Source sound level	The sound pressure level or sound exposure level measured 1 metre from a theoretical point source that radiates the same total sound power as the actual source.
Temporary threshold shift (TTS)	Temporary loss of hearing sensitivity caused by excessive noise exposure.

6.2.3.2 Geophysical survey and acoustic modelling

Based on a review of the geophysical equipment to be used for the seabed assessment 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 was not undertaken for the seabed assessment. Modelling results for the Otway geophysical survey (McPherson and Wood, 2017) have been used based on the following information provided by JASCO Applied Sciences (Jasco):

Equipment:

The geophysical equipment (boomer and SBP) considered for the seabed assessment survey similar parameters as those considered in McPherson and Wood (2017). This includes the potential peak pressure, peak-peak pressure, SPL and per-pulse SEL source levels, as well as the frequency range.

Environment

The seabed within the seabed assessment area consists of very soft to soft alternating layers of silty carbonate clay and silty sands. Three profiles for the seabed were considered within the Otway seabed assessment area:

1. well-cemented carbonate caprock over increasingly cemented calcarenite (Sites 1 and 2 in > 100m water);
2. thin layer of coarse carbonate sand over increasingly cemented calcarenite (Sites 3, 4, 6 in 70-85m water); and
3. 20 m layer of coarse carbonate sand over increasingly cemented calcarenite (Site 5 in 72 m water).

From an acoustic perspective, the third profile is considered more like that within the seabed assessment area than the other two. This profile will result in higher transmission loss for lower frequencies below approximately 100 Hz, increasing with range from the source. Higher frequency components of the signal will still experience transmission loss, but this will be proportionally significantly less than that experienced by lower frequency components (Duncan et al. 2009).

The differences between the third profile from the Otway seabed assessment area is that the seabed assessment area will result in signals experiencing higher transmission loss at close range, as the seafloor within the seabed assessment area is less reflective for steeper grazing angles – which occur close to the source. At longer range, the seafloor is more reflective for shallower grazing angles, and as such the levels could be slightly higher.

If the comparison was being with the geology from the first listed profile from the Otway, the ranges would be quite different, however as the third profile shares more similarities, the differences will be lower. It is approximated that at longer ranges, the sound levels experienced could be 3-10 dB higher for an equivalent distance beyond one water depth horizontally from the source, considering the frequencies of relevance and differences in seabed and the examples provided in (Duncan et al. 2009).

As the ranges to noise effect criteria for any fauna group occur within one water depth, they will likely be either uninfluenced, or comparatively shorter at the seabed assessment area then they were predicted to be for the Otway sites. The distance at which marine mammal or turtle behaviour effects could occur could increase. The difference in ranges to the marine mammal behavioural threshold of 160 dB re 1 µPa between modelling sites in McPherson and Wood (2017) associated with the first and third geological profiles could be as much as a factor of two (75 vs 136 m). Therefore, considering this, and the similarities and differences between the third listed profile in McPherson and Wood (2017) and the seabed assessment area, it is anticipated that the ranges would be in the order of twice as much again.

JASCO Applied Sciences (JASCO) was commissioned to undertake the acoustic modelling for a representative boomer (AP3000) and SBP (Edgetech X-star system) both towed at 3 m depth. The boomer and SBP geophysical survey sources have not yet been identified, therefore JASCO chose commonly used representative systems for each source, with levels derived from previous JASCO field measurement campaigns of such sources (McPherson and Wood 2017). The modelling results are detailed in two reports. McPherson and Wood (2017) (Appendix C) detail the single pulse sound fields results and Wood and McPherson (2019) (Appendix D) detail the sound exposure level results for the different auditory classes of marine mammal.

The Otway geophysical survey acoustic modelling assessed six locations as detailed in Figure 6-2. Table 6-4 details the relevant seabed assessment locations for the modelled sites. Based on the information provided by Jasco in relation to applying the Otway geophysical survey acoustic modelling to the seabed assessment, Site 5 was used for the single pulse results as this was the most representative. For the 24 hour cumulative sound exposure levels the greatest distance was used as Site 5 was not modelled.

Table 6-4: Acoustic modelling locations

Modelled Location	Water Depth (m)
Site 1: THY MID PT	100.5
Site 2: MURCH DDIP	129.5
Site 3: G3	85
Site 4: ARTISAN	71.6
Site 5: VICP69 NTH	72.8
Site 6: VICP69 MEEKI	79.1

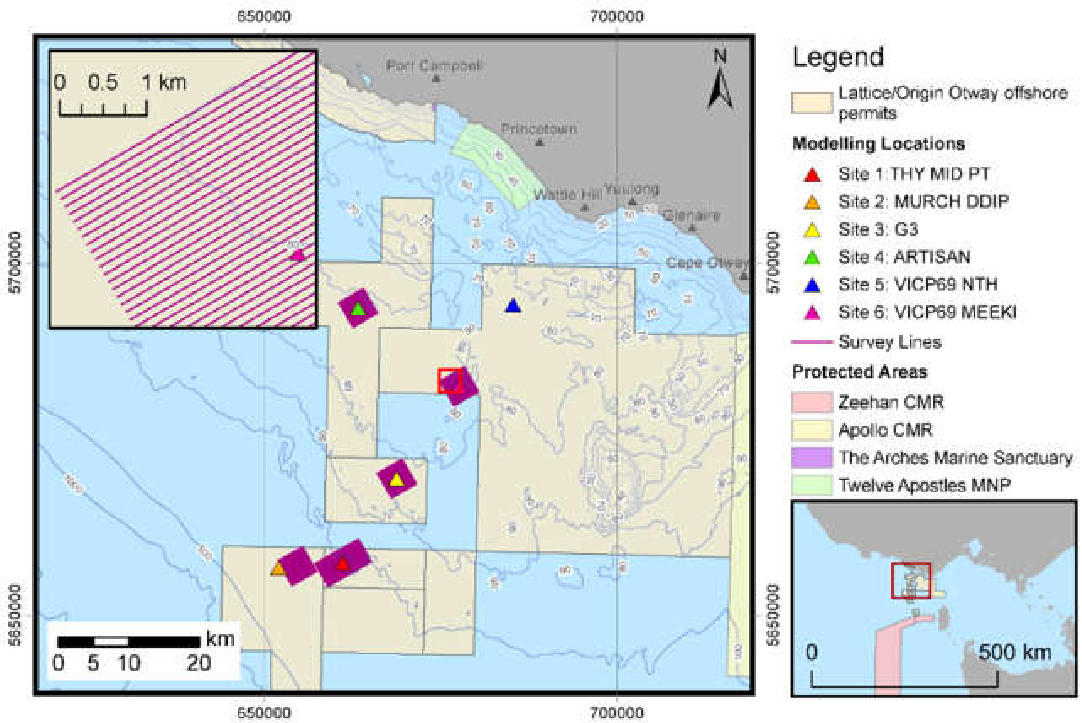


Figure 6-2: Otway geophysical survey acoustic noise modelling locations

6.2.3.3 Impulsive acoustic noise effect criteria

To assess whether an impact may occur modelled received sound levels were compared to receptor noise effect criteria. These criteria are based on published scientific research and papers as detailed in Table 6-5 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.

The largest distance to the noise effect criteria from the Otway geophysical survey modelling have been used to provide a level of conservatism in applying the results to the seabed assessment geophysical survey.

Table 6-5: 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
Scallop: effect at the seafloor	191-213 dB PK-PK	Not reached	Not reached	Day et al. 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
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	136	2	NMFS 2013
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

Receptor	Noise Effect Criteria	Boomer Maximum R_{max} Distance (m)	SBP Maximum R_{max} Distance (m)	Noise Effect Criteria Reference
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}	2.8 Not reached	0.6 Not reached	NMFS 2018
High-frequency cetaceans: TTS (pygmy and dwarf sperm whales)	196 dB PK 140 dB SEL_{24h}	5.5 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 hours 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.

6.2.4 Impulsive acoustic emissions impact evaluation and risk assessment

6.2.4.1 Marine invertebrates

There have been several 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*) and scallops are typically used.

Commercially important species such as squid or octopus may occur in the operational area. No catch effort was identified within the operational area for other invertebrate fisheries such as scallop, rock lobster or giant crab. For rock lobsters the Day *et al.* (2016) 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 $\mu Pa^2.s$
- accumulated SEL: 192–199 dB re 1 $\mu Pa^2.s$
- 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 $\mu Pa^2.s$.

Table 6-4 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.

For scallops the Day et al. (2016) study found that sub-lethal effects, relating to physiological damage and changes in behaviour and reflexes, were observed after exposure to measured received sound levels of 191 – 213 dB re 1 µPa (PK-PK). Table 6-5 details that the sound levels from the representative boomer and SBP do not reach these levels at the seafloor.

Based on the modelling no mortality or injury effects to mollusc and invertebrates are predicted.

McCauley et al. (2000) assessed the effects of air gun noise on caged squid (*Sepioteuthis australis*). No sub-lethal injury or mortality as a result of exposures in this study was observed. Several squid showed alarm responses to the start-up of an airgun by firing their ink sacs and/or jetting away from the source, but this was not observed for similar or greater levels if the signal was ramped up. General habituation was observed with a decrease in alarm responses with subsequent exposures. During the trial the squid showed avoidance to the airgun by keeping close to the water surface at the end of the cage furthest from the airgun (within the sound shadow). McCauley suggests a threshold of 166 SPL would give an indication of the extent of disruption of a seismic survey by significant alteration in swimming patterns. Table 6-5 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.

Squid may be caught by the Commonwealth Trawl Sector as incidental catch by demersal trawling while octopus are targeted by the Tasmanian Octopus Fishery.

The extent of the area of where squid or octopus swimming patterns may be altered is predicted to be 36 m from the vessel when undertaking the geophysical survey which has a maximum duration of 25 days. The severity of impacts to individuals and to the fishery is assessed as minor based on:

- any impacts to individuals will 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 seabed assessment area is approx. 70 km^2 and the distance to the noise effect criteria at which an alteration of swimming patterns may occur is predicted at a maximum of 36 m, compared to the area where trawling is undertaken.
- the extent at which impacts could occur (36 m) is not spatially large enough to impact on the Squid Jig or Octopus Fishery as individuals outside of this area are not likely to be affected.

6.2.4.2 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 6-5 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, if site attached species are present, they are unlikely to be impacted as the noise effect criteria are reached at a maximum distance of 1.6 m and hence not reached at the seabed. 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.

The operational area overlaps a distribution BIA for the white shark and the Trawl, Shark Hook and Shark Gillnet Sectors fisheries.

The extent of the area of where fish may be impacted by noise is predicated to be 1.6 m from the vessel when undertaking the geophysical survey which has a maximum duration of 25 days. The severity of impacts to fish and the shark fishery is assessed as minor based on:

- any impacts to fish and sharks 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 seabed assessment area is approx 71 km^2 and the distance to the noise effect criteria at which impacts could occur is 1.6 m, compared to the white shark distribution BIA area of 215,260 km^2. This equates to an area of overlap of 0.03%.

- the extent at which impacts could occur (1.6 m) is not spatially large enough to impact on the Trawl, Shark Hook and Shark Gillnet fisheries as fish and sharks outside of this area are not likely to be affected.

6.2.4.3 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 6-5 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. Jasco noted that at the seabed assessment area the behavioural response criteria could be twice the distance (see Section 6.2.3.2) compared to the Otway modelled location. So, for this assessment 72 m is used.

Though 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 are likely to be restricted to avoidance behaviour as the vessel moves through the 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.

The extent of the area of where turtles may be impacted by noise is predicted to be 72 m from the vessel when undertaking the geophysical survey which has a maximum duration of 25 days. The severity of impact to turtles is assessed as minor based on:

- any impacts to turtles 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 seabed assessment area is approx 71 km^2 and the distance to the noise effect criteria at which impacts could occur is 72 m.
- the area of impact is not within a BIA or habitat critical to the survival of a turtle species and thus impacts are unlikely to have a significant impact on individuals or at a population level.

6.2.4.4 Marine mammals

Noise effect criteria used in this assessment for impacts to marine mammals are:

- the United States National Marine Fisheries Service (NMFS, 2013) 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 6-5 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.

Table 6-5 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. Jasco noted that at the seabed assessment area the behavioural response criteria could be twice the distance (see Section 6.2.3.2) compared to the Otway modelled location. So, for this assessment 290 m is used.
- 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.

Seals

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. This would not result in any population levels impacts to these species.

The extent of the area of where seals may be impacted by noise is predicted to be 290 m from the vessel when undertaking the geophysical survey which has a maximum duration of 25 days. The severity of impact to seals is assessed as minor based on:

- any 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 seabed assessment area is approx 71 km^2 and the distance to the noise effect criteria at which impacts could occur is 290 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.

Cetaceans

Nine whale species may occur within the operational area with foraging behaviours identified for blue, fin, pygmy right whales and sei whales. The operational area intersects a foraging BIA for the pygmy blue whale and a distribution BIA for the southern right whale. Foraging is likely linked to the Bonney Upwelling with pygmy blue whales typically foraging in the area between January through to April (Gill et al., 2011). Neither the operational area or esonification area overlap the pygmy blue whale high use foraging area.

High frequency cetaceans

High frequency cetaceans such as pygmy and dwarf sperm whales were not identified as occurring in the operational area. It is unlikely that high frequency cetaceans would come as close to the sound source as the predicted distances to the PTS and TTS noise effect criteria of 2.8 and 5.5 m, respectively. If high frequency cetaceans were in the area impacts to these species is likely to be restricted to avoidance behaviour as the vessel moves through an area over the 25 day period that the geophysical survey is undertaken. As these species do not have BIAs within 290 m (distance to the behavioural noise effect criteria) of the operational area, potential impacts are unlikely to lead to behavioural disturbance of significance to the species.

Low frequency cetaceans - PTS and TTS

For low frequency cetaceans such as blue, fin, sei, pygmy right and southern right whales the noise effect criteria for PTS and TTS for the single pulse was not reached. The application of the 24-hour cumulative SEL criteria is seen as appropriate to apply to those cetaceans 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 esonification area above the TTS criteria (10 m) for a period of 24 hrs or greater. These were identified from the protected matters search report (Table B-10-4) and BIAs which identify the blue whales are known to forage; fin and sei whales are likely to forage; and pygmy right whales may forage in the esonification area above the TTS criteria (10 m) for a period of 24 hrs or greater (Table 6-6). As part of this review it was identified that the southern right whale distribution BIA is within the esonification area above the PTS and TTS criteria. Although distribution is not identified as a biologically important behaviour the southern right whale has been included in this assessment.

For low frequency cetaceans the boomer and SBP the 24-hour cumulative SEL TTS criteria was only reached at 10 m. The area of impact based on the seabed assessment area (68.32 km^2) plus the additional distance to the 24-hour cumulative SEL TTS criteria of 10 m, equates to 69.21 km^2.

Table 6-6: Cetacean species with biologically important behaviours within the TTS esonification area

Species	Biologically Important Behaviour
Blue whale	Foraging BIA (known to occur)
Fin whale	Foraging, feeding or related behaviour likely to occur within area.
Pygmy right whale	Foraging, feeding or related behaviour may occur within area.
Sei whale	Foraging, feeding or related behaviour likely to occur within area.

The Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015) 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. The conservation plan 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.

The Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012) 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. The conservation plan details that given the behavioural impacts of noise on southern right whales are largely unknown, a precautionary approach has been taken regarding assignation of possible consequences.

The extent of the area of impact is predicted to be 10 m (69.21 km^2) from the geophysical vessel which equates to 0.032% of the southern right whale distribution BIA (217,825 km^2).

The fin, pygmy right and sei whales do not have conservation management plans. The fin and sei whales have conservation advice (TSSC, 2015f; TSSC, 2016d) which both identify anthropogenic noise as a threat with a consequence rating of minor. There is no conservation advice for the pygmy right whale and the Species Profile and Threats Database (DotEE, 2019a) does not identify anthropogenic noise and acoustic disturbance as a threat. Though foraging behaviours have been identified as potentially occurring in the area there are no BIAs for these species within the area where the TTS noise effect criteria is reached.

The extent of impact where the noise levels are above the TTS 24-hour cumulative SEL criteria is predicted to be a distance of 10 m from the geophysical vessel, which equates to an area of impact of approx. 71 km^2, for a duration of up to 25 days when undertaking the geophysical survey. The severity is assessed as moderate as:

- the pygmy blue whale foraging BIA is large and covers the whole of Bass Strait. The area of impact is more than 150 km from the known annual high use foraging area and more than 300 km from the Bonney Upwelling KEF.
- adopted controls as detailed in Table 6-19 will prevent possible TTS impacts to whales that may be undertaking biologically important activities in the ensonified area.

- the Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015c) 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, 2015c) 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." The noise effect criteria for PTS and TTS for the single pulse was not reached.
- though the geophysical survey may be undertaken during the period when southern right whales are within the distribution BIA the area of potential impact within the BIA is very small (0.032%) compared to the large area of the distribution BIA.
- there is no overlap with southern right whale BIAs where biologically important behaviours such as calving, foraging, resting or migration (as defined by Commonwealth of Australia, 2015a).
- the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012) 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 fin and sei whale's conservation advice (TSSC, 2015f; TSSC, 2016g) has a consequence rating for anthropogenic noise and acoustic disturbance as minor.
- the pygmy right whale Species Profile and Threats Database (DotEE, 2019a) in lieu of no conservation advice, does not identify anthropogenic noise and acoustic disturbance as a threat.
- the seabed assessment area, based on surveys at the Yolla platform, is unlikely to have features that would provide for upwellings where congregations of krill are likely to occur. Hence, it is unlikely that the area provides foraging opportunities for pygmy blue or other whales.

Low frequency cetaceans – Behaviour

The acoustic threshold for behavioural effects is predicted at a maximum of 290 m which based on the seabed assessment area (approx 71 km^2) plus the distance reached to the behavioural disturbance criteria of 290 m which equates to 94.36 km^2. Within this area the following was identified:

- nine whale species and four dolphin species.
- blue whale foraging BIA (known foraging area).
- southern right whale distribution BIA.
- fin and sei whale foraging, feeding or related behaviour likely to occur within area.
- pygmy right whale foraging, feeding or related behaviour may occur within area.

Blue Whale

The Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015) 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. According to the Guidance on key terms within the Blue Whale Conservation Management Plan (DAWE, 2021a), a whale could be displaced from a foraging area if stopped or prevented from foraging, caused to move on when foraging, or stopped or prevented from entering a foraging area. A whale is considered to be displaced from a foraging area if foraging behaviour is disrupted, regardless of whether the whale can continue to forage elsewhere within that foraging area (DAWE, 2021a).

The conservation plan details that shipping and industrial noise are classed as a minor consequence where individuals are affected but no affect at a population level. The conservation plan details that given the behavioural impacts of noise on pygmy blue whales are largely unknown, a precautionary approach has been taken regarding assignation of possible consequences.

The extent of the area of impact is predicted to be 290 m from the geophysical vessel, equating to a total area of 94.36 km^2. The pygmy blue whale foraging BIA is large and covers the whole of Bass Strait. The area of impact is more than 150 km from the known annual high use foraging area and more than 300 km from the Bonney Upwelling KEF.

The DAWE (2021a) guidance regarding the definition of 'displaced from a foraging area' states that mitigation measures must be implemented to reduce the risk of displacement occurring during operations where modelling indicates that behavioural disturbance within a foraging area may occur. The implementation of the control measures and EPS presented in Table 6-19 will ensure that blue whale displacement from a foraging area will not occur. As such, the activity will not be inconsistent with the Conservation Management Plan for Blue Whales (DoE, 2015d), specifically Action Area A.2. See Table 6-7 for an assessment of the activity with the conservation objectives and actions of the Conservation Management Plan for the Blue Whale.

The behaviour threshold is more than 150 km from the high use foraging BIA and more than 300 km from the Bonney Upwelling. Based on surveys at the Yolla platform, the seabed assessment area is unlikely to have features that would provide for upwellings where congregations of krill are likely to occur. Hence, it is unlikely that the area provides foraging opportunities for pygmy blue or other whales. Thus, pygmy blue and other whale foraging is likely to be opportunist only within the ensonified area. Attard *et al* (2017) showed that pygmy blue whales travel widely between the two known foraging areas (Bonney coast upwelling and Perth Canyon) and that records suggest that this population of blue whales may visit diverse, widespread areas for feeding during the austral summer, including perhaps the southern Indian Ocean and sub-Antarctic region, and travel to winter breeding grounds in the Indonesian region where they may also feed.

Anthropogenic noise in BIAs will be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area. The EPS listed in Table 6-19 ensure that blue whales will continue to utilise foraging BIAs without injury and are not displaced from the foraging area.

Table 6-7: Assessment of the activity against the relevant conservation objectives, recovery targets and management actions of the Conservation Management Plan for the Blue Whale

Relevant aim/objective	**Action Assessment**
Relevant Interim Recovery Objectives	
4. Anthropogenic threats are demonstrably minimised.	The EIA in this EP provides a comprehensive assessment to address anthropogenic noise generated by this activity on PBW. The EPS listed in Table 6-19 address anthropogenic noise from the activity and effectively reduce its potential for impact on blue whales. The activity will be managed in a manner that is not inconsistent with this conservation objective
Relevant Interim Objective Targets	
Target 4-1: Robust and adaptive management regimes leading to a	The EPS listed in Table 6-19 provide controls that reduce anthropogenic noise on blue whales. The activity will be

reduction in anthropogenic threats to Australian blue whales are in place.	managed in a manner that is not inconsistent with this conservation objective
Target 4-2: Management decisions are supported by high quality information and high priority research projects identified in this plan are achieved or underway.	The EPS listed in Table 6-19 ensure learnings and observations from the Otway drilling campaign, and in response to new information and recommendations from the Blue Whale Study, will be considered prior to commencement of the activity to ensure continual improvement in the efficacy of control.
Relevant Action Areas	
Action Area A.2. Assessing and addressing anthropogenic noise.	The EIA in this EP provides a comprehensive assessment of assessing and addressing anthropogenic noise generated by this activity on blue whales. The EPS listed in Table 6-19 provide controls that reduce anthropogenic noise on blue whales. The activity will be managed in a manner that is not inconsistent with this conservation objective
Action 3. 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.	The EIA in this EP provides a comprehensive assessment of assessing anthropogenic noise generated by this activity on blue whales. The EPS listed in Table 6-19 address anthropogenic noise from the activity and effectively reduce its potential for impact on blue whales. The activity will be managed in a manner that is not inconsistent with this conservation objective.
Action 4. EPBC Policy Statement 2.1 Interaction between offshore seismic exploration and whales is applied to all seismic surveys	The EPS listed in Table 6-19 ensure that blue whales will continue to utilise foraging BIAs without injury and are not displaced from the foraging area. Therefore, the activity will be managed in a manner such that it is not inconsistent with the relevant management action

Other whales

The Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012) identifies shipping and industrial noise as a threat of minor consequence (individuals affected but no affect at a population level). The Plan acknowledges the behavioural impacts of noise on southern right whales are largely unknown so takes a precautionary approach regarding assignation of possible consequences.

The extent of the area of impact is predicted to be 290 m (94.36 km^2) from the geophysical vessel which equates to 0.043% of the southern right whale distribution BIA. The distribution BIA is not restricted, and the small area of impact is unlikely to impede southern right whales from travelling from their southern feeding ground to their coastal aggregation and migration areas.

The fin, pygmy right and sei whales do not have conservation management plans. The fin and sei whales have conservation advice (TSSC, 2015f; TSSC, 2016d) which both identify anthropogenic noise as a threat with a consequence rating of minor. There is no conservation advice for the pygmy right whale and the Species Profile and Threats Database (DotEE, 2019a) does not identify anthropogenic noise and acoustic disturbance as a threat. Though foraging behaviours have been identified as potentially occurring in the area there are no BIAs for these species within the area where the behavioural noise effect criteria is reached.

Summary - behaviour

The extent of impact where the noise levels are above the behavioural criteria for low frequency cetaceans is predicted to be a distance of 290 m from the geophysical vessel, which equates to an area of impact of 94.63 km^2, for a duration of up to 25 days when undertaking the geophysical survey. The severity is assessed as moderate based on:

- the pygmy blue whale foraging BIA is large and covers the whole of Bass Strait. The area of impact is more than 150 km from the known annual high use foraging area and more than 300 km from the Bonney Upwelling KEF.
- adopted controls as detailed in Table 6-19 will prevent possible behavioural impacts to whales that may be undertaking biologically important activities in the ensonified area.
- the Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015c) 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.
- though the geophysical survey may be undertaken during the period when southern right whales are within the distribution BIA the area of potential impact within the BIA is very small (0.043%) compared to the large area of the distribution BIA.
- there is no overlap with southern right whale BIAs where biologically important behaviours such as calving, foraging, resting or migration (as defined by Commonwealth of Australia, 2015a).
- the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012) 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 fin and sei whale's conservation advice (TSSC, 2015f; TSSC, 2016g) has a consequence rating for anthropogenic noise and acoustic disturbance as minor.
- the pygmy right whale Species Profile and Threats Database (DotEE, 2019a) in lieu of no conservation advice, does not identify anthropogenic noise and acoustic disturbance as a threat.
- the seabed assessment area, based on surveys at the Yolla platform, is unlikely to have features that would provide for upwellings where congregations of krill are likely to occur. Hence, it is unlikely that the area provides foraging opportunities for pygmy blue or other whales.

6.2.5 Continuous acoustic emissions impact evaluation and risk assessment

The survey vessels will emit noise from propeller cavitation, thrusters, hydrodynamic flow around the hull, and operation of machinery and equipment including the geophysical equipment.

6.2.5.1 Fish

Popper et al. (2014) details that there is no direct evidence of mortality or potential mortal injury to fish from ship noise. Popper et al., (2014) details that risks of mortality and potential mortal injury, and recoverable injury impacts to fish with no swim bladder (sharks) is low and that temporary threshold shift (TTS) in hearing may be a moderate risk near (tens of metres) the vessel. For fish with a swim bladder risks of mortality and potential mortal injury impacts is low. No cumulative impacts are expected as there are no habitats likely to support site-attached fish in the seabed assessment area.

Behavioural impacts are more likely such as moving away from the survey vessel. There are no habitats or features within the operational area that would restrict fish and sharks from moving away from the survey 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, 2013) does not identify noise impacts as a threat.

There is potential fish and shark fishing by the Trawl, Shark Hook and Shark Gillnet Sectors fisheries within the operational area.

The extent of the area of impact is predicted to be within tens of metres for a duration of up to 55 days while the seabed assessment is undertaken. The severity is assessed as minor based on:

- the Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a) does not identify noise impacts as a threat.
- avoidance behaviour may occur within the seabed assessment area, however, no habitats likely to support site-attached fish have been identified within the seabed assessment area.
- commercial fishing for shark and fish species may occur within the operational area, however, if sharks did avoid the area to a distance of tens of metres, they would still be available to be caught outside this very small area.

6.2.5.2 Marine turtles

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a) identifies noise interference as a threat to turtles. It details that exposure to chronic (continuous) loud noise in the marine environment may lead to avoidance of important habitat.

Popper et al. (2014) details that there is no direct evidence of mortality or potential mortal injury to sea turtles from ship noise.

There are currently no quantitative exposure guideline or criteria for marine turtles for continuous sound such as those generated by vessels. Popper et al. (2014) found that there was insufficient data available 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 hundreds of metres from the seabed assessment area.

Three marine turtle species may occur within the operational area 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 hundreds of metres for a duration of up to 55 days while the seabed assessment is undertaken. The severity is assessed as minor based on:

- the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a) 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.
- avoidance behaviour may occur within the seabed assessment area where no marine turtle important habits are located.
- low numbers of marine turtles are predicted in the noise exposure area and therefore impacts would be limited to a small number of individuals and not at a population level.

6.2.5.3 Marine mammals

PTS and TTS

The US National Marine Fisheries Service (NMFS 2018) reviewed available literature to determine exposure criterion for TTS and injury, referred to as the onset of non-recoverable permanent hearing loss (PTS) for marine mammals based on their frequency hearing range. The NFMS (2018) exposure criteria are based on a cumulative sound exposure levels over a period of 24 hours and are detailed in Table 6-8.

Jasco Applied Sciences undertook modelling of a typical offshore support vessel typical for Woodside's Browse to North West Shelf Project (Woodside 2019). Modelling was undertaken for two locations in water depths of 463 m and 515 m.

SVT undertook modelling for an offshore support vessel (Shell, 2018)at three locations in water depths of 152 m to 192 m. For the support vessel the cetacean PTS and TT criteria were not reached under any modelled scenarios.

Though the water depths at the modelled locations for both the Woodside and Shell projects are deeper than those within the operational area (64 - 82 m) this would lead to an overestimate of the received noise levels based as propagated noise levels may be higher in deeper water for the same source. SVT (Shell, 2018) details that:

the propagation of noise through the water is dependent upon a number of environmental factors. The depth of the water limits the lowest frequency of noise that can propagate, the deeper the water the lower the cut-off frequency. Because of this, propagated noise levels may be higher in deeper water for the same source.

Thus, the results of the Woodside and Shell projects modelling for the support vessel can be applied to the activity with confidence as they:

- are in deeper water and hence more likely to be an over estimate in distance to received levels.
- used a source level of 183 dB re 1 µPa @ 1 m which is at the higher range of source level for a DP support vessel based on support vessels can generate sound at levels between 108 and 182 dB re 1 µPa @ 1 m at dominant frequencies between 50 Hz and 7 kHz (Simmonds et al., 2004; McCauley, 1998).

High frequency cetaceans

High frequency cetaceans such as pygmy and dwarf sperm whales were not identified as occurring in the operational area or within 3.5 km from the seabed assessment (the furthest distance to a continuous noise criteria – 3.5 km for behaviour) (See Appendix A.3 Noise PMST Report).

Mid frequency cetaceans

The single pulse was not reached and 24 hr SELcum for PTS and TTS noise effect criteria for mid frequency cetaceans was not reached.

Low frequency cetaceans

For low frequency cetaceans such as blue, fin, sei, pygmy right and southern right whales the noise effect criteria for PTS and TTS for the single pulse was not reached. The application of the 24-hour cumulative SEL criteria is seen as appropriate to apply to those cetaceans 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 esonification area above the PTS and TTS criteria for a period of 24 hrs or greater. These were identified from the protected matters search report (Table B-10-4) and BIAs which identified that blue whales are known to forage, fin and sei whales are likely to forage and pygmy right whales may forage in the esonification area above the PTS (60 m) and TTS criteria (400 m) for a period of 24 hrs or greater (Table 6-8).

Neither the operational area or esonification area overlap the pygmy blue whale high use foraging area. As part of this review it was identified that the southern right whale distribution BIA is within the esonification area above the PTS and TTS criteria. Although distribution is not identified as a biologically important behaviour the southern right whale has been included in this assessment.

For the assessment the modelling results from Woodside (2019) are used as detailed in Table 6-8:

- PTS criteria being reached at 60 m from the vessel within an area of 0.062 km^2.
- TTS criteria being reached at 400 m from the vessel within an area of 8.26 km^2.

Table 6-8: Cetacean noise criteria and predicted distances

Hearing group	**Threshold** Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)	**RMax km**	**Area* km^2**
PTS			
Low-frequency cetaceans	199	0.06	0.062
Mid-frequency cetaceans	198	-	-
High- frequency cetaceans	173	0.07	0.29
TTS			
Low-frequency cetaceans	179	0.4	8.26
Mid-frequency cetaceans	178	0.06	0.19
High- frequency cetaceans	153	0.86	93.7

* Note this is from the Woodside (2019) modelling not calculated from the distance to the PTS or TTS criteria.

The Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015) 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. According to the Guidance on key terms within the Blue Whale Conservation Management Plan (DAWE, 2021a), a whale could be displaced from a foraging area if stopped or prevented from foraging, caused to move on when foraging, or stopped or prevented from entering a foraging area. A whale is considered to be displaced from a foraging area if foraging behaviour is disrupted, regardless of whether the whale can continue to forage elsewhere within that foraging area (DAWE, 2021a).

The conservation plan details that shipping and industrial noise are classed as a minor consequence where individuals are affected but no affect at a population level.

The furthest distance to the PTS or TTS noise effect criteria is predicted to be 400 m from the survey vessel which is predicted to have an area of impact of approx. 8.26 km^2 based on the modelling.

The Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012) 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. The conservation plan details that given the behavioural impacts of noise on southern right whales are largely unknown, a precautionary approach has been taken regarding assignation of possible consequences.

The further distance to the PTS or TTS noise effect criteria is predicted to be 400 m from the survey vessel. The area of impact is predicted to be 8.26 km^2 based on the modelling, which equates to 0.0038% of the southern right whale distribution BIA (217,825 km^2).

The fin, pygmy right and sei whales do not have conservation management plans. The fin and sei whales have conservation advice (TSSC, 2015f; TSSC, 2016d) which both identify anthropogenic noise as a threat with a consequence rating of minor. There is no conservation advice for the pygmy right whale and the Species Profile and Threats Database (DotEE, 2019a) does not identify anthropogenic noise and acoustic disturbance as a threat. Though foraging behaviours have been identified as potentially occurring in the area there are no BIAs for these species within the area where the PTS or TTS noise effect criteria is reached.

The extent of impact where the noise levels are above the TTS 24-hour cumulative SEL criteria is predicted to be a distance of 400 m from the vessel with an area of impact predicted to be 8.26 km^2 for a duration of up to 55 days when a vessel will be operating. The severity is assessed as moderate based on:

- though the survey vessel may be operating during the period when pygmy blue whales may forage there is no overlap with the pygmy blue whale high density foraging BIA.
- the pygmy blue whale foraging BIA is large and covers the whole of Bass Strait. The area of impact is more than 150 km from the known high use foraging area and more than 300 km from the Bonney Upwelling KEF
- adopted controls as detailed in Table 6-19 will prevent possible TTS or PTS impacts to whales that may be undertaking biologically important activities in the ensonified area.
- the Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015c) 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, 2015c) 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 a continuous noise sources and does not have high intensity signals it is unlikely that they would cause injury to foraging pygmy blue whales.
- though the survey vessel may be operating during the period when southern right whales are within the distribution BIA the area of potential impact within the BIA is very small (0.0038%) compared to the large area of the distribution BIA.
- there is no overlap with southern right whale BIAs where biologically important behaviours such as calving, foraging, resting or migration (as defined by Commonwealth of Australia, 2015a).
- the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012) 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 fin and sei whale's conservation advice (TSSC, 2015f; TSSC, 2016g) has a consequence rating for anthropogenic noise and acoustic disturbance as minor.
- the pygmy right whale Species Profile and Threats Database (DotEE, 2019a) in lieu of no conservation advice, does not identify anthropogenic noise and acoustic disturbance as a threat.
- the seabed assessment area, based on surveys at the Yolla platform, is unlikely to have features that would provide for upwellings where congregations of krill are likely to occur. Hence, it is unlikely that the area provides foraging opportunities for pygmy blue or other whales.

Behaviour

The current interim NFMS (2014) 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) review of literature and studies in relation to marine mammal behavioural response to impulsive (seismic, pile driving) and non-impulsive (drilling, vessels) found that most marine mammals exhibited varying responses between 140 and 180 dB re 1 µPa.

Studies of underwater noise generated from propellers of support vessels when holding position indicate highest measured levels up to 182 dB re 1 µPa, with levels of 120 dB re 1 µPa recorded at 3.5 km (Hannay et al., 2004; McCauley, 1998). When underway at 12 knots (22 km/h) vessel noise of 120 dB re 1 µPa was recorded at 0.5 – 1 km (McCauley, 1998). McCauley (1998) measured noise levels of a drill rig and support vessels in the Timor Sea and identified that the dominant noise emission was from the support vessel when holding position for unloading to the drill rig: whilst drilling, levels of 117 dB re 1µPa at 125 m were measured (McCauley, 1998). As the vessel to be used will be much smaller than a drill rig, it can be expected that the dominant noise source will be from the vessel while maintaining position (DP: dynamic positioning) while undertaking the geotechnical survey.

Thus, for this assessment a distance of 3.5 km (38.48 km^2) from the vessel is used which based on the seabed assessment area (approx 71 km^2) plus the distance reached to the behavioural disturbance criteria of 3.5 km equates to 425 km^2.

Based on the PMST Report for 3.5 km from the operational area (Appendix A.3) and a review of the BIAs within the EMBA the following marine mammals were identified within the behavioural esonification area:

- nine whale species and four dolphin species.
- blue whale foraging BIA (known foraging area).
- southern right whale distribution BIA.
- fin and sei whale foraging, feeding or related behaviour likely to occur within area.
- pygmy right whale foraging, feeding or related behaviour may occur within area.

Blue Whales

The Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015) 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. According to the Guidance on key terms within the Blue Whale Conservation Management Plan (DAWE, 2021a), a whale could be displaced from a foraging area if stopped or prevented from foraging, caused to move on when foraging, or stopped or prevented from entering a foraging area. A whale is considered to be displaced from a foraging area if foraging behaviour is disrupted, regardless of whether the whale can continue to forage elsewhere within that foraging area (DAWE, 2021a).

The conservation plan details that shipping and industrial noise are classed as a minor consequence where individuals are affected but no affect at a population level. The conservation plan details that given the behavioural impacts of noise on pygmy blue whales are largely unknown, a precautionary approach has been taken regarding assignation of possible consequences.

The extent of the area of impact is predicted to be 3.5 km (425 km^2) from the vessel. The foraging BIA is not restricted, and there is no overlap with the pygmy blue whale annual high use foraging BIA.

The DAWE (2021a) guidance regarding the definition of 'displaced from a foraging area' states that mitigation measures must be implemented to reduce the risk of displacement occurring during operations where modelling indicates that behavioural disturbance within a foraging area may occur. The implementation of the control measures and EPS presented in Table 6-19 will ensure that blue whale displacement from a foraging area will not occur. As such, the activity will not be inconsistent with the Conservation Management Plan for Blue Whales (DoE, 2015d), specifically Action Area A.2. See Table 6-7 for an assessment of the activity with the conservation objectives and actions of the Conservation Management Plan for the Blue Whale.

The behaviour threshold is more than 100 km from the high use foraging BIA and more than 300 km from the Bonney Upwelling. Thus, pygmy blue and other whale foraging is likely to be opportunist within the ensonified area. Attard *et al* (2017) showed that pygmy blue whales travel widely between the two known foraging areas (Bonney coast upwelling and Perth Canyon) and that records suggest that this population of blue whales may visit diverse, widespread areas for feeding during the austral summer, including perhaps the southern Indian Ocean and sub-Antarctic region, and travel to winter breeding grounds in the Indonesian region where they may also feed.

Anthropogenic noise in BIAs will be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area. The EPS listed in Table 6-19 ensure that blue whales will continue to utilise foraging BIAs without injury and are not displaced from the foraging area.

Other Whales

The Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012) 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. The conservation plan details that given the behavioural impacts of noise on southern right whales are largely unknown, a precautionary approach has been taken regarding assignation of possible consequences.

The extent of the area of impact is predicted to be 3.5 km (425 km^2) from the vessel which equates to 0.20% of the southern right whale distribution BIA (217,825 km^2). The distribution BIA is not restricted, and the small area of impact is unlikely to impede southern right whales from travelling from their southern feeding ground to their coastal aggregation and migration areas.

The fin, pygmy right and sei whales do not have conservation management plans. The fin and sei whales have conservation advice (TSSC, 2015f; TSSC, 2016d) which both identify anthropogenic noise as a threat with a consequence rating of minor. There is no conservation advice for the pygmy right whale and the Species Profile and Threats Database (DotEE, 2019a) does not identify anthropogenic noise and acoustic disturbance as a threat. Though foraging behaviours have been identified as potentially occurring in the area there are no BIAs for these species within the area where the behavioural noise effect criteria is reached.

Summary - behaviour

The extent of impact where the noise levels are above the behavioural criteria is predicted to be a distance of 3.5 km from the vessel, which equates to an area of impact of 42.5 km^2 for a duration of up to approx. 55 days when the vessel is undertaking the seabed assessment. The severity is assessed as moderate based on:

- though the vessel may be operating during the period when pygmy blue whales are likely to be foraging within the BIA (January through to April (Gill et al., 2011) there is no overlap with the pygmy blue whale annual high use foraging BIA.
- the pygmy blue whale foraging BIA is large and covers the whole of Bass Strait. The area of impact is more than 150 km from the known high use foraging area and more than 300 km from the Bonney Upwelling KEF.

- adopted controls as detailed in Table 6-19 will prevent possible behavioural impacts to whales that may be undertaking biologically important activities in the ensonified area.
- the Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015c) 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, 2015c) 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 a continuous noise sources and does not have high intensity signals it is unlikely that they would cause injury to foraging pygmy blue whales.
- though the vessel may be operating during the period when southern right whales are within the distribution BIA the area of potential impact within the BIA is very small (0.20%) compared to the large area of the distribution BIA.
- there is no overlap with southern right whale BIAs where biologically important behaviours such as calving, foraging, resting or migration (as defined by Commonwealth of Australia, 2015a).
- the southern right whale distribution BIA is not restricted, and the small area of impact is unlikely to impede southern right whales from travelling from their southern feeding ground to their coastal aggregation and migration areas.
- the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012) 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 fin and sei whale's conservation advice (TSSC, 2015f; TSSC, 2016g) has a consequence rating for anthropogenic noise and acoustic disturbance as minor.
- the pygmy right whale Species Profile and Threats Database (DotEE, 2019a) in lieu of no conservation advice, does not identify anthropogenic noise and acoustic disturbance as a threat.
- the seabed assessment area, based on surveys at the Yolla platform, is unlikely to have features that would provide for upwellings where congregations of krill are likely to occur. Hence, it is unlikely that the area provides foraging opportunities for pygmy blue or other whales.

6.2.6 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Underwater acoustic emissions	
ALARP Decision Context and Justification	**ALARP Decision Context: Type B** Impacts from noise 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.
Control Measures	**Source of good practice control measures**
CM#8: 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.

Control, ALARP and acceptability assessment: Underwater acoustic emissions	
	As the activity is to be undertaken within the period that blue, fin, pygmy right and sei whales have been identified as foraging and southern right whales (SRW) may be travelling through the area to coastal aggregation and migration areas, the safe operating distance to whales will be increased to 500 m. Typically, vessel follow the 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. The PTS and TTS criteria for low-frequency cetaceans such as blue, fin, pygmy right, sei and SRW, is predicted to be a maximum distance of 60 m and 400 m respectively from the vessel when it is operating under DP. The distance of 500 m will be used rather than the furthest predicted impact distance of 400 m as it was assessed as a more conservative distance to ensure impacts to whales are managed to an acceptable level and ALARP with minimal additional cost. As the vessel is manoeuvrable, even when the geophysical equipment is in the water this requirement will be applied. If pygmy blue whales or any other whales are sighted within 500 m of the vessel it will move away from the whale to maintain a 500 m separation distance. Maintaining a 500 m distance to whales will ensure that impacts will be managed such that they can continue to utilise the area without injury. For the geotechnical survey the vessel will maintain 500 m from any whale except for the period when it is at a location to take a geotechnical sample. In that circumstance, pre-start visual observations will be undertaken. If the vessel is under DP, CM #29 and CM #31 must also be implemented.
CM#19: Pre-start visual observations (vessel not under DP)	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 290 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. The geophysical 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. The PTS and TTS criteria for low-frequency cetaceans such as blue, fin, pygmy right, sei and SRW, is predicted to be a maximum distance of 60 m and 400 m, respectively, from a vessel operating under DP. The distance of 500 m will be used rather than the furthest predicted impact distance of 400 m as it was assessed as a more conservative distance to ensure impacts to whales are managed to an acceptable level and ALARP without having an additional cost. 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. 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 SRW are potentially moving through the area in May/June and Oct/Nov.

Control, ALARP and acceptability assessment: Underwater acoustic emissions	
CM#20: Marine Mammal Observer	Blue whales may be present in the region from November (though less likely prior to this time) through to May. If seabed assessment SBP equipment are to be used or geotechnical activities are to be undertaken during these periods, a dedicated MMO will be present on the vessel to undertake prestart visual observations and implement the 500 m distance to any whales. This control will be implemented to ensure impacts to any whale that may be foraging in the area or moving through the area, are ALARP. If vessels are using DP during identified blue whale foraging periods, a dedicated MMO will be present on the vessel to undertake pre-start observations and implement the 3.5 km shut-down zone for blue whales daylight hours. This is consistent with the Conservation Management Plan for the Blue Whale (DoE, 2015d) which states that anthropogenic noise in BIAs must be managed such that any (i.e., individual) blue whale continues to utilise the area without injury and is not displaced from a foraging area. This control will be implemented to ensure impacts to blue whales in the foraging BIA are ALARP. 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#29: Pre-start visual observations (vessel under DP)	The marine mammal behavioural criteria for low frequency cetaceans (LFC) for the vessel under DP is reached at a maximum distance of 3.5 km. Prior to the use of DP, a prestart visual observation of the 3.5 km behavioural zone will be undertaken for pygmy blue whales. In order to not injure or displace whales that may be present in this zone prior to operations commencing, a pre-start survey of the observation zone (3.5 km radius around the activity location) will be undertaken in daylight hours prior to the vessel beginning DP operations in the activity area. This will ensure that no foraging or migrating whales will be exposed to injury (e.g., PTS or TTS) or be displaced when the vessel begins DP operations. If a whale is spotted during the pre-start survey, the vessel will not commence DP operations until such time as: • No blue whales are observed for 30 minutes within the observation zone; or • Blue whales are observed leaving the observation zone. 30 minutes is sufficient time for the vessel and/or whale to have moved 3.5 km away and to account for pygmy blue whales that are capable of diving for periods upwards of 20 minutes. This will ensure that individual pygmy blue whales will not be displaced from the foraging BIA and hence is consistent with the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b).
CM#21: 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

Control, ALARP and acceptability assessment: Underwater acoustic emissions	
	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. Based on data in Appendix B3.3.3 Cetaceans, pygmy blue whale numbers are typically lower within the Bass Strait than at Portland, which is closer to the Bonney upwelling, however, in some seasons conditions in Bass Strait can be favourable to pygmy blue whales and numbers can exceed those at Portland (McCauley et al. 2018). Thus, the implementation of an adaptive management process will ensure that if numbers are greater in the Bass Strait than expected due to favourable conditions, impacts and risks can continue to be managed to ALARP and within the defined acceptable level.
CM#30: Implement night time and low visibility whale procedures for blue whale sightings	Commencing vessel DP operations at night or in low visibility conditions (i.e. when observations cannot extend to the 3.5 km observation zone) can only occur if there have been no sightings of individual blue whales in the observation zone in the 2 hours prior to sunset. Two hours is considered adequate as research undertaken by Moller et al (2015) in the Bonney Upwelling indicated that the average duration of dive times for pygmy blue whale foraging, migrating and exploring ranged from 5.2 to 8.6 minutes (with maximums ranging between 17.5 to 26.7 minutes), leading to the assumption that dive times are typically less than 30 minutes. This means that over the course of 2 hours from the point of first sighting, an MMO would typically have an opportunity to sight the whale again up to 4 times at a minimum (when it surfaces to breathe), which is adequate to determine whether a whale has moved beyond the 3.5 km observation (behavioural) zone. In 2 hours, it is expected that a whale would be many kilometres away from the original observation location. As the seabed assessment area is more than 150 km from the annual high use foraging area, 300 km from the Bonney upwelling and is unlikely to have features that would provide for upwellings where congregations of krill are likely to occur, it is unlikely that the area provides foraging opportunities for pygmy blue or other whales. As such, a pre-watch period of 2 hours in considered adequate.
CM #31: shutdown zones for the vessel under DP	*Implemented with safety controls* Shutting down the vessel DP system during geotechnical 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 equipment if it is suspended by a crane in the air or in the water at the time of shutdown. It could also result in a vessel strike to the whales that shutting down the propulsion system is meant to protect. The marine mammal behavioural criteria for the vessel under DP is reached at a maximum distance of 3.5 km. It can be assumed that if whales are sighted within the observation zone (3.5 km) then they are not being displaced from the area. However Beach acknowledge that if a whale is sighted moving through the behavioural area it is difficult to determine if it is moving away and so being displaced from the area, or is unaffected and just passing through. As such, in the event of a blue whale sighting within the observation zone (3.5 km from the vessel), DP would be shutdown where safe to do so (i.e., if there are no suspended loads). This is consistent with the Conservation Management Plan for the Blue Whale (DoE, 2015d) which states that anthropogenic noise in BIAs must be managed such that any (i.e., individual) blue whale continues to utilise the area without injury and is not displaced from a foraging area. If a whale is within the 3.5 km and is positively identified as **not** being a blue

Control, ALARP and acceptability assessment: Underwater acoustic emissions	
	whale, DP does not have to be shut-down. This is not inconsistent with management plans and advice for other non-blue whale species. If a whale is within the 3.5 km and it cannot be positively identified, it will be assumed to be a blue whale and DP will be shut down if safe to do so. The vessel cannot re-commence DP operations until such time as: • no blue whales are observed for 30 minutes within the shutdown zone; or • whales are observed leaving the observation zone. Modelling has indicated that TTS and PTS to marine mammals may occur to 400 m. If any whale enters the 500 m zone, DP will be shut down.
Control Measures considered but not adopted.	

Control, ALARP and acceptability assessment: Underwater acoustic emissions		
Implementation of the EPBC Act Policy 2.1 Shut-down Zones (Geophysical equipment use only)	Good Practice	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. • 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 290 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 290 m for the noise effect criteria for behavioural disturbance and 8.9 m for the noise effect criteria for TTS for high frequency whales which are not likely to be present in the area. For low frequency whales such as pygmy blue whales that maybe present in the foraging BIA the TTS noise effect criteria was reached at 10 m. 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 290 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. It is unlikely that whales would come into the area where noise levels are above the PTS and TTS criteria once the vessel is on location. Pre-start up observations and delayed start where whales are within 500 m of the vessel, will ensure that pygmy blue whales can continue to utilise the foraging BIA without being injured or displaced as per the requirements of the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b). It also ensures other whales such as fin, pygmy right, sei and southern right whales will not be injured or displace whales foraging or moving through the area. Shutdown zones associated with Vessel DP use are discussed in CM #31
Implementation of the EPBC Act Policy 2.1 Seasonal Timing	Good Practice	The seabed assessment area intersects a foraging BIA for the pygmy blue whale. Foraging is likely linked to the Bonney Upwelling (~ 300 km from the seabed assessment area) with pygmy blue whales typically foraging in the area between January and April (Gill et al., 2011). Thus, there may be a period of overlap with this foraging period. The predicted extent of impact (TTS, PTS or behavioural) does not overlap the

Control, ALARP and acceptability assessment: Underwater acoustic emissions		
		annual high use foraging area. Committing to undertaking assessments outside of the identified foraging periods is not possible due to safety requirements associated with weather. Bass Strait is known for its harsh weather, especially strong winds and large waves during winter months. Summer (Jan – April) is the safest time to mobilise the activity and has the least potential for damage to personnel, the vessel and equipment. Mobilising outside of summer will likely increase the length of the survey as the vessel will have to mobile and leave site frequently to account for inclement weather. This results in an increase in fuel consumption and generation of GHG. Due to the small period of potential overlap (up to approx. 55 days) with the foraging period and that any impacts are not predicted to injure or displace pygmy blue whales from the foraging BIA, avoiding the period of January to April does not afford any further benefit.
Implementation of the EPBC Act Policy 2.1 Soft start	Good Practice	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.
Anchoring of the vessel during Assessment activities	Substitution	Vessel noise could be minimised by the vessel anchoring while on location. This is not feasible as the majority of the assessment activities requires the vessel to either be moving or moving location on a very regular basis; or undertaking minor adjustments to the vessel position during an activity. The vessel must also be able to react to an errant vessel, man overboard or other safety issues. Thus, anchoring of the vessel is not a feasible option.
Use of passive acoustic monitoring (PAM) for the detection of cetaceans	Engineering	As a cetacean detection method, PAM has been used to detect whales that vocalise at high frequencies/intensities such as MFC and HFC (e.g., sperm whales) and, in conjunction with visual monitoring, can enhance cetacean detection effectiveness. PAM has the advantage of potentially detecting cetaceans during night hours and during periods of poor visibility when they cannot be visually detected. Although PAM can be a valuable tool in identifying the presence of cetaceans, the following factors limit its effectiveness: • Most suitable for MFC and HFC, which are generally of lower concern in this region compared to LFC. It is difficult for PAM to pick up vocalisations of LFC such as blue whales and southern right whales. • Bearing accuracy and range estimation is limited because it is not as accurate as visual observations. The use of an experienced MMO negates the need for using PAM given that LFC (which surface to breath more regularly that deeper-water MFC and HFC) will generally be able to be easily detected.
Adoption of increased shutdown distance for other LFC (non-blue whale)	Good practice	Once vessel operations are underway, it is assumed that if LFC (non-blue) whales are sighted within the observation zone (3.5 km) then they are not being displaced from the area. Therefore, it is safe to assume that only the extent of the potential zone for TTS and PTS impacts (i.e., up to 400 m and 60 m from the vessel, respectively) need to be managed once operations have begun. This means that for other LFC that may be present in and around the activity, such as humpback whales, the vessel shutdown zone will be 400 m, in line with the modelling results for TTS.
Timing of activity to avoid	Good Practice	There are no Victorian or Tasmanian fisheries in the seabed assessment area. The seabed assessment area overlaps the Trawl, Shark Hook , Shark Gillnet and Squid

Control, ALARP and acceptability assessment: Underwater acoustic emissions		
peak fishing periods		Jig Fishery where there is potentially catch effort. This fishery does not have a closed season. To date no fisher has requested that an area be avoided or sequenced in a certain order to avoid a certain time period. The Commercial Fisher Operating Protocol details how Beach will manage any such requests.
Substitution of equipment.	Engineering Risk Assessment	Equipment has been selected to meet the objective of the seabed assessment. Modelling has shown that the survey equipment to be used generates very low received noise levels and distances to noise effect criteria are very low with the largest predicted distance at 290 m for the behavioural noise effect criteria for marine mammals. Thus, there is no benefit in changing the equipment as it is unlikely to significantly reduce the distance within which the noise effect criteria are met.
Implement nighttime and low visibility whale procedures for all other LFC sightings (non-blue whales)	Admin	The only other LFC species likely to be sighted are humpback whales, who are not known to forage or feed in Bass Strait during their migration through the region. Their migration is unlikely to be impacted by the activity because they are likely to be habituated to shipping noise that is present year-round in the region. As such, implementing restrictions on operating at night time if one or more LFC (other than blue whales) will have negligible environmental benefit, while extending the time that the vessel remains on location and potentially impacting on blue whale foraging
Satellite imagery	Admin	A number of satellite types exist, however the most suitable for monitoring whales is Digital Globe's WorldView3 Satellite which uses 30 cm resolution. This is recommended by a recent study by Cubaynes *et al* (2018) due to the better resolution that is needed to confidently identify objects such as whales (e.g., characteristic features such as flippers and flukes that are not easily detected on lower resolution images (e.g., 50 cm), and which are essential for identifying an object such as a whale, and for differentiating between species (e.g., pygmy blue whale vs another large baleen whale)). Several factors make the use of satellite imagery to monitor for whale presence unviable, as below: • Uncertainty as to whether satellite image quality will be sufficient to identify whales. • There will be a lag between when the satellite images are being taken and when Beach will receive them. • Additional time will then be required to analyse the images. This delay makes satellite imagery unsuitable for making a decision to mobilise or to begin operations. • Whales need to be at or above the sea surface to be able identifiable – therefore submerged whales, even if just below the surface, will be missed. Given these factors, this technology is unreliable for the purpose of whale behaviour identification, thus no environmental benefit is achievable regardless of the cost.
Drone surveys	Admin	Drones have been considered as a method of increasing the observation distance of MMOs and monitoring the PTS, TTS and observation zones. Drone surveys have been carried out for cetaceans mainly in the nearshore marine environment via beach operations. To date it is not known if drone surveys have been effectively used as a real-time monitoring method. Drone effectiveness offshore is limited due to the following:

Control, ALARP and acceptability assessment: Underwater acoustic emissions		
		• Physical range of drones is only approximately 4-5 km. • Drone operations are sensitive to wind, particularly gusting winds, which would limit the use of this equipment. • Technical support and operators required. Given an MMO will be present on the vessel during identified sensitive periods and/or certain geophysical operations, the extra observation distance afforded through the use of drones provides negligible observation benefit. The additional cost, safety issues and operational limitations outweigh the negligible environmental benefit.
Infra-red systems	Admin	Infra-red (IR) systems could enhance the ability of MMOs to visually detect the presence of foraging or potentially foraging whales. Infra-red systems are not available as a real-time monitoring tool for operations and have the following limitations: • Poor performance of the system in sea states greater than Beaufort Sea State 4 (due to the inability to adequately stabilise the camera) (Verfuss et al., 2018; Smith et al., 2020). • Conditions such as fog, drizzle and rain limit detections that can be made using IR (Verfuss et al., 2018). • Detection range for large baleen whales is 1 to 3 km. Given an MMO will be present on the vessel during identified sensitive periods and/or certain geophysical operations, the use of IR technology provides negligible observation benefit. The additional cost, safety issues and operational limitations outweigh the negligible environmental benefit.
Undertake aerial observations for whales prior to and during the activity	Admin	Flights in small aircraft over open water introduce significant safety risks, and there is no guarantee that whales will be spotted. Previous spotter flights undertaken in the nearby Otway have identified that the ability to detect cetaceans can be severely limited during: • Choppy sea states, when white caps make it extremely difficult to spot tell-signs of whale presence, • Calm conditions, when glare from the water can significantly reduce the ability to detect any features on the sea surface, and • Mists and fogs, which can severely reduce visibility. The speed and turning time of the aircraft make positive identification of potential sightings very challenging. Spotter flights are also unable to detect cetaceans that are not active on the ocean surface. Undertaking aerial spotter flights has a low likelihood of success and involves taking a high safety risk. This, combined with the high costs of spotter flights, means the risks and costs associated with this control are disproportionately high when considering the minor residual impact consequence for cetaceans.

Control, ALARP and acceptability assessment: Underwater acoustic emissions	
Consequence Rating	Moderate (2)
Likelihood of Occurrence	N/A
Residual Risk	Low
Acceptability Assessment	
Policy compliance	The proposed management of the impact is aligned with the Beach Environment Policy.
Management system compliance	The seabed assessment will be undertaken in accordance with the OEMS as detailed in Section 7 Implementation Strategy.
Stakeholder engagement	During stakeholder engagement no objections or claims were raised.
Laws and standards	Noise emissions will be managed in accordance with legislative requirements. Noise emissions will: • not impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia,2017a). • 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, 2015). • not impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015). • not impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012). • not impact the recovery of sei, fin whale or humpback whales, covered by conservation advice. • not impact the recovery of the white shark as per the Recovery Plan for the White Shark (DSEWPaC, 2013). Actions from the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015) 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 6.2.4 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 6.2.4 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.
Industry practice	The use of vessel and geotechnical and geophysical surveys are normal marine practices in the oil and gas industry.
Environmental context	The impact assessment predicts that acoustic emissions will not result in death, injury or significant behavioural effects to marine fauna or injury or displacement of pygmy blue whales from the foraging BIA. This is in alignment with relevant conservation advice and recovery plans for EPBC species that may occur in the seabed assessment area including the pygmy blue whale, southern right whales, fin whales, sei whales, marine turtles and white shark. Impacts to commercial invertebrate and fish species were not predicted.

Control, ALARP and acceptability assessment: Underwater acoustic emissions	
Environmentally Sustainable Development principles	The seabed assessment was 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.
Monitor and review	Impacts associated with acoustic emissions are for a short duration, over small area and not predicted to have long term impacts to fauna in the area. Therefore, the monitoring of underwater noise and vibration emission is not proposed.
Acceptability outcome	**Acceptable**

6.3 Loss of marine diesel from vessel collision

6.3.1 Hazards

Marine diesel oil is used in offshore vessels. A collision between a Beach contracted vessel and third-party vessel has the potential to result in a spill of fuel.

6.3.2 Known and potential environmental impacts

The known and potential environmental impacts of a diesel spill are:

- temporary decrease in marine water quality
- toxicity effects and/or physical oiling of marine fauna
- habitat damage where the spill reaches shoreline.

6.3.3 Impact evaluation and risk assessment

6.3.3.1 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 6-9), 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 6-10 shows the boiling point ranges for the diesel used in the spill modelling.

Table 6-9: 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 6-10: Diesel boing point ranges

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 be distributed over time into the following components:

- surface
- entrained (non-dissolved oil droplets that are physically entrained by wave action)
- dissolved (principally the aromatic hydrocarbons)
- evaporated
- decayed.

Of these components, surface hydrocarbons, entrained hydrocarbons and dissolved aromatics have the most significant impact on the marine environment. These are discussed in further detail below.

6.3.3.2 Modelling results – vessel collision spill

A spill of 100 m^3 was modelled using ADIOS II. The spill volume is consistent with the AMSA technical guidance (AMSA, 2015) for determining spill scenarios for shipping operations, which indicates the basis of volume calculation is the volume of the largest fuel tank. The worst-case spill volume assumes complete loss of inventory from one tank on the largest potential vessel, using representative metocean conditions during the proposed survey period (Table 6-11).

Relevant findings from the ADIOS modelling are:

- the surface life for an instantaneous diesel spill of 100 m^3 from a worst-case vessel collision incident is estimated at 12 hours (Figure 6-3).
- in this time, surface diesel may travel up to 4.57 km, based on an estimate in which the surface spill will travel at 100% of the speed and direction of ambient currents, and 3% of speed and direction of local winds.
- shorelines are not predicted to be impacted.

A schematic depicting these environmental factors used to determine the spatial extent of the EMBA has been depicted in Figure 6-4.

Table 6-11: Modelled average characteristics for the Bass Strait region (summer)

	Current (from)	Wind	Water Temperature	Salinity
Details	0.1 m/s	8.07 m/s	14°C	35 ppt
Direction	East	South-west	-	-

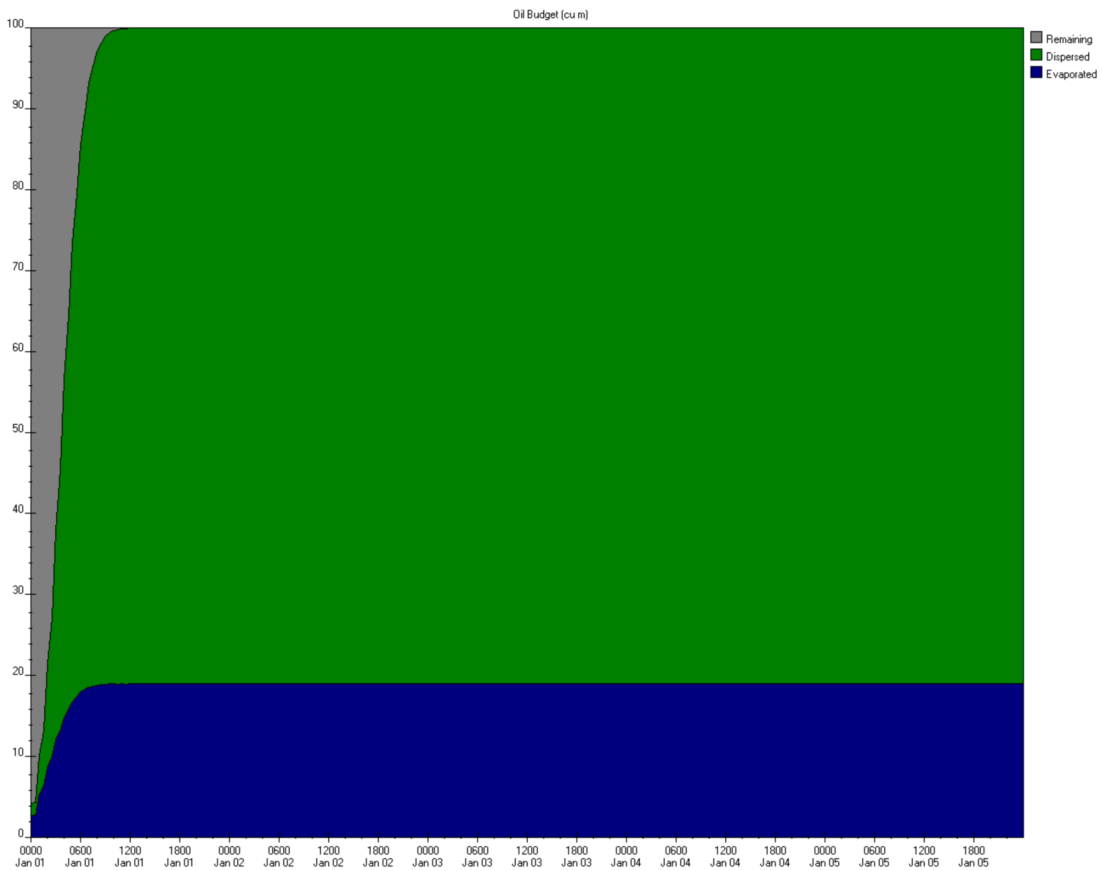


Figure 6-3: Percentage of oil remaining from a 100 m^3 of diesel spill due to vessel collision

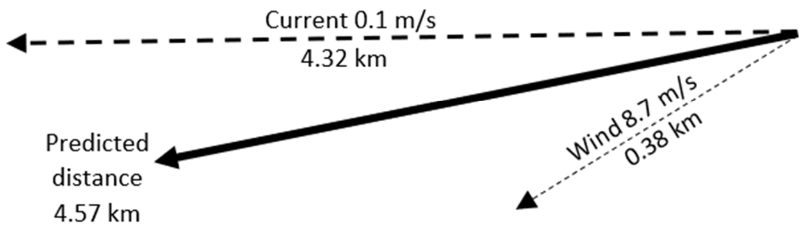


Figure 6-4: Travel distance of a 100 m^3 of diesel spill due to vessel collision

Due to rapid and high levels of evaporation when spilt at sea, the environmental effects of diesel spills are generally short-term. When spilt at sea, diesel will spread and thin out quickly, with up to 67 m^3 predicted to be lost by evaporation and dispersion within 6 hours, depending upon sea temperature and winds (Figure 6-3). Diesel oils also has low viscosity which result in hydrocarbons becoming physically dispersed as fine droplets into the water column when winds exceed 10 knots. Droplets of diesel oil that are naturally dispersed will be sub-surface and will behave quite differently to surface oil. Diesel droplets move solely with the currents while dispersed in the water, while on the surface are affected by both wind and currents. Natural dispersion of diesel reduces the hydrocarbons ability to evaporate into the air (RPS, 2017).

Although evaporation reduces the 'quantity of hydrocarbons on the water surface, it increases the quantity of hydrocarbons in the atmosphere available to be inhaled. This increased hydrocarbon vapour exposure can affect any air breathing marine fauna (RPS, 2017).

The different diesel product compositions, together with different environmental conditions during marine spills (sea temperature, wind and sea states) can vary the quantities of hydrocarbons lost to the atmosphere due to evaporation (but generally ranges between 40-65%). Dispersion into the sea by the action of wind and waves can result in 25 to 50% of the loss of hydrocarbons from surface slicks and dissolution (solubility of hydrocarbons) can account for 1-10% loss from the surface (RPS, 2017).

6.3.4 Ecological impacts of diesel spills

The environmental effects of diesel spills are not as visually obvious as those of heavier fuel oils or crude oils. Diesel oil is considered to have a higher aquatic toxicity in comparison to many other crude oils and condensates due to the types of hydrocarbons present and the resulting increased bioavailability of dispersed droplets of diesel to marine organisms. Diesel oil has components with the potential to bio-accumulate in organisms and have high water solubility along with a higher potential to naturally entrain into the water column than heavy fuel oils (HFO).

The potential environmental impacts to receptors within the EMBA are discussed in Table 6-12 to Table 6-15

If a vessel collision occurred releasing 100 m^3 of diesel the predicated extent of impact is 4.57 km with a duration of 12 hours. The severity is assessed as moderate and likelihood as highly unlikely based on:

- within the seabed assessment area vessels will be slow moving to stationary.
- the occurrence of vessel collisions is remote with no incidents occurring to date associated with Beach's activities in the Otway or Bass Strait region.
- if an incident occurred, impacts would cover a small area for a short duration and not impact at a population level or impeded the recovery of a protected species.

.

Table 6-12: Consequence evaluation to ecological receptors within the EMBA – sea surface

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Marine fauna	Seabirds	Several listed Threatened, Migratory and/or listed marine species have the potential to be rafting, resting, diving and feeding within the spill area. The EMBA intersects foraging BIAs for several albatross, common diving-petrel, short-tailed shearwater and white-faced storm-petrel. These foraging BIAs are typically large broad areas covering most or all of the SEMR. These species can feed via surface skimming or diving – both exposing the bird to any oil on the water surface. No breeding activity occurs in oceanic waters.	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 may be impacted; however, it is unlikely that many birds will be affected as sea surface oil is only predicted for the first 12 hours. Seabirds rafting, resting, diving or feeding at sea have the potential to encounter areas where hydrocarbons concentrations are greater than 10 g/m^2 and due to physical oiling may experience lethal surface concentrations. As such, acute or chronic toxicity impacts (death or long-term poor health) to birds are possible but unlikely for a diesel spill as the number of birds would be limited due to the small area and brief period of exposure above 10 g/m^2. Therefore, potential impact would be limited to individuals.
	Marine reptiles	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 these species within this area.	Marine turtles are vulnerable to the effects of oil at all life stages. Marine turtles can be exposed to surface oil externally (i.e. swimming through oil slicks) or internally (i.e. swallowing the oil). Ingested oil can harm internal organs and digestive function. Oil on their bodies can cause skin irritation and affect breathing. The number of marine turtles that may be exposed to surface diesel is expected to be low as there are no BIAs or habitat critical to the survival of turtle species; however, turtles may be transient within the EMBA. Sea surface oil is only predicted for the first 12 hours limiting the period when oiling may occur. Therefore, potential impact would be limited to individuals.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
	Pinnipeds	There may be pinnipeds in the area predicted to be exposed to surface oil. However, there are no BIAs or habitat critical to the survival of these species within this area.	Pinnipeds 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 pinnipeds that may be exposed to surface diesel is expected to be low as there are no BIAs or habitat critical to the survival of pinniped species; however, pinnipeds may be transient within the EMBA. Sea surface oil is only predicted for the first 12 hours limiting the period when oiling may occur. Therefore, potential impact would be limited to individuals
	Cetaceans	Several Threatened, Migratory and/or listed marine cetacean species have the potential to be migrating, resting or foraging within the area predicted to be exposed to surface oil. Known BIAs are present for foraging for pygmy blue whales and distribution for southern right whales within the EMBA. There are no dolphin BIAs or habitat critical to the survival of the species within this area.	Physical contact by individual cetaceans with a surface diesel spill is unlikely to lead to any long-term impacts. Given the mobility of cetaceans, only a small proportion of the population would surface in the affected areas, resulting in short-term and localised consequences, with no long-term effects on population viability. If whales are foraging at the time of the spill, a greater number of individuals may be present in the area where sea surface oil is present, however due to the short duration of the surface exposure (~12 hours), this is not likely. Therefore, potential impact would be limited to individuals

Table 6-13: Consequence evaluation to socio-economic receptors within the EMBA – sea surface

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Human systems	Recreation and tourism (including recreational fisheries)	Marine pollution can result in impacts to marine-based tourism from reduced visual aesthetic. Diesel is known to rapidly spread and thin out on release and consequently, a large area may be exposed to hydrocarbon concentrations greater than 1 g/m^2.	Visible surface hydrocarbons have the potential to reduce the visual amenity of the area for tourism and discourage recreational activities. Given the nature of the oil, it is expected to rapidly weather offshore (within 4.57 km of the spill area) and unlikely to be visible from onshore. The closest shoreline is approximately 89 km from the extent of the spill.
	Industry (shipping)	Shipping occurs within the area predicted to be exposed to surface hydrocarbons.	Vessels may be present in the area where 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)	The Beach Yolla platform is located within the area predicted to be exposed to surface hydrocarbons.	Impacts to the Beach Yolla platform are unlikely due to the short duration of the surface exposure (approximately 12 hours) .

Table 6-14: Consequence evaluation to physical and ecological receptors within the EMBA – in water

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Marine fauna	Plankton	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. Plankton are numerous and widespread but do act as the basis for the marine food web, meaning that an oil spill in any one location is unlikely to have long-lasting impacts on plankton populations at a regional level. Once background water quality conditions have been re-established, the plankton community may take weeks to months to recover (ITOPF, 2011a), allowing for seasonal influences on the assemblage characteristics.
	Marine invertebrates	Marine invertebrates may reside on the seabed (molluscs, crabs) or in the water column (squid) area exposed to entrained hydrocarbons. Squid	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. Exposure to invertebrates

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		may occur in the EMBA and be caught by the Squid Jig Fishery. No catch effort was identified within the EMBA for other invertebrate fisheries such as scallop, rock lobster or giant crab. 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.	including commercial species to dissolved/entrained hydrocarbons is unlikely due to waters being greater than 64 m and effects will be greatest in the upper 10 m of the water column. Squid may be fished in the area with exposure predicted for a short duration in the top 10 m of the water column.
	Fish	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. Commercial trawl and shark fishing potentially occur in the are likely to be exposed to entrained hydrocarbon. As does a white shark distribution BIA.	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). 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, and the limited areal extent of the spill. As egg/larvae dispersal is widely distributed in the upper layers of the water column it is expected that current induced drift will rapidly replace any oil affected populations.
	Pinnipeds	Pinnipeds may be in the area temporarily exposed to low concentrations of entrained diesel in the water column. However, there are no BIAs or habitat critical to the survival of these species within this area.	Exposure to low/moderate effects level hydrocarbons in the water column or consumption of prey affected by the oil may cause sub-lethal impacts to pinnipeds. However, 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 EMBA), is it not anticipated to result in long-term effects on population viability.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
	Cetaceans	Several Threatened, Migratory and/or listed marine cetacean species that if in the area may be temporarily exposed to low concentrations of entrained diesel in the water column. Known BIAs are present for foraging for pygmy blue whales and distribution for southern right whales within the EMBA. 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 diesel weathers.	If whales are foraging at the time of the spill, a greater number of individuals may be present in the area where entrained hydrocarbons are present, however due to the short duration of exposure (~12 hours) and low volume of oil, impacts from ingesting oil are not likely. Therefore, potential impact would be limited to individuals for a short duration.

Table 6-15: Consequence evaluation to socio-economic receptors within the EMBA – in water

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Human systems	Commercial fisheries	Due to their higher solubility and ease of entrainment/ dispersion into the water column, diesel spills can have a greater ecological impact in comparison to other floating oil slicks and are known to taint seafood. According to the International Maritime Organisation (IMO), diesel oil has a Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection rating of 3 for acute toxicity (damage to living organisms) and 4 for bioaccumulation/ tainting (4 = high potential to bioaccumulate, 5 is the highest). In-water exposure to entrained diesel may result in a reduction in commercially targeted marine species, resulting in impacts to commercial fishing and aquaculture. No catch effort was identified within the EMBA for other invertebrate fisheries such as scallop, rock lobster or giant crab.	For pelagic commercial species of fish, sharks and squid exposure would be limited as they moved through the spill area. Physical displacement of commercial fishers is unlikely based on the short duration of exposure (12 hours) and low numbers of fishers within the EMBA.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		Commercial squid, fish and shark fishing potentially occurs in the area and sharks may be exposed to entrained hydrocarbon.	

6.3.5 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Loss of marine diesel from vessel collision	
ALARP Decision Context and Justification	**ALARP Decision Context: Type B** Vessels have been used for activities within the BassGas offshore natural gas development for many years with no 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.
Control Measures	**Source of good practice control measures**
CM#10: 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 AUSCOAST 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 9.7 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#18: SMPEP (or equivalent)	In accordance with MARPOL Annex I and AMSA's MO 91 [Marine Pollution Prevention – oil], a SMPEP (or equivalent, 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 details: • response equipment available to control a spill event; • review cycle to ensure that the SMPEP is kept up to date; and • testing requirements, including the frequency and nature of these tests. In the event of a spill, the SMPEP 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 contains procedures to stop or reduce the flow of hydrocarbons to be considered in the event of tank rupture.
CM#22: MO 21: Safety and emergency procedures	AMSA MO 21 effect to SOLAS regulations dealing with life-saving appliances and arrangements, safety of navigation and special measures to enhance maritime safety.

Control, ALARP and acceptability assessment: Loss of marine diesel from vessel collision			
CM#23: MO 30: Prevention of collisions	AMSA MO 30 requires that onboard navigation, radar equipment, and lighting meets industry standards.		
o	All vessels contracted to Beach will have in date certification in accordance with AMSA MO 31.		
Additional Controls Assessed			
Control	**Control Type**	**Cost/Benefit Analysis**	**Control Implemented?**
Eliminate or substitute the use of diesel.	Good Practice	The use of diesel for fuel for vessels and machinery cannot be eliminated. Substituting for another fuel, i.e. HFO or bunker fuel oil, would have a higher environmental impact than diesel.	No
Exclusion zone established around the seabed assessment area during the seabed assessment.	Good Practice	The duration of the seabed assessments at specific locations will be short in duration and the vessel transient. The exclusion of vessels from this area would cause greater impact on socio-economic receptors, such as fisheries and shipping.	No
Smaller vessel used for the seabed assessment.	Engineering Risk Assessment	The vessels proposed for the seabed assessment and their vessel tank sizes are considerably smaller than vessels used for other petroleum activities, such as seismic surveys and support vessels, within the Bass Strait region.	No
Consequence Rating	Moderate (2)		
Likelihood of Occurrence	Highly Unlikely (2)		
Residual Risk	Low		
Acceptability Assessment			
Policy compliance	The proposed management of the impact is aligned with the Beach Environment Policy.		
Management system compliance	Activities will be undertaken in accordance with the Implementation Strategy (Section 7).		
Stakeholder engagement	No objections or claims have been raised during stakeholder consultation regarding the potential for diesel spills.		
Laws and standards	Vessels will comply with: • MO 21 (Safety and emergency procedures); • MO 30 (Prevention of collisions); • MO 31 (SOLA and non-SOLAS certification); • MO 91 (Marine pollution prevention – oil); and • *Navigation Act 2012*.		
Industry practice	The use of vessels to support exploration of the offshore environment is standard industry practice.		
Environmental context	Diesel is a medium-grade oil that has a low density, a low pour point and a low dynamic viscosity, indicating that this oil will spread quickly		

Control, ALARP and acceptability assessment: Loss of marine diesel from vessel collision	
	when spilled at sea and thin out to low thicknesses, increasing the rate of evaporation. In the marine environment diesel will tend to spread rapidly in the direction of the prevailing wind and waves. Evaporation is the dominant process contributing to the fate of spilled diesel from the sea surface and will account for > 50% reduction of net hydrocarbon balance. In addition, a proportion of the diesel will entrain under the water surface particularly when wind speed and resultant wave action increase. Because of the tendency of diesel to spread quickly to a thin surface layer, small amounts over a relatively large area will become entrained. As such, entrained oil at concentrations above impact thresholds will be limited to a localised area around the vessel. Long-term impacts to physical, ecological and socio-economic receptors that come in contact with the diesel both on the sea surface and in-water are unlikely. Shoreline impacts are not predicted.
Environmentally Sustainable Development principles	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.
Monitoring and reporting	Impacts as a result of a hydrocarbon spill will be monitored as per Section 8 and reported as per Section 7.10.1.
Acceptability outcome	**Acceptable**

6.4 Oil spill response

This section presents the risk assessment for oil spill response options as required by the OPGGS(E)R.

6.4.1 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 6-16 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.

6.4.2 Hazards

The following activities have been identified for responding to a vessel collision oil spill event:

- mobilisation and demobilisation of spill response personnel, plant and equipment; and
- handling, treatment and/or relocation of affected fauna (oiled wildlife response).

Table 6-16: Suitability of response options for a vessel collision resulting in a diesel spill

Response Option	Description	Vessel Collision Scenario Assessment	Option Viable?	Strategic Net Benefit?
Source Control	Limit flow of hydrocarbons to environment.	Achieved by vessel SMPEP.	✓	✓
Monitor and Evaluate	Direct observation: • marine • aerial • vector calculations • oil spill trajectory modelling. To maintain situational awareness, all monitor and evaluate options are suitable.	Diesel spreads rapidly to thin layers. Manual calculation based upon weather conditions will be used at the time to provide guidance to aerial observations. Oil spill trajectory modelling may also be used to forecast impact areas.	✓	✓
Assisted Natural Dispersion	The dispersion of hydrocarbon surface slicks can be facilitated through agitation of the water surface. Typically, this is done using vessel propellers, fire hoses or by towing equipment through the slick.	Diesel will evaporate and disperse rapidly. Unless surface slick remains thick and is threatening sensitive resources this response is unlikely to provide net environmental benefit analysis (NEBA).	✓	-
Chemical Dispersants	Breakdown surface spill and draw droplets into upper layers of water column. Increases biodegradation and weathering and provides benefit to sea-surface air breathing animals.	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, 2011b).	-	-
Containment and Recovery	Booms and skimmers to contain surface oil where there is a potential threat to environmental sensitivities.	Low viscosity property allows for efficient containment by boom and recovery by oleophilic skimmers (i.e. komara disc skimmer) with ~90% hydrocarbon to water recovery rate. The normal sea state of the Bass Strait does not provide significant opportunities to utilise this equipment.	-	-
Protection and Deflection	Booms and skimmers deployed to protect environmental sensitivities.	No shoreline impact is predicted.	-	-

Response Option	Description	Vessel Collision Scenario Assessment	Option Viable?	Strategic Net Benefit?
Shoreline Assessment and Clean-up	Shoreline clean-up is a last response strategy due to the potential environmental impact.	No shoreline impact is predicted.	-	-
Oiled Wildlife Response (OWR)	Consists of capture, cleaning and rehabilitation of oiled wildlife. May include hazing or pre-spill captive management.	Given limited size and rapid spreading of the diesel spill, large scale wildlife response is not expected. However, individual birds could become oiled in the vicinity of the spill. OWR is viable and would be initiated for any oiled wildlife that could be captured.	✓	✓
Scientific Monitoring	Scientific monitoring is undertaken to understand and quantify the nature of short term and long-term environmental impacts and subsequent recovery.	Given the size and rapid dispersion of a diesel spill scientific monitoring would only be implemented to demonstrate to stakeholders that the impacts from the spill were short-term and localised as predicted. Thus, water sampling and impacts fish may be triggered.	✓	✓

6.4.3 Known and potential environmental risks

Known and potential environmental impacts as a result of undertaking oil spill response include:

- impacts to the existing environment as a result of aerial/vessel operations
- restricted public access to marine environment
- damage to onshore environmental sensitivities from the establishment of OWR response centres (if required).

6.4.4 Source control

Source control arrangements from vessel failures includes:

- closing water tight doors
- checking bulkheads
- determining whether vessel separation will increase spillage
- isolating penetrated tanks
- tank lightering.

Implementation of source control for vessels is detailed within the below documents, and is not discussed further:

- vessel-specific Shipboard Marine Pollution Emergency Plan (SMPEP) or equivalent
- vessel Specific Safety Case or Safety Management Plan and/or management systems
- National Plan for Maritime Environmental Emergencies (NatPlan).

6.4.5 Monitor and evaluate

Ongoing monitoring and evaluation of the oil spill is a key strategy for maintaining situational awareness and to complement and support the success of other response activities. In some situations, monitoring and evaluation may be the primary response strategy where the spill volume/risk reduction through dispersion and weathering processes is considered the most appropriate response (i.e. vessel diesel spills). Due to the limited diesel carrying capacity of the proposed vessel and the remote offshore location, a vessel collision spill will likely result in a Level 1 or 2 incident. Higher levels of surveillance such as aerial surveillance, oil spill trajectory modelling and deployment of satellite tracking drifter buoys will only be undertaken for Level 2/3 spills. However, aerial observations and oil spill trajectory modelling has been included in this EP in the event the vessel monitoring is not effective to inform the response.

Monitor and evaluate Type 1 operational monitoring includes the following:

- vessel observation;
- aerial observation;
- computer-based tools:
  - oil spill trajectory modelling (OSTM);
  - vector analysis (manual calculation); and
  - ADIOS II.

There are no significant or non-routine health and safety risks associated with monitoring and evaluation activities. Note that in the event of a vessel collision, the damaged vessel would not be able to conduct vessel surveillance activities, and other vessels may be prioritised to complete tasks that are not directly related to the oil spill response, such as transfer of injured personnel to a nearby facility or to shore, or search and rescue operations.

6.4.5.1 Response implementation, resource requirements and availability

In the event of an accidental event that resulted in a diesel spill to the waters surrounding the survey vessel, Beach would be responsible for undertaking operational monitoring (unless AMSA as Control Agency directs otherwise; see Section 8) with the primary objective of spill surveillance and tracking. This monitoring will be implemented to:

- determine the extent and character of a spill;
- track the movement and trajectory of surface diesel slicks;
- identify areas/ resources/ fauna potentially affected by surface slicks; and
- determine sea conditions/ other constraints.

Operational monitoring will commence immediately from the survey vessel. If safe and practicable to do so, the Vessel Master will monitor and document the progress of the oil spill, including location, movement and extent. This operational monitoring will continue throughout the response process until response termination or until advised otherwise by the Control Agency.

This oil spill monitoring will enable the necessary information to be provided to the Control Agency (AMSA) via a Marine Pollution Report (POLREP) to determine and plan appropriate response actions under NatPlan (if this plan is activated). Operational monitoring and observation in the event of a spill will inform an adaptive spill response and scientific monitoring of relevant key sensitive receptors, including wildlife and fisheries.

Operational monitoring will be restricted to daylight hours only, when surface slicks will be visible from the vessel. The information gathered from this monitoring will be passed on to AMSA, via the POLREP form, but also via ongoing Situation Reports (SITREPs) following the initial spill notification.

Vessel surveillance can also be conducted from any offshore vessel under Beach's control which may be engaged immediately in the event of a spill depending on the time of day.

Aerial surveillance may be undertaken from specially mobilised aircraft. Due to the short timeframe of the spill being visible, it may not be feasible to get trained observers, as it will take up to 48 hours to mobilise a trained observer. In that situation an observer will be provided with sufficient information such as the AMSA Identification Oil-on-Water Guide. The frequency of flights will be sufficient to ensure that the information collected during each flight (i.e. observer log and spill mapping) meets the information needs to validate dispersion of the spill.

Manual calculations for a rough estimate of spill trajectory will be used for an initial calculation with OSTM modelling to provide an accurate spill trajectory for the current weather conditions and type/volume of hydrocarbon spill. In the event of a Level 1 spill, the trajectory would be estimated based on manual calculations only due to the rapid predicted natural weathering and small EMBA of the spill. If required, OSTM would be conducted based on real time spill and metocean data and this information would be used to refine the spill response planning and execution. Initial modelling results will be available within two hours of request for modelling.

Table 6-17: Monitor and evaluate resource capability

Strategy	Minimum Requirement	Resource Availability	Comment
Vessel monitoring	1 x vessel	Beach contracted vessel providers	May be utilised for other response strategies.
Aerial monitoring	1 x aircraft (helicopter)	Beach contractor aircraft supplier	Daylight activation within 2 hours.
	1 x visual observer	Australian Marine Oil Spill Centre (AMOSC)	AMOSC has five trained observers and AMOSC Core Group have four trained members available within 24-48 hours from call-out via the AMOSC Service Level Statement.
Oil spill trajectory modelling	OSTM contractor direct callout on a 24/7 basis.	RPS	RPS provide 24 hr callout for OSTM.
Manual Trajectory Calculations and ADIOS II	Current and wind data.	Bureau of Meteorology (BOM) "Meteye" Service	Current and wind data available online.

6.4.6 Oiled wildlife response

Under the National Plan for Maritime Environmental Emergencies (AMSA, 2019) the Control Agency for an OWR for a vessel spill in Commonwealth waters is AMSA. If an incident which affects wildlife occurs in Commonwealth waters, AMSA may still request support from the Department of Environment, Land, Water and Planning (DELWP) to assess and lead a response if required. DELWPs response to oiled wildlife is undertaken in accordance with the Victorian Wildlife Response Plan for Marine Pollution Emergencies.

The spill is not predicted to enter Victorian state waters.

6.4.6.1 Response implementation, resource requirements and availability

Beach will provide support for the response through the provision of resources to the Control Agency (AMSA). The equipment which Beach can supply or coordinate through external assistance (such as AMOSC) includes:

- vessels for transport of wildlife and equipment;
- oiled fauna kits;
- wildlife intake and triage; and
- wildlife cleaning and rehabilitation kits.

AMOSC has wildlife equipment which can be mobilised directly by Beach in the event of a spill where there is a likelihood of oiled wildlife requiring treatment. However, it is noted that the remoteness and typical sea conditions of the Bass Strait offshore area and the logistic constraints associated with finding and collecting oiled wildlife at sea, will limit the feasibility of an offshore wildlife response effort.

Advice will be sought from AMOSC and regulatory agencies to guide any decisions regarding mounting a wildlife response will be based on the risks posed by the spill and safety and feasibility of a response.

Table 6-18: OWR resource capability

Resource	Minimum Requirement	Resource Availability	Comment
Vessel	1 x vessel	Beach contracted vessel providers	May be utilised for other response strategies.
Oiled wildlife response personnel	Trained group of first response personnel: AMOSC Industry Team (mutual aid) - 10 x personnel	AMOSC	Industry team trained for field deployment of spill equipment and are available on an 'as soon as practicable' basis. This group would be expected to be available within 24-48 hours of call-out. These personnel are available through Beach's membership with AMOSC.
Equipment	1 x oiled wildlife kit (Geelong)	AMOSC	Kits can process 50 units per day and Geelong kit available at site within 24 hours of call-out.
	1 x Container (Geelong)	AMOSC	Each container can process approximately 100 units per day. Geelong container available onsite within 24 hours of call-out.

Resource	Minimum Requirement	Resource Availability	Comment
OWR facility establishment and management	1 x Facilities Establishment Group (Dwyertech)	AMOSC Call-off Contract	Current call-off contract has service available within 24 hours of call-out.

6.4.7 Scientific monitoring

The objective of Type 2 scientific monitoring is to assess the impacts of a marine hydrocarbon spill and to help guide restoration and subsequent evaluations of environmental harm and recovery. The final selection of scientific monitoring studies and the detailed nature of these studies will depend on the observed and predicted fate of the spill, including surface and dissolved hydrocarbons, and the receptors that may have been impacted by the spill. Under the Beach OSMP, RPS are on 24 hr callout to provide scientific monitoring services.

The scientific monitoring studies (SMSs) that may be initiated following a diesel spill include:

- SMS1 - Monitoring hydrocarbon fate and distribution in water; and
- SMS2 - Monitoring hydrocarbon contamination and exposure of fish.

6.4.7.1 Implementation, resource requirements and availability

The objectives, triggers for study initiation, methods, resources required, timeframes for mobilisation and termination for each of the scientific monitoring studies are presented in Section 8.

Data from post-spill environmental monitoring studies will form a basis on which to develop any required restoration plans and inform the requirement for any subsequent detailed scientific studies required to assess long-term effects. Monitoring activities will continue until it is demonstrated that residual constituents do not pose a significant risk to human or ecological health.

6.4.8 Impact evaluation and risk assessment

Impacts and risks associated with operation of vessel surveillance and monitoring (in responding to a hydrocarbon spill) are similar to those discussed for routine vessel use. Therefore, the relevant 'aspects' in Table 6-2 should be referred to for a detailed evaluation and assessment for any oil spill response activities, including:

- vessel operations – atmospheric emissions;
- vessel operations – light emissions;
- vessel operations – planned discharges: cooling water, brine, treated bilge, sewage and greywater;
- vessel operations – planned discharge: food waste;
- vessel operations – underwater sound emissions: continuous;
- vessel operations – physical presence: collision with marine fauna;
- vessel operations – physical presence;
- vessel operations – accidental release: waste, minor spill (hydrocarbon or chemical); and

- vessel operations – introduction of IMS.

This section therefore assesses the impact from additional activities, including OWR.

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.

6.4.9 Control measures, ALARP and acceptability assessment

Control, ALARP and acceptability assessment: Oil spill response			
ALARP Decision Context and Justification	**ALARP Decision Context: A** 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**		
CM#8: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans	Vessels adhere to the distances and vessel management practices of EPBC Regulations (Part 8).		
CM#10: Ongoing consultation	Consultation in the event of a spill will ensure that relevant government agencies support the response strategies thus minimising potential impacts and risks to sensitivities.		
CM#25: Emergency response preparedness	Emergency response capability will be maintained in accordance with the EP, and related documentation.		
CM#26: Monitor and evaluate response management	Monitor and evaluate response activities will be managed in accordance with the nature and scale of the spill, using appropriate response methodologies.		
CM#27: OWR response management	OWR will be managed by relevant regulatory Authorities.		
CM#28: Scientific monitoring management	Scientific monitoring will be managed in accordance with the Scientific Monitoring Programs (SMPs) to achieve scientific objectives.		
Additional Controls Assessed			
Control	**Control Type**	**Cost/Benefit Analysis**	**Control Implemented?**
Monitor and evaluate: Satellite tracking buoys.	Good Practice	The surface life for a vessel diesel spill is estimated at 12 hours thus tracking buoys are not required for such a short-lived spill.	No
Monitor and evaluate: Utilise additional vessels for spill observations during initial response stages.	Engineering Risk Assessment	Beach has existing contracts in place to support its maritime requirements. The contract for Bass Strait currently resides with a number of service providers that have completed the Beach contracting and procurement process.	No

Control, ALARP and acceptability assessment: Oil spill response			
		A single vessel is expected to be sufficient for the initial stages of the response planning and using additional vessels is not considered to provide a considerable environmental benefit.	
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 and the surface spill will only be visible for approximately 12 hours. 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 oiled wildlife is unlikely based on the rapid dispersion of a diesel spill.	No

Consequence Rating	Moderate (2)
Likelihood of Occurrence	Highly Unlikely (2)
Residual Risk	Low
Acceptability Assessment	
Policy compliance	The proposed management of the impact is aligned with the Beach Environment Policy.
Management system compliance	Activities will be undertaken in accordance with the Implementation Strategy (Section 7).
Stakeholder engagement	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 will occur and thus there will be ongoing consultation with relevant persons during response operations.
Laws and standards	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)

Control, ALARP and acceptability assessment: Oil spill response	
Industry practice	Proposed activities are consistent with industry practice and based on current NOPSEMA guidance notes.
Environmental context	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.
Environmentally Sustainable Development principles	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.
Monitoring and reporting	Impacts will be monitored in accordance with Section 8
Acceptability outcome	**Acceptable**

6.5 Environmental performance outcomes, Environmental performance standards and measurement criteria

In accordance with Regulation 13(7) of the OPGGS(E)R, this section provides the EPOs, EPSs and measurement criteria for the control measures identified.

Table 6-19: Seabed assessment control measures, EPOs, EPSs and measurement criteria

Environmental Performance Outcome	Control Measure #	Environmental Performance Standard	Measurement Criteria	Responsible Person
EPO1: Seabed disturbance will be equal to or less than 1229 m^2 and within the operational area.	CM#1: Geotechnical Scope of Work	Geotechnical samples will be undertaken as per the Geotechnical Scope of Work.	Geotechnical report	Activity Offshore Representative
EPO2: No death or injury to fauna, including listed threatened or migratory species, from the activity. EPO3: Noise emissions in BIAs will be managed such that any whale,	CM#4: National Light Pollution Guidelines	Vessel lighting will be restricted to that necessary for safe operations.	Lighting inspection	Vessel Master
	CM#3: MO 97: Marine Pollution Prevention – Air Pollution	• very low-sulphur (<0.5% m/m) marine-grade diesel used. • vessels with diesel engines>130 kW must be certified to emission standards (e.g. International Air Pollution Prevention. • vessels 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 Master

Environmental Performance Outcome	Control Measure #	Environmental Performance Standard	Measurement Criteria	Responsible Person
including blue whales, continues to utilise the area without injury, and is not displaced from a foraging area. EPO4: Biologically important behaviours within a BIA or outside a BIA can continue while the activity is being undertaken.	CM#6: Preventative Maintenance System	• combustion equipment maintained in accordance with preventative maintenance system.	Planned maintenance system (PMS) records.	Vessel Master
EPO5: No impact to water or sediment quality outside of the	CM#2: Offshore Environmental Chemical Assessment Process	• drill fluids will be seawater and/or bentonite. • chemicals used as a component of a planned vessel discharge will meet the requirements of the Beach Chemical Assessment Process.	Geotechnical report Completed and approved chemical assessment.	Activity Project Manager

Environmental Performance Outcome	Control Measure #	Environmental Performance Standard	Measurement Criteria	Responsible Person
operational area. EPO6: No unplanned discharge of waste to the marine environment.	CM#5: *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*	• bilge water treated via a MARPOL (or equivalent) approved oily water separator and only discharge if oil content less than 15 ppm. • sewage discharged at sea is treated via a MARPOL (or equivalent) approved sewage treatment system. • food waste only discharged when macerated to ≤25 mm and vessel greater than 3 nm from land.	Oil record book. Garbage record book.	Vessel Master
	CM#6: Preventative Maintenance System	• equipment used to treat planned vessel discharges maintained in accordance with preventative maintenance system.	Planned maintenance system (PMS) records.	Vessel Master
	CM#7: MO 95: Marine Pollution Prevention - Garbage	• waste handled according to vessel waste management plan. • waste with potential to be windblown stored in covered containers. • waste lost overboard recovered if possible.	Garbage record book. Incident report.	Vessel Master
EPO7: No death or injury to fauna, including listed threatened or migratory species, from the activity. EPO8: Noise emissions managed such that any blue whale continues to utilise the area	CM#8: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans	Vessels adhere to the vessel management practices of EPBC Regulations (Part 8) and will use a 500 m safe operating distance for whales.	Daily operations report details when whales, dolphins or seals sighted, and the interaction management actions implemented, if required.	Vessel Master
	CM#9: Vessel speed restrictions	Vessel speeds within the seabed assessment area will be restricted to 10 knots.	Project induction Vessel log	Vessel Master

Environmental Performance Outcome	Control Measure #	Environmental Performance Standard	Measurement Criteria	Responsible Person
without injury and is not displaced from a foraging area. EPO9: Biologically important behaviours within a BIA can continue while the activity is being undertaken.	CM#19: Pre-start visual observations (non-DP)	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. • the geophysical 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.	Daily operations report details pre-start observation period, any sightings and any actions required.	Activity Offshore Representative
	CM#29: Pre-start visual observations (Vessel under DP).	• a prestart visual observation period of 30 mins will be applied to 3.5 km prior to the vessel commencing DP operations during daylight hours. • If a blue whale is spotted during the pre-start survey, the vessel will not commence DP operations until such time as: o No blue whales are observed for 30 minutes within the observation zone; or o Blue whales are observed leaving the observation zone.	Daily operations 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#20: Marine Mammal Observer	• if SBP activities are to be undertaken a marine mammal observer (MMO) will be present on the vessel to undertake prestart visual observations and implement the 500 m distance to any whales. • If vessels are using DP during identified blue whale foraging periods, a MMO will be present on the vessel to undertake pre-start observations and implement the 3.5 km shut-down zone for blue whales during daylight hours. • 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.	MMO resume. Daily report detailing MMO observations.	Activity Offshore Representative
	CM#21: 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 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#30: Implement night time and low visibility whale procedures for blue whales	Commencing vessel DP operations at night or in low visibility conditions can only occur if there have been no sightings of individual blue whales in the observation zone in the 2 hours prior to sunset.	Daily operations report details pre-start observation period and any sightings. Vessel log	Activity Offshore Representative

Environmental Performance Outcome	Control Measure #	Environmental Performance Standard	Measurement Criteria	Responsible Person

	CM #31: shutdown zones for the vessel under DP	• If any whale enters the 500 m zone, DP will be shut down.
		• If a blue whale is observed within 3.5 km from the vessel, DP will be shutdown where safe to do so.
		• If a whale is within the 3.5 km and it cannot be positively identified, it will be assumed to be a blue whale and DP will be shut down if safe to do so.
		• The vessel cannot re-commence DP operations until such time as:
		  ◦ no blue whales are observed for 30 minutes within the shutdown zone; or
		  ◦ whales are observed leaving the observation zone.
			Daily operations report details pre-start observation period and any sightings.
			Vessel log
				Activity Offshore Representative

EPO10: 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#10: Ongoing consultation	Notifications for any on-water activities and ongoing consultations undertaken as per Section 8 Stakeholder Consultation.	Notification records.	Activity Project Manager
	CM#11: Commercial Fisher Operating Protocol	Beach will implement the requirements within the Commercial Fisher Operating Protocol made available to potentially impacted fishers.	Stakeholder log. Daily report details notifications to fishers and any action required.	Activity Project Manager
	CM#12: Telstra cable buffer	No borehole or piezocone penetration sampling will be undertaken within 1 km either side of the known Telstra subsea cable location. This will be communicated to the geotechnical contractor and included in the Contractor Execution Plan.	Geotechnical report	Activity Offshore Representative
EPO11: No introduction of a known or potential invasive marine	CM#13: MO 98: Marine pollution – anti-fouling systems	Vessel will have a current anti-fouling certificate.	Vessel anti-fouling certificate.	Vessel Master

Environmental Performance Outcome	Control Measure #	Environmental Performance Standard	Measurement Criteria	Responsible Person
species.	CM#14: Australian Ballast Water Management Requirements	Vessel will have a valid Ballast Water Management Plan and ballast water management certificate, if required.	Ballast water records. Vessel Ballast Water Management Plan. Vessel Ballast Water Management certificate.	Vessel Master
	CM#15: National Biofouling Management Guidance for the Petroleum Production and Exploration Industry	Vessel will have a low-risk rating based on the WA Department of Fisheries Biofouling Risk Assessment Tool. In-water equipment will be clean of biofouling prior to deployment.	Ballast water records. Vessel Ballast Water Management Plan. Vessel Ballast Water Management certificate. In-water equipment checklist.	Vessel Master
	CM#16: Beach Domestic IMS Biofouling Risk Assessment Process	Prior to the initial mobilisation of the survey vessel into the seabed assessment area Beach shall undertake a domestic IMS biofouling risk assessment as per Section 7.20.2 of this EP.	Domestic IMS biofouling risk assessment records	Activity Project Manager

Environmental Performance Outcome	Control Measure #	Environmental Performance Standard	Measurement Criteria	Responsible Person
EP12: No spills of chemicals or hydrocarbons to the marine environment.	CM#17: Spill containment	Materials and equipment that have the potential to spill onto the deck or marine environment are within a contained area.	Vessel inspection.	Vessel Master
	CM#18: SMPEP, or equivalent	Vessel has 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 vessels test schedule. Spill response kits are located in high spill risk areas and routinely checked to ensure adequate.	Vessel SMPEP. Vessel exercise schedule. Vessel inspection.	Vessel Master
	CM#22: MO 21: Safety and emergency procedures	Vessels will meet the safety measures and emergency procedures of the AMSA MO 21.	Vessel inspection.	Vessel Master
	CM#23: MO 30: Prevention of collisions	Vessels will meet the navigation equipment, watchkeeping and radar requirements of the AMSA MO 30.	Vessel inspection.	Vessel Master
	CM#24: MO 31: SOLA and non-SOLAS certification	Vessels will meet survey, maintenance and certification of regulated Australian vessels as per AMSA MO 31.	Vessel certification.	Vessel Master
	CM#25: Emergency response preparedness	Emergency response capability will be maintained in accordance with the EP.	Outcomes of internal audits and tests demonstrate preparedness.	Activity Project Manager

Environmental Performance Outcome	Control Measure #	Environmental Performance Standard	Measurement Criteria	Responsible Person
EP13: Undertake oil spill response in a manner that will not result in additional impacts to marine environment and oiled wildlife.	CM#26: Monitor and evaluate response management	In the event of a diesel vessel collision spill: • where possible, the survey vessel will conduct visual observations as soon as practicable after the spill event. • aerial surveillance initiated within 120 minutes of spill. • OSTM received within 120 minutes of request.	EMT log. Vessel Surveillance Report. Aerial Surveillance Report Spill Modelling Report	Beach EMT
	CM#27: OWR response management	OWR will be managed by relevant regulatory Authorities and trained personnel.	EMT log.	Beach EMT
	CM#28: Scientific monitoring management	Scientific monitoring will be implemented in accordance with the SMPs.	Records confirm that scientific monitoring have been implemented in accordance with the SMPs.	Beach EMT

7 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 Trefoil seabed assessments. The OEMS provides direction on how Beach will meet the requirements of its Environmental Policy (Figure 7-2). 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 and how it 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; and
- arrangements for ongoing consultation.

7.1 Operations Excellence Management System

The seabed assessments will be undertaken in accordance with the OEMS. The OEMS documents the Environmental Policy, 11 OEMS Elements, HSE procedures and the key HSE processes and requirements for activities where Beach is the titleholder. It provides a management framework for achieving the requirements in a systematic way but allows flexibility to achieve this in a manner which 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); and
- AS 4801 (Occupational Health and Safety Management Systems).

At the core of the OEMS are 11 elements and associated standards which detail specific performance requirements for the implementation of the HSE Environmental Policy (Figure 7-2) and management of potential HSE impacts and risks (Table 7-1, Figure 7-1). 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 of the vessel as per the requirements of their management system.

The application of OEMS Elements and Standards relevant to the seabed assessments are described in the following sections.

Table 7-1: OEMS 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

Figure 7-1.The Beach OEMS

7.2 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.

There are three standards (see Table 7-1) and 11 outcomes to be delivered under this element.

To this effect, Beach's Environment Policy (Figure 7-2) provides a clear commitment to conduct its operations in an environmentally responsible and sustainable manner.

Demonstratable compliance with this EP is a key commitment for Beach. This will be managed through the use of a commitments register to track all EP commitments through to completion.

The Beach CEO has the ultimate responsibility for ensuring that Beach has the appropriate organisation in place to meet the commitments established within this EP. The Beach Survey Project Manager and Principal Environmental Advisor (offshore), have the responsibility and delegated authority to ensure that adequate and appropriate resources are allocated to comply with the OEMS and this EP.

The roles and responsibilities for the implementation, management and review for this EP are summarised in Table 7-2

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 7-2: Beach's Environmental Policy

Table 7-2: Activity environmental roles and responsibilities

Role	Responsibilities
Chief Executive Officer	Ensures: • Beach has the appropriate organisation in place to be compliant with regulatory and other requirements and this EP. • the OEMS continues to meet the evolving needs of the organisation.
Survey Project Manager	Ensures: • compliance with regulatory and other requirements and this EP. • records associated with the activity are maintained as per Section 7.4.2. • 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. • 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 **Error! Reference source not found.**. • incidents are managed and reported as per Section 7.10 • the EP environmental performance report is submitted to NOPSEMA not more than three months after the anniversary date of the EP acceptance. • 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 are assessed Management of Change process detailed in Section **Error! Reference source not found.**. • oil spill response arrangements for the activity are tested as per Section 8. • ensure audits and inspections are undertaken in accordance with Section 7.12.
Environment Advisor	• communicate regulatory and other requirements and the requirements in this EP to persons who have specific responsibilities pertaining to the implementation of this EP or OPEP. • develop the environmental component of the activity induction. • provide support in relation to incident management and reporting as per Section 7.10. • develop the EP environmental performance report. • review and document any new or change to an environmental impact or risk or a change that may impact the EP as per Section 7.8.1. • assess any chemicals that will be discharged offshore as per Section 7.11.1. • provide support to ensure audits and inspections detailed in Section 7.12.5 are undertaken and any actions from non-conformances or improvement suggestions tracked. • review and revise the EP as per the requirements in Section 7.12.4.
Community Relations Manager	• undertake stakeholder consultation for the activity. • record and report to the Activity Manager and Environment Advisor any objections or claims raised by relevant stakeholders. • maintain a stakeholder consultation log.
Survey Offshore Representative	Ensures: • the activity is carried out in accordance with regulatory requirements and this EP. • vessel personnel complete the environmental component of the activity induction. • 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.

Role	Responsibilities
	• initiate the adaptive management review within 2 hours for if the adaptive management trigger reached. • 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 7.8.1. • environmental incidents are managed and reported as per Section 7.10. • emissions and discharges identified in Section 6 are recorded and provided to the Activity Manager. • the 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 7.8.1. • chemicals that will or may be discharged offshore are assessed as per Section **Error! Reference source not found.** prior to use. • weekly vessel inspections are undertaken to ensure ongoing compliance with the EP.
Vessel Master	Ensures: • vessel operations are carried out in accordance with regulatory requirements and this EP. • vessel personnel are competent to fulfil their designated role. • 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 7.8.1. • vessel adheres to the distances and vessel management practices for seals as per the Wildlife (Marine Mammals) Regulations 2009 and whales and dolphins as per the EPBC Regulations (Part 8). • environmental incidents are reported to the Activity Offshore Representative within required timeframes as per Section **Error! Reference source not found.** . • emissions and discharges identified in Section 6 are recorded and provided to the Activity Offshore Representative. • the Activity Offshore Representative 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. • oil spill response arrangements are in place and tested as per the vessel's SMPEP or equivalent. • chemicals that will or may be discharged offshore are assessed as per Section 7.11.1 prior to use. • general and hazardous wastes are backloaded to port for disposal to a licenced waste facility. • weekly vessel inspections as detailed in Section 7.12 are undertaken to ensure ongoing compliance with the EP.
Marine mammal observer	• complete activity induction. • implement EPBC Policy Statement 2.1 procedures and additional controls detailed in Table 6-19 when geophysical activities are being undertaken • maintain a daily log of cetacean sightings using the DotEE template for seismic surveys. • produce the final report for submission to DotEE. • NB. MMO will only be required for geophysical activities
Vessel personnel	• complete activity induction. • report fauna sightings • report hazards and/or incidents via company reporting processed.

Role	Responsibilities
	• adhere to vessel's OEMS and this EP for all tasks. • undertake tasks safely and without harm to themselves, others, equipment or the environment and in accordance with their training, operating procedures and work instructions. • seek assistance if required to undertake a task that they are not competent to perform. • stop any task that they believe to be unsafe or will impact on the environment.

7.3 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 (see Table 7-1) and ten outcomes to be delivered under this element.

This EP does not cover the risks involved in financial management and impact on the Trefoil seabed assessment survey. The relevant impacts of financial and business planning risks are managed under the other OEMS elements described in this chapter.

7.4 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 and seven outcomes to be delivered under this element. The standards relevant to the implementation of this EP are described below.

7.4.1 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 permissioning, project execution, operating and reporting.

Chapter 2 of this EP details the key environmental legislation applicable to the MSS. The acceptability discussion for each hazard assessed in Chapter 7 specifically details the legislation pertaining to each hazard.

7.4.2 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.

7.4.3 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.

7.5 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 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.

7.5.1 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.

Vessel contractors will be assessed to ensure they have the capabilities and competencies to implement the control measures identified in Section 6. Training and competency of contractor personal engaged to work on the activity shall be competent in accordance with their Health and Safety Management System.

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 vessel personnel will complete a project-specific environmental induction. Records of completion of the induction will be recorded and maintained. The induction will cover (but is not limited to):

- Description of the environmental sensitivities and conservation values of the survey area;
- Controls to be implemented to ensure impacts and risks are ALARP and of an acceptable level, including an overview of EPBC Policy Statement 2.1 procedures and controls associated with managing acoustic impacts;
- 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; and
- Overview of emergency response and spill management plans and vessel interaction procedures.

In addition to the project-specific induction, each person 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.

The Beach Offshore Representative is responsible for delivering the induction, or facilitating it if presented by another member of the project team.

The survey contractor will conduct their own company and vessel-specific inductions independently of the project-specific HSE induction.

This element also includes the management of HSE risks to personnel associated within the working environment and encourages a healthy lifestyle for its employees and provides formal programs to promote health and fitness.. These are not related to the implementation of the EP and are not addressed here.

The Survey Project Manager has responsibility for ensuring that systems are in place to facilitate the communication of HSE issues to survey and vessel crew. This is typically via the daily operations meeting and weekly HSE meetings.

7.5.2 Toolbox Talks and HSE Meetings

Environmental matters will be included in daily toolbox talks as required by the specific task being risk assessed (e.g., waste management).

Environmental issues will also be addressed in daily operations meetings and weekly HSE meetings, where each shift will participate with the Beach Offshore Representative, Party Chief and Vessel Master in discussing HSE matters that have arisen in the previous week, and issues to consider for the following week.

Records associated with project-specific training, environmental training, inductions and attendance at toolbox meetings will be recorded and maintained on board the vessel.

7.5.3 Communications

The Vessel Master, Party Chief and Beach Offshore Representative are jointly responsible for keeping the marine and survey crews informed about HSE issues, acting as a focal point for personnel to raise issues and concerns and consulting and involving all personnel in the following:

- Issues associated with implementation of the EP;
- Any proposed changes to equipment, systems or methods of operation of equipment, where these may have HSE implications; and
- Any proposals for the continuous improvement of environmental protection, including the setting of environmental objectives and training schemes.

Table 7-3 outlines the key meetings that will likely take place onshore and offshore during the seabed assessment.

Table 7-3: Project communications

Meeting	Frequency	Attendees
Onshore		
Beach project team	Daily	All team members
Offshore		
Operations (including cetacean strategy)	Daily	Beach onshore project team, department heads, Beach Offshore Representative, Party Chief, MMOs
Pre-start safety meeting	Daily – prior to each shift	All personnel

Toolbox	Before each task	All personnel involved in task
HSE	Weekly	All personnel

7.6 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 and four outcomes to be delivered under this element.

The vessel contractor will be assessed to ensure they have the capabilities and competencies to implement the control measures identified in Chapter 6. Training and competency of contractor personal engaged to work on the activity shall be managed in accordance with the contractor's HSEMS (or equivalent).

7.7 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 and eight outcomes to be delivered under this element.

These standards are not of particular relevance to activities where Beach has no operational control of a facility (in this case, the survey vessel). Nevertheless, plant and equipment that have been identified as a control measure for the purpose of managing potential environmental impacts and risks, have an associated EPS that details the performance required of the plant and/or equipment as detailed in Chapter 6. During the contractor selection process and through ongoing inspections during the seabed survey, Beach will ensure that the contractor maintains all plant and equipment in good working order.

7.8 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 and ten outcomes to be delivered under this element. The standard of relevance to this EP is briefly discussed below.

7.8.1 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 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 7.9 identify a change in hazards, controls or risk (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.

7.9 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 and seven outcomes to be delivered under this element. The standards of relevance to this EP are briefly discussed below.

7.9.1 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 Trefoil seabed assessment survey is described in Chapter 7.9 and applied to all the hazards assessed in Chapter 6 of this EP.

As described in Section 7.12, 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 7.8.1.

7.9.2 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 Trefoil seabed assessment survey is outlined below.

7.9.2.1 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 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 7-4.

7.9.2.2 Emergency Response Plan

Beach will prepare a bridging ERP that bridges to the emergency response measures in the survey contractor's vessel-specific ERP to ensure that all emergency management functions are accounted for.

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.

The Bridging ERP will be supported by the Beach EMP. The 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.

Where a third-party contractor (TPC) company is required to work under its own HSE management system while on the survey vessel, the Bridging ERP will detail the clear reporting lines between the TPC representatives and Beach personnel.

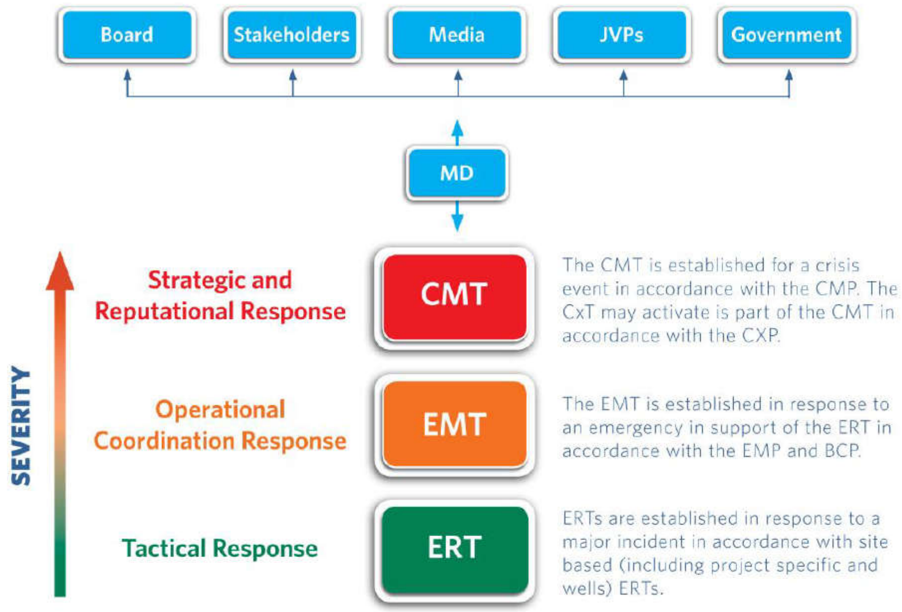


Figure 7-3: Beach Crisis and Emergency Management Framework

Table 7-4: Responsibilities of the Beach CMT and EMT

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. • activate the Crisis Communication Team if required.
EMT	Adelaide or Melbourne (depending on roster)	• provide operational management support to the ERT to contain and control the incident. • implement the Business Continuity Plan. • liaise with external stakeholders in accordance with the site-specific ERP • regulatory reporting.
ERT	Site	• respond to the emergency in accordance with the site-specific ERP.

Prior to commencing the survey, office and vessel-based personnel will participate in a survey-specific desktop emergency response exercise to test the emergency response arrangements. The outcomes of the test will be documented to assess the effectiveness of the exercise against its objectives and to record any lessons and actions, and the outcomes will be communicated to participants. Actions will be recorded and tracked to completion. This emergency response exercise may be combined with a test of spill response arrangements (see Section 8).

7.9.3 Adverse Weather Protocols

It is the duty of the Vessel Master to act as the focal point for all actions and communications with regards to any emergency, including response to adverse weather or sea state, to safeguard his vessel, all personnel onboard and environment.

During adverse weather, the Vessel Master is responsible for the following:

- Ensuring the safety of all personnel onboard;
- Monitor all available weather forecasts and predictions;
- Initiating the vessel safety management system, vessel HSE procedures and/or vessel ERP;
- Keeping the Party Chief and Beach Offshore Representative fully informed of the prevailing situation and intended action to be taken;
- Assessing and maintaining security, watertight integrity and stability of vessel; and
- Proceeding to identified shelter location(s) as appropriate.

Other appropriate responsibilities shall be taken into consideration as dictated by the situation.

In addition to in-vessel VHF Marine Radio Weather Services, the survey contractor will obtain daily weather forecasting from the Bureau of Meteorology (and/or other services) to monitor weather within the operational area in the lead up to and for the duration of the survey

7.10 Element 9 – Incident Management

Standard 9.1 defines the requirement for incident 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 CMO Incident Management System.

7.10.1 Incident Reporting

Notification and reporting requirements for environmental incidents to external agencies are provided in Table 7-5.

Table 7-5: Regulatory incident reporting

Requirement	Timing	Contact
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 reportable 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

Requirement	Timing	Contact
• corrective actions taken to avoid or mitigate any adverse environmental impacts of the incident 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: • vessel collision resulting in a loss of containment. • introduction of marine pests from vessel.		
Verbal notification The notification must contain: • all material fact and circumstances concerning the incident • any action taken to avoid or mitigate the adverse environmental impact of the incident • 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
A written notification must be provided as soon as practicable after the verbal notification. The written notification is to be provided to the regulator (NOPSEMA), Titles Administrator (NOPTA) and Department of the responsible State Minister (Tasmania).	ASAP after the verbal notification	• NOPSEMA - submissions@nopsema.gov.au • DPIPWE-incidentresponse@environment.tas.gov.au. • NOPTA – reporting @nopta.gov.au
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 prevent a recurrence of the incident • The action that has been taken or is proposed to be taken to prevent a similar incident occurring in the future.	Within 3 days of notification of incident	• NOPSEMA - submissions@nopsema.gov.au
Written incident reports to be submitted to NOPTA and DPIPWE.	Within 7 days of written report submission to NOPSEMA	• DPIPWE-incidentresponse@environment.tas.gov.au • NOPTA – reporting @nopta.gov.au
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 as soon as practicable (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/

Requirement	Timing	Contact
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 • contact details for the response coordinator.
Vessel strike with marine mammals	Within 72 hours	• DotEE - online National Ship Strike Database https://data.marinemammals.gov.au/report/shipstrike
	ASAP for injury assistance	• DPIPWE Whale Hotline – 0427 942 537.
Injury to or death of EPBC Act-listed species	Within seven days	• DotEE - 1800 803 772 • EPBC.Permits@environment.gov.au
Suspected or confirmed Invasive Marine Species introduction	Verbal notification ASAP	• DPIPWE – 1300 368 550
Identification of item of underwater cultural heritage such as vessel or aircraft remains and/or associated relics	Written notification within 1 week	• Written notification via the notification of discovery of underwater cultural heritage online submission form.

7.11 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 and three outcomes to be delivered under this element, with the standards discussed below.

7.11.1 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. The key environmental management issues for this activity are outlined and assessed in Section 6.

Beach's requirements associated with managing IMS and chemical selection to ensure potential adverse environmental effects are minimised, are provided in Appendix H and Appendix J respectively.

7.11.2 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 Trefoil seabed assessment survey is described in Section 9 of the EP. Wherever possible, concerns expressed by stakeholders have been addressed throughout the EP.

7.12 Element 11 – Assurance and Reporting

Element 10 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 and four outcomes to be delivered under this element, with the standards relevant to the Trefoil seabed assessment survey discussed below.

7.12.1 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.

The assurance methods that will be used to ensure compliance with the EPS in this EP are described in this section.

7.12.2 Emissions and Discharges

In accordance with the OPGGS(E)R Regulation 14(7) emissions and discharges shall be recorded for the duration of the activity. Table 7-6 details the types of emissions and discharges that shall be recorded including the monitoring method and frequency of reporting.

Table 7-6: Summary of environmental monitoring

Emission / Discharge	Monitoring Parameter	Monitoring Method	Reporting Frequency
Fuel	Volume used	Daily report	Daily

7.12.3 Routine Reporting and Notifications

Regulation 11A of the OPGGS(E) specify that consultation with relevant authorities, persons and organisations must take place. This consultation includes an implicit obligation to report on the progress of the survey. Table 7-7 outlines the routine reporting obligations that Beach will undertake with external organisations.

Table 7-7: External routine reporting obligations

Requirement	Timing	Contact details	OPGGS(E) regulation
Pre-survey			
Notify AMSA in order to issue daily AusCoast warnings.	Within 24 hours of survey starting.	rccaus@amsa.gov.au	11A
Notify NOPSEMA with the survey commencement date.	At least 10 days prior to survey starting.	submissions@nopsema.gov.au	29
Notify all other stakeholders in the stakeholder register with the survey commencement date.	Two weeks prior to survey starting.	Via email addresses managed by the Community Manager	11A
Notify the AHO of the survey commencement date and duration to enable Notices to Mariners to be issued.	Three weeks prior to survey starting.	datacentre@hydro.gov.au, 02 4223 6500	11A
Survey completion			
Notify AMSA in order to cease daily AusCoast warnings.	Within 24 hours of survey completion.	rccaus@amsa.gov.au	11A
Notify all stakeholders in the stakeholder register.	Within 2 days of survey completion.	Via email addresses managed by the Community Manager	11A
Notify the AHO in order to cease the issuing of Notices to Mariners.	Within 2 days of survey completion.	datacentre@hydro.gov.au, 02 4223 6590	11A
Notify NOPSEMA of the survey end date.	Within 10 days of survey completion.	submissions@nopsema.gov.au	29
Notify NOPSEMA of the end of the operation of the EP.	After acceptance of the end-of-activity EP performance report.	submissions@nopsema.gov.au	25A
Performance reporting			
Submit an end-of-survey EP Performance Report.	Within 3 months of survey completion.	submissions@nopsema.gov.au	26C
Provide marine fauna observation data to the DAWE.	Within 3 months of survey completion.	Upload via the online Cetacean Sightings Application at: https://data.marinemammals.gov.au/nmmdb	N/A – EPBC Act

7.12.4 Environment Plan Review

A member of the Beach Environment Team may determine that an internal review of the EP may be necessary based on any one or all of the following factors:

- Changes to hazards and/or controls identified in the review of the EP, which in itself is supported by:
    - Reviewing changes to AMP management arrangements (through subscription to the AMP email update service at https://parksaustralia.gov.au/marine/about/).
    - Environment and industry legislative updates (through subscriptions to NOPSEMA, APPEA and legal firms).
    - Running a new EPBC Act PMST for the EMBA to determine whether there are newly-listed threatened species or ecological communities in the EMBA.
    - Remaining up to date with new scientific research that may impact on the EIA/ERA in the EP (for example, through professional networking and APPEA membership).
    - Remaining in regular contact with stakeholders.
- Implementation of corrective actions to address internal or external inspection or audit findings;
- An environmental incident and subsequent investigation identifies 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 identified through the MoC process, such as hazards or controls, organisational changes affecting personnel in safety critical roles or OEMS; and
- Changes to any of the relevant legislation.

The Environment Team provides advice to the Project Manager on the material impact of the items listed previously and whether or not a review of the EP should be undertaken. The scope of a review is determined by the factors that trigger the review and an appropriate team will be assembled by the Principle Environmental Advisor to conduct the review. The team may consist of representatives from the Community, Engineering, HSE, Operations or Supply Chain teams as required by the scope.

All personnel can propose changes to HSE documentation via a register located in the Document Management System. If a review of the EP is initiated, then any proposed changes held in the register will also be considered by the review team.

If a review of the EP relates to a topic that had previously been raised by a stakeholder, an updated response to affected stakeholders will be prepared and provided to affected stakeholders in a process managed by the Community Manager.

7.12.4.1 Revisions Triggering EP Re-submission

Beach will revise and re-submit the EP for assessment as required by the OPGGS(E) regulations listed in Table 7-8

Table 7-8: EP revision submission requirements

Regulations	OPGGS(E) regulation
Submission of a revised EP before the commencement of a new activity	17(1)
Submission of a revised EP when any significant modification or new stage of the activity that is not provided for in the EP is proposed	17(5)
Submission of a revised EP before, or as soon as practicable after, the occurrence of any significant new or significant increase in environmental impact or risk not provided for in the EP	17(6)
Submission of a revised EP if a change in titleholder will result in a change in the manner in which the environmental impacts and risks of an activity are managed	17(7)

Revisions and re-submission of the EP generally centre around 'new' activities, impacts or risks and 'increased' or 'significant' impacts and risks. Beach defines these terms in the following manner:

- **New** impact or risk: one that has not been assessed in Chapter 6.
- **Increased** impact or risk: one with greater extent, severity, duration or uncertainty than is detailed in Chapter 7.
- **Significant** change:
    - The change to the survey design deviates from the EP to the degree that it results in new activities that are not intrinsic to the existing Activity Description in Chapter 3.
    - The change affects the ability to achieve ALARP or acceptability for the existing impacts and risks described in Chapter 7.
    - The change affects the ability to achieve the EPO and EPS contained in Chapter 7.

A change in the activities, knowledge, or requirements applicable to the Trefoil seabed assessment survey are considered to result in a 'significant new' or 'significant increased' impact or risk if any of the following criteria apply:

- The change results in the identification of a new impact or risk and the assessed level of risk is not 'Low', acceptable and ALARP;
- The change results in an increase to the assessed impact consequence or risk rating for an existing impact or risk described in Chapter 7; and
- There is both scientific uncertainty and the potential for significant or irreversible environmental damage associated with the change.

While an EP revision is being assessed by NOPSEMA, any activities addressed under the existing accepted EP are authorised to continue. Additional guidance is provided in NOPSEMA Guideline When to submit a proposed revision of an EP (N04750-GL1705, Rev 1, January 2017).

<u>Minor EP Revisions</u>

Minor revisions to this EP that do not require resubmission to NOPSEMA will be made where:

- Minor administrative changes are identified that do not impact on the environment (e.g., document references, contact details, etc.).

- A review of the activity and the environmental risks and impacts of the activity do not trigger a requirement for a revision, as outlined in Table 7-8.

Minor revisions to the EP will not be submitted to the regulators for formal assessment. Minor revisions will be tracked in the document control system.

7.12.5 Inspections and Audits

Various inspections and audits will be undertaken for the Trefoil seabed assessment survey using competent personnel, as outlined in Table 7-9.

Table 7-9: Summary of environmental inspections and audits

Type	When	Frequency	Vessel	Method	Details
HSE due diligence inspection	Post-award, pre-survey	Once	Survey vessel & support vessels	Desktop or in port/ during mobilisation	Focused on ensuring EPS can be met through review of relevant records and databases
EP compliance audit	Post-award, pre-survey	Once	Survey vessel	In person on board	A suitably experienced auditor will assess compliance against each EPS through interviews, observations and review of databases and records.
Ongoing informal inspections	During survey	Weekly	Survey vessel & support vessels	In person on board	Checklists provided by Beach to be completed by: • Survey vessel – Party Chief and/or Beach Offshore Representative • Support vessels – Vessel Master (or delegate)

Weekly inspections throughout the activity to ensure ongoing compliance with relevant EP requirements will include, but not be limited to:

- spill preparedness such as spill kit checks and SMPEP or equivalent drills
- waste management
- review of any new or changed chemicals that maybe discharged offshore
- maintenance checks for equipment identified as controls such as oily water separator.

Non-compliances are communicated via the daily report and pre-start meetings.

Any non-compliances or opportunities for improvement identified at the time of an inspection or audit will be communicated to the relevant Beach and contractor personnel at the time of the inspection or audit. These are tracked in the Beach incident management system, which includes assigning responsibilities to personnel to manage the issue and verify that it is closed out.

A summary of the EP commitments for the survey will be distributed aboard the vessels (including role-specific checklists), and implementation of the EPS will be continuously monitored by the Beach Offshore Representative and verified by the Beach Principal Environmental Advisor (offshore) (or delegate) through review of the completed weekly checklists and attendance at relevant meetings.

Non-compliances and/or opportunities for improvement will be communicated to survey personnel in writing and at appropriate meetings.

7.12.6 Regulatory Inspections

Under Part 5 of the OPGGS Act, NOPSEMA inspectors have the authority to enter Beach premises, including the survey vessel, to undertake monitoring or investigation against this EP. Beach will cooperate fully with the regulator during such investigations.

7.12.7 End of Activity Performance Report

In accordance with the OPGGS(E) Regulation 14(2), Beach will submit an end-of-activity EP performance report to NOPSEMA within three months of completion of the Trefoil seabed assessment survey. Performance will be measured against the EPO and EPS outlined in Chapter 6. The information in the report will be based on the information collected during routine communications, inspections and audits, as outlined in this chapter.

8 Oil Pollution Emergency Plan

Based on the impact and risk assessment an accidental release or spill of oil or other hazardous material would not result in an impact consequence level greater than moderate. Therefore, there is not an oil pollution emergency event associated with this EP for which a standalone Oil Pollution Emergency Plan (OPEP) is required.

Given the nature and scale of the potential spill risks associated with the seabed assessments, any spill from the vessel would be managed by the vessel with AMSA as the Control Agency. Beach would provide support to the vessel contractor and AMSA as detailed in Section 6.4.

In the event of an oil or diesel spill to the sea, AMSA will be immediately notified by the Vessel Master to ensure prompt and appropriate mobilisation of relevant response plans. Section 7.10.1 and Table 7-5 details notification and reporting requirements.

8.1.1 Vessel Shipboard Marine Pollution Emergency Plan

To prepare for a spill event, the vessel Shipboard Marine Pollution Emergency Plan (SMPEP) or equivalent will detail:

- response equipment available to control a spill event
- review cycle to ensure that the document is kept up to date
- testing requirements, including the frequency and nature of these tests.

In the event of a spill, the SMPEP or equivalent details:

- reporting requirements and a list of authorities to be contacted
- the activities to be undertaken to control the discharge of oil
- procedures for coordinating with local officials.

As described in Section 7.12, Beach will evaluate the relevant SMPEP or equivalent document against the impacts and risks identified in this EP prior to the survey commencing to ensure that response capability and procedures are appropriate, the document is up to date including reporting requirements. Beach will ensure that the vessel operator's emergency notification procedures include notification to Beach.

8.1.2 Control Agency

AMSA is the Control Agency in Commonwealth waters for all shipping (vessel) spills and spills that result from vessels undertaking offshore petroleum activities where the Commonwealth *Navigation Act 1912* applies. The contract vessel operator will conduct the first-strike response as per their SMPEP, or equivalent, with the support of Beach as required, until such time as AMSA or a nominated National Plan agency arrives to assume incident command. Beach will support the contract vessel operator with any applicable resources at Beach's disposal.

The following arrangements relevant to the seabed assessment apply for spills in Commonwealth waters:

- AMSA is the Control Agency for vessel (shipping) spills in Commonwealth waters.
- first strike response to be undertaken by vessel contractor under the vessel's SMPEP or equivalent.
- Beach would provide support to the vessel contractor and AMSA as detailed in Section 6.4.

8.1.3 Beach EMT activation process

Beach's incident response levels are described in **Error! Reference source not found.**. Given the nature and scope of the seabed assessment activities, any incident that might occur would most likely be a Level 1 or Level 2 event.

Based on the nature of the petroleum activity being undertaken (vessel-based), a Level 1 or Level 2 spill incident would be managed by the contractor vessel operator, as per their emergency plans. Beach will be available to support the contract vessel operator with any available and applicable resources. Examples of this support may include personnel to supplement the contractor's EMT or accessing surveillance capabilities through Beach contracts with AMOSC.

As per Beach's standards, Beach's EMT Incident Commander (IC) would be notified in the event of a spill incident and Beach's EMT would be activated if required by the EMT IC. The Beach Environment Lead would implement any required response strategies as per Sections 6.4.5, 6.4.6 and 6.4.7.

Table 8-1: Overall response level indication

Level 1	Level 2	Level 3
An incident which is likely to have no adverse impact on the public or the environment. Control of the incident will be through the use of resources normally available on the vessel concerned without the need to mobilise the Beach EMT or seek external assistance.	An incident that cannot be controlled by the use of the vessel resources alone and requires external support and resources to combat the situation; or an incident that can be controlled by the vessel, but which may have an adverse impact on the public or the environment. Beach EMT shall be activated.	An incident likely to have a wide-ranging impact on the public, the environment, and Beach. A level 3 incident may require the mobilisation of external state, national or international resources to bring the situation under control. Beach EMT shall activate the CMT.

8.1.4 Scientific Monitoring Program

The OPGGS(E)R also require the EP to plan for monitoring of impacts to the environment from oil pollution and associated response activities. This Scientific Monitoring Program (SMP) has been developed to meet the requirements of OPGGS(E)R Regulation 14. Beach have engaged an external consultant (RPS) on a 24 hour call out basis to assist in the implementation of the SMP and its requirements.

7.16.4.1 Scope of the SMP

The only hydrocarbon spill scenario for the seabed assessment is a diesel release from a vessel collision. The risks of a hydrocarbon spill from a vessel collision, and the associated response activities are anticipated to be limited to Level 1 and 2 spill events, with relevant response arrangements described in the EP (Table 6-16).

The geographical scope of the SMP is the EMBA described in Section 4.1 which is wholly in Commonwealth waters.

7.16.4.2 Objectives

In the event of a hydrocarbon spill incident, this SMP will be implemented to determine whether their environmental goals have been met during and after a response (scientific monitoring activities).

Scientific monitoring studies will be undertaken in the event of a Level 2 hydrocarbon spill incident at an appropriate scale, whereby scientific monitoring systems (SMSs) will.be used to characterise the short- (impact) and long- (recovery) term environmental effects from a hydrocarbon release incident. Scientific monitoring will also be used to assess if oil spill response measures have been effective in protecting and/or mitigating environmental sensitivities under threat from an incident.

7.16.4.3 Scientific monitoring studies

In the event of a Level 2 hydrocarbon spill during this activity, the oil spill response, and evaluation of environmental impacts and recovery will be informed by SMSs as summarised in **Error! Reference source not found.** to **Error! Reference source not found.**. Beach has in place a contract with a scientific monitoring consultant with the expertise and resources to undertake this monitoring.

Table 8-2: SMS1 - Monitoring hydrocarbon fate and distribution in water

SMS1 - Monitoring hydrocarbon fate and distribution in water
Objective To determine and document the distribution and concentrations of hydrocarbon in waters due to a spill and response activities and to document recovery to background levels. This assessment may include distribution and concentrations of entrained hydrocarbons in seawater.
Trigger for study initiation Measured hydrocarbons in the water column of ≥10 ppb or modelled dissolved aromatic hydrocarbons of ≥6 pbb, **or** Modelled or, where direct measurement has occurred by the Control Agency, measured surface hydrocarbon thickness of ≥10 g/m^2 in areas where there is potential for contamination of sensitive benthic habitats or receptors (e.g. protected areas, intertidal/subtidal reefs or benthic fisheries).

SMS1 - Monitoring hydrocarbon fate and distribution in water

Methods

As there is relatively little existing baseline data on contamination status of marine waters in the region, the design of these studies would be a combination of control-impact (Keough and Mapstone, 1995) and gradient (Ellis and Schneider, 1997) studies.

Trajectory and fate modelling and the results of monitoring conducted by Control Agencies will be used to identify likely fate and concentrations of hydrocarbon in the water column and identify where the multiple impact and reference sites where scientific monitoring will be conducted.

Where trigger criteria thresholds are exceeded, triplicate seawater samples will be collected from a number of impact and reference sites. In general, sites will be accessed by vessels, although nearshore shallow water sites may be accessed on foot if conditions allow safe access. Samples will be collected from a range of depths using Niskin bottles or similar remotely triggered samplers. Physico-chemical sampling will be undertaken at the same locations using a hand-held probe.

Water samples will be immediately stored in glass bottles supplied by the analytical laboratory and chilled to ≤4°C or frozen depending on advice from the receiving laboratory. Sample ID, sampler name, location and time/date information will be recorded for each sample taken. Quality Assurance/Quality Control samples will be taken in accordance with ANZECC (2000). Any requirement for preservation of samples will be discussed in advance with the analytical laboratory. Water samples will be transported in chilled containers to a NATA accredited laboratory within 7 days of collection and will be analysed for total petroleum hydrocarbons and polycyclic aromatic hydrocarbon concentrations. All samples will be accompanied by Chain-of-Custody documentation.

Resources required

- vessels (offshore site access)
- trained samplers
- sampling equipment (water & sediment)
- sample storage and chilling facilities
- courier services
- analytical laboratory

Timeframes for mobilisation

As far as practicable this study will commence as soon as possible after the initial spill trajectory modelling (within 24-72 hours) depending on weather and sea condition restrictions for safe access to and operation at sample sites. The frequency of sampling will be determined by the results of the first sampling events and will continue as determined by the EMT IC.

Termination criteria

Hydrocarbon levels in marine waters are within natural variability of the established baseline condition or no longer pose a risk to environmental sensitivities; and monitoring will only terminate with the approval of the EMT IC.

Table 8-3: SMS2 - Monitoring hydrocarbon contamination and exposure of fish

SMS2 - Monitoring Hydrocarbon Contamination and Exposure of Fish

Objective

Determine levels of contamination in commercial fish species (including invertebrates) in shallow waters significantly impacted by surface hydrocarbon contamination or response activities, including confirming safety for human consumption.

Trigger for study initiation

Modelled or, where direct measurement has occurred by the Control Agency, measured surface hydrocarbons in the water column of ≥10 ppb or modelled dissolved aromatic hydrocarbons of ≥6 pbb, at depths where there is potential for contamination of sensitive benthic habitats or receptors (e.g. subtidal reefs or benthic fisheries).

or

SMS2 - Monitoring Hydrocarbon Contamination and Exposure of Fish
Reports of tainted seafood are received.
Methods Sampling will include fisheries resources from contaminated and clean control locations, with species selection based on the presence and potential for commercial harvest of fisheries from contaminated areas. Study methods will be refined in consultation with fisheries experts and government agencies but are anticipated to include measurement of total petroleum hydrocarbon concentrations in fish tissues, and biomarker assessment for evidence of exposure to hydrocarbon contamination. Sample identification, sampler name, location and time/date information will be recorded for each sample taken. Preservation and handling of samples will be in accordance with recommendations from the receiving laboratory. Tainting of fisheries resources would be investigated using an olfactory analysis. Trained panellists would determine if they could distinguish between an uncooked sample from a fish captured in an "impacted" location and a sample from a fish captured in a "non-impacted" location. The panellists would not be aware of the origin of the test material, and only requested to identify if differences existed between the portions. Panellists would be asked to provide qualitative comments on the olfactory qualities of the samples. The trial would be repeated after the samples were cooked. Results will be compared to relevant food safety guidelines as well as published literature on concentrations causing tainting or fish health impacts in comparable species to those collected for the study.
Resources required • vessels • fishing equipment • fisheries experts • food safety experts • ecotoxicology experts
Timeframes for mobilisation As far as practicable this study will commence as soon as possible after the initial spill trajectory modelling (within 24-72 hours), depending on weather and sea condition restrictions for safe access to and operation at sample sites. As the requirement for this study is partially based on food safety requirements, the exact timing would be determined in consultation with the Commonwealth Department of Agriculture (including Australian Fisheries Management Authority & Fisheries Research and Development Corporation), DJPR and/or the Department of Primary Industries, Parks, Water and Environment (DPIPWE), and various others (possibly including Commonwealth Scientific and Industrial Research Organisation [CSIRO], State governments, seafood and fishing industry groups, Food Safety Australia New Zealand and expert technical advisors).
Termination criteria Surveys determine 'no statistically significant difference' between fish at impact and control/reference sites 12 months after the incident; or Recovery of hydrocarbon levels in fish/shellfish tissue to acceptable levels no longer pose a risk for seafood consumption and selected key ecological fish processes over two consecutive years. If after two years of consecutive monitoring seafood is fit for human consumption but uncertainty remains in regard to selected key ecological fish process, Beach will review the requirement for ongoing monitoring and alternative termination criteria will be considered via consultation with NOPSEMA, DotEE, DJPR and/or DPIPWE. Monitoring will only terminate with the approval of the EMT IC.

8.1.5 Testing of spill response arrangements

In accordance with Regulation 14(8A)(8C) of the OPGGS(E)R and OEMS Standard 16: Crisis and Emergency Preparedness and Response, the response arrangements will be tested:

- when they are introduced
- when they are significantly amended

- not later than 12 months after the most recent test.

Prior to commencing the seabed assessment activities, spill response arrangements applicable to the survey vessel will be tested. The outcomes of the test will be documented to assess the effectiveness of the exercise against its objectives and to record any lessons and actions. Any actions will be recorded and tracked to completion.

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 OPGGSA 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 undertook for the seabed assessment was:

- identify stakeholders that may be potentially affected by the activity by reviewing its stakeholder database and consulting with existing stakeholders to identify other relevant stakeholders. Beach, through its subsidiary Lattice Energy, has operated in the area since the early 2000s, and has built an extensive database of stakeholders from ongoing engagement in relation to its existing BassGas and Otway operations.
- 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 either requested by the stakeholder or that become available during the consultation period and allow a reasonable time for the stakeholder to review and respond. Depending on the information provided this may take between one to four weeks.
- ensure relevant stakeholders are informed about the consultation process and how their feedback, questions and concerns are considered in the EP.

9.3.1 Fishery specific consultation approach

From reviewing the existing environment, the main stakeholder group for the activity is commercial fishers. For the seabed assessment the consultation strategy for potentially impacted fishers is as follows:

- Request fishing data from VFA, DPIPWE and AFMA to verify fishing effort within designated fisheries in the operational area, in order to seek engagement with relevant fishing associations and commercial fishers.
- provide an updated information sheet to SETFIA and SIV for distribution to their members as applicable.
- provide an updated information sheet to other relevant fishery associations and individual fishers where known.
- publish the information sheets on Beach's website at https://www.beachenergy.com.au/bass-basin/. The information sheets are available in Appendix F.
- provide additional information to interested fishery groups where requested. Beach provided information to fishery groups and to date has not had any response from fishers.
- where fishers have identified that they may be potentially impacted by the activity the following is undertaken:
  - for fishers who have contacted SIV (or other fishing associations), Beach liaise with SIV to gather information about the fishers fishing patterns and locations and to establish contact for ongoing consultation throughout the activity.
  - for fishers who have contacted Beach directly, engage with them and gather information about their fishing patterns and locations and to establish contact for ongoing consultation throughout the activity.
  - where fishers are providing Beach with sensitive fishing data Beach provide them Beach's privacy policy and obligations.
  - Beach offered SMS messaging to commercial fishers and their associations to provide project updates before, during and after the activity. Beach provide regular updates on the locations that the vessel will be operating in as well as the expected duration so fishers can plan their fishing activities with the least disruption. Such messaging was offered and carried out successfully for the geophysical activities carried out in accordance with this EP, during June 2020, and will continue to be offered for the geotechnical activities.
- Beach's position is that the commercial fisheries cover a vast area and the seabed assessment only require access to a relatively small area over a short period of time and so Beach aim to minimise impact to third party activities. However, Beach has a stated position that fishers should not suffer an economic loss as a result of our activities. Should a fisher incur additional costs in order to work around our activities, or if they have lost catch or have damaged equipment Beach will assess the

claim and ask for evidence of past fishing history and the loss incurred and, where the claim is genuine, will provide compensation. Beach will also ensure that the evidence required is not burdensome on the fisher while ensuring genuine claims are processed.

- Beach's position regarding economic losses as a direct result of its activities is now set out in the the *Fair Ocean Access - Procedure for Compensation Claims From Commercial Fishers* that Beach drafted and refined in consultation with SETFIA and CFA/BSSIA during consultation for the Prion Seismic Survey planned by Beach. The procedure was subsequently provided for consultation and feedback by TSIC, SFAT, SIV and VFA.
- Beach's *Fair Ocean Access - Procedure for Compensation Claims From Commercial Fishers* has been explained in clear and simple language in the *Fair Ocean Access information sheet* (Appendix G) that summarises Beach's procedures for minimising and mitigating potential impacts to commercial fishing from Beach activities and procedures for compensation claims from commercial fishers. The information sheet is available on Beach's website and will be provided to any commercial fishers who advise Beach of a potential impact, along with an offer to consult regarding and concern or claim.

9.4 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 and BassGas activities undertaken by Beach
- 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.

Given the extensive consultation undertaken by Beach in relation to the Prion 3D Marine Seismic Survey, and the time elapsed since initial consultation for the Trefoil Seabed Assessment EP, Beach undertook a full review of stakeholders in preparation for the resubmission of this EP and the completion of the geotechnical activities.

This stakeholder review identified a small number of potentially impacted stakeholders with whom Beach has consulted for the Prion 3D Marine Seismic Survey during 2021 and established impact mitigations for the avoidance of each other's activities. The same approach will be undertaken with regard to the short spatial and temporary potential impacts associated with the Trefoil geotechnical assessment activities.

A small number of potentially interested stakeholders were also identified and Beach will engage with those stakeholders, although it is assessed that there will be no impacts.

Table 9-1 details the relevant stakeholders identified and groups them by the categories listed under OPGGS(E)R Regulation 11A. It should be noted that no fishing effort by Tasmanian or Victorian fisheries was identified within the operational area.

9.5 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.

To determine the type of information to provide to a stakeholder an Information Category was developed and is detailed in Table 9-2.

9.6 Summary of stakeholder consultation

Table 9-4 provides a summary of the stakeholder consultation undertaken as part of the development 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 5 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.

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 Auscoast warnings	2
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 - Earth Resources Regulation	Regulatory body for oil and gas activities in Victorian waters. Required to be notified of reportable incidents that may impact Victorian waters.	2
DJPR - Victorian Gas Program	Comprehensive program of scientific research and related activities that assesses the potential for further discoveries of onshore conventional gas and offshore gas in Victoria. Beach provide information as have ongoing engagement.	3
Victorian Fishery Authority (VFA)	Manage Victorian commercial fisheries.	1
The Department of the Responsible State or Northern Territory Minister		
Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE)	Regulatory body for oil and gas activities in Tasmanian waters. Required to be notified of reportable incidents.	2
A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP		
Blue Whale Study	Primary research into the ecology of endangered pygmy blue whales in south-east Australia. The operational area overlaps the pygmy blue whale foraging BIA.	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: • Commonwealth Trawl Section – Danish seine • Commonwealth Shark Hook and Shark Gillnet Sectors • Southern Squid Jig Fishery	1

Stakeholder	Relevance	Information Category
Ocean Racing Club of Victoria	Club conducts regular offshore racing including the Melbourne to Hobart and the Melbourne to Launceston yacht races.	1
Seafood Industry Victoria (SIV)	Peak body representing professional fishing, seafood processors and exporters in Victoria. SIV primary contact for State fishers.	3
SeaRoad Holdings Pty Ltd	Sea freight services operating in Bass Strait and elsewhere.	1
Southern and Eastern Scalefish and Shark Fishery Licence Holders (SESSF Fishery)	AFMA identified active licences within the Southern and Eastern Scalefish and Shark Fishery within the operational area. Based on data from ABARES reports from 2014-2019 it is likely that the Southern and Eastern Scalefish and Shark Fishery fish within the operational area. Engagement is via SETFIA as the industry body association.	NA
South East Trawl Fishing Industry Association (SETFIA)	SETFIA represents businesses with a commercial interest in the South East Trawl Fishery and the East Coast Deepwater Trawl Sector. SETFIA represent the following fisheries that have catch effort within the operational area: • Shark Hook and Shark Gillnet Sectors • Commonwealth Trawl Section – Danish seine	1
Sustainable Shark Fishing Inc (SSFI)	SSFI represent interests of its Commonwealth-licenced shark gillnet and shark hook members. The Shark Hook and Shark Gillnet Sectors have catch effort within the operational area.	1
Spirit of Tasmania	Passenger ferry and freight service from Victoria to Tasmania.	1
Toll Group	Sea freight services operating in Bass Strait and elsewhere.	1
TopFish Tasmania	Octopus and giant crab fishing company based in Stanley Tasmania.	1
Trinsand Fisheries	Southern Squid jig fishing.	1
Any other person or organisation that the titleholder considers relevant		
Abalone Victoria Central Zone Limited	Abalone Victoria (Central Zone) Limited (AVCZ) represent the views and interests of its members. DPIPWE have confirmed there is no Tasmanian fishery catch effort within the operational area. VFA have confirmed there is no Victorian fishery catch effort within the operational area. Beach maintain engagement in relation to activities within the Bass Strait.	3
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	ASBTIA is the peak body representing Southern Bluefin Tuna ranching companies in Australia. There is no tuna fishing or ranching within the operational area. Beach maintain engagement in relation to activities within the Bass Strait.	3
Bass Strait Scallop Industry Association	Industry association for the Bass Strait Scallop fishery. Beach has established through engagement in regard to the Prion Seismic Survey EP that there is no scallop fishing in the area of the Trefoil seabed assessments.	3

Stakeholder	Relevance	Information Category
Bunurong Land Council Aboriginal Corporation (BLCAC)	Incorporated association representing the Bunurong traditional custodians (west Gippsland, Victoria)	3
King Island Council	Local government authority who has shown interest in Beach's activities.	3
Lang Lang Gas Plant Environment Liaison Group	Liaison group associated with the Beach Lang Lang Gas Plant. Beach maintain engagement in relation to activities within the Bass Strait.	3
Mersey Yacht Club	May host ocean yacht racing events in vicinity of operational area.	3
Marinus Link (TasNetworks)	Proposed undersea electricity cable in Bass Strait. Not in operational area but Beach has engaged and established general interests.	3
Portland Professional Fisherman's Association	Represent Victorian licenced fishers primarily focussed on rock lobster and giant crab fishing in Otway Basin but may also include members with Commonwealth licences.	3
Royal Yacht Club of Tasmania	May host ocean yacht racing events in vicinity of operational area.	3
Scallop Fishermen's Association of Tasmania Inc and Bass Strait Scallop Industry Management Committee	Industry association for Tasmanian based scallop fishers who may also hold licences for the Commonwealth Bass Strait Central Zone Scallop Fishery. Beach has established through engagement in regard to the Prion Seismic Survey EP that there is no scallop fishing in the area of the Trefoil seabed assessments.	3

Stakeholder	Relevance	Information Category
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. DPIPWE have confirmed there is no Tasmanian fishery catch effort within the operational area. VFA have confirmed there is no Victorian fishery catch effort within the operational area. Beach maintain engagement in relation to activities within the Bass Strait.	3
Surfrider Foundation Australia	Registered not for profit organisation dedicated to the protection of Australia's waves and beaches.	3
TARFish	Independent peak body representing interests of recreational marine fishers in Tasmania since 2004. Recreational fishing focussed on southern Tasmanian coastal locations.	3
Tasmanian Abalone Council Limited	The Tasmanian Abalone Council is the voice of the fishery, representing divers, non-diving quota-holders, processors and exporters. DPIPWE have confirmed there is no Tasmanian fishery catch effort within the operational area. Beach maintain engagement in relation to activities within the Bass Strait.	3
Tasmanian Aboriginal Centre (TAC) (Burnie)	Represents the political and community development aspirations of the Tasmanian Aboriginal Community.	3
Tasmanian Rock Lobster Fisherman's Association	The Tasmanian Rock Lobster Fishermen's Association is the peak commercial fishing body recognised under the Act for the rock lobster fishery. DPIPWE have confirmed there is no Tasmanian fishery catch effort within the operational area. Beach maintain engagement in relation to activities within the Bass Strait.	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. DPIPWE have confirmed there is no Tasmanian fishery catch effort within the operational area. Beach maintain engagement in relation to activities within the Bass Strait.	3
Telstra	Manage the Bass Strait 2 Cable which overlaps the seabed assessment area.	1

Stakeholder	Relevance	Information Category
Tuna Australia	Represents statutory fishing right owners, holders, fish processors and sellers, and associate members of the Eastern and Western tuna and billfish fisheries of Australia. Based on ABARES reports from 2014-2019 there is no tuna fishing catch effort within the operational area. Beach maintain engagement in relation to activities within the Bass Strait.	3
VR Fish	Victorian recreational fishing peak body	3
Victorian Scallop Fishermen's Association Inc.	Victorian Scallop Fishermen's Association Inc represents the interests of scallop fishermen operating within Australia's south east waters. DPIPWE have confirmed there is no Tasmanian fishery catch effort within the operational area. VFA have confirmed there is no Victorian fishery catch effort within the operational area. Beach maintain engagement in relation to activities within the Bass Strait.	3
Watersure, Victorian Desalination Plant	Operate the Victorian Desalination Plant. No impact to stakeholders' functions, interests or activities. Beach maintain engagement in relation to activities within the Bass Strait.	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 associated with the BassGas development.	Information Sheet

9.7 Ongoing stakeholder consultation

As the seabed assessment locations and timings are to be finalised and will be undertaken over two phases Beach will continue to consult with stakeholders to keep them informed of the schedule and location coordinates as information becomes available. This will be done via ongoing consultation including commencement and cessation notifications and updates in relation to the seabed assessments and broader BassGas Development project via one-on-one communications, mail outs and provision of information on the Beach website. Beach will use a message media system to provide regular (most likely daily) information on the vessel location to stakeholders that have requested this service. Beach will also have the vessel master put out daily radio messages on channel 16.

November 2021 Update

In support of this EP revision and the change in survey assessment timing, information on the activity was sent to relevant stakeholders on 6/10/ 2021 and published on the Beach website.

This initial notification had an incorrect end of activity date: stating 31st December 2022 instead of 31st December 2023. To rectify this and inform stakeholders of the correct date, the following was undertaken:

- The Beach website was updated on 10/10/21 with the correct end of activity date.
- An email with the correct end of activity date was sent to stakeholders on 17/11/2021.

As at 22/11/2021, no comments, claims or objections had been received regarding the change of end date to 31st December 2022.

Beach have undertaken extensive consultation with relevant stakeholders over many years in the Bass Strait and have a strong understanding of their areas of concern. Consequently, Beach do not envisage any comments, claims or objections on the revised end of activity date. Any objections or claims raised from ongoing consultation, including those associated with the end of activity date, will be managed as per Section 9.7.2.

Table 9-4 details the ongoing stakeholder consultation requirements. Records of ongoing stakeholder engagement will be maintained as per Section 7.4.2 Records Management.

9.7.1 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 7.12.4. 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 9.7.2

9.7.2 Management of objections or claims

If any objections or claims are raised 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 5 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 7.12.4. 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	Stakeholder notification of activity commencement. Notification to include: • location of survey, coordinates and map; • timing of activities: expected start and finish date and duration; • sequencing of activities; • vessel, vessels details including call sign and contact; • requested clearance from other vessels; and • Beach contact details. For applicable stakeholders the time of the daily vessel call on Ch 16 VHF will be provided. Note: coordinates to be provided as degrees and decimal minutes referenced to the WGS 84 datum.	2 weeks prior to activity commencing
AHO	Notification of activity for publication of notice to mariners. Information provided should detail: • type of activity; • size, location and geographical coordinates for area of operation; • area of operation and requested clearance from other vessels; • period that NTM will cover (start and finish date); • vessel details including vessel name, call-sign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), contact details and calls signs; and • Beach contact details. Only need to update AHO of changes including if activity start or finish date changes. Do not need to provide cessation notification as long as NTM covers period of activity.	3 weeks prior to activity commencing
AMSA - JRRC	Notification of activity for publication of Auscoast warning. Information provided should detail: • type of activity; • size, location and geographical coordinates for area of operation; • period that warning will cover (start and finish date); • vessel details including vessel name, call-sign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), contact details and calls signs; and • Beach contact details. Only need to update JRCC of changes including if activity start of finish date changes. Do not need to provide cessation notification as long as Auscoast warning covers period of activity.	48 – 24 hours prior to activity commencing

Stakeholder	Ongoing Stakeholder Requirement	Timing
NOPSEMA	Regulatory notification of start of activity. As the activity is not a drilling or seismic activity notification to the State regulator is not required.	10 days prior to activity commencing

Relevant stakeholders who have requested vessel location information.	• regular (most likely daily) text message of vessel locations and expected duration.
	• daily radio message: via channel 16 at:
	  ◦ 17:05 hours: Notification of the expected location of the vessel for the next day.
	  ◦ 09:05 hours (the next morning): Confirmation of the location of the vessel for the day, or any changes (due to unforeseen circumstances).
	• 'on water' communications via channel 16, where vessels can communicate in real time, if required.
		During activity

NOPSEMA	Regulatory notification of cessation of activity. As activity is not a drilling or seismic activity notification to the State regulator is not required.	Within 10 days of activity completion

Table 9-4: Summary of stakeholder consultation records and Beach assessment of objections and claims

Information sheet is available in Appendix F.

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
Abalone Victoria Central Zone (AVCZ)	29/11/2019	AVCZ_01 AVCZ_01_Continuing development Bass offshore gas email.pdf; GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Abalone Victoria Central Zone (AVCZ)	30/01/2020	AVCZ_02 AVCZ_02_Bass Offshore Project Update Trefoil email.pdf	This email is to provide an update on our Bass Offshore Project in the Bass basin. The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed, we will provide a further update. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Abalone Victoria Central Zone (AVCZ)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
ANZT Fishing Company (SESSF fishery)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Australian Fisheries Management Authority (AFMA)	20/11/2019	AFMA_06 AFMA_06 Trefoil and White Ibis Data Request 25 Sep 2019.pdf; AFMA 06 AFMA Data Request Form Beach Trefoil and White Ibis email.pdf; AFMA 06 AFMA Data Request Form Beach Trefoil and White Ibis.pdf	Beach request to AFMA for fishing data within the Trefoil and White Ibis areas.	AFMA and Beach still processing the request.
Australian Fisheries Management Authority (AFMA)	20/11/2019	AFMA_07 AFMA_07 Beach AFMA Fishing Licences Trefoil.pdf; AFMA_07 Beach Trefoil Survey Location.pdf	Beach request to AFMA to identify any licence holders that currently fish or have fished in the Trefoil survey area in the 5 years. A map of the area and coordinates were provided.	Information received from AFMA see Stakeholder Record AFMA_10.
Australian Fisheries Management Authority (AFMA)	29/11/2019	AFMA_08 AFMA_08_Continuing development Bass offshore gas email.pdf GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to	Provision of information

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
			start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	
Australian Fisheries Management Authority (AFMA)	13/12/2019	AFMA_10 AFMA_10_Trefoil and White Ibis Fishing Licence Holders.pdf; AFMA_10_Trefoil and White Ibis Fishing Licence Holders Records.pdf	Obtained licence holder information from AFMA for those fisheries that fish in the White Ibis and Trefoil area. Records show that there are: 13 current licences: • Southern and Eastern Scalefish and Shark Fishery: 9 licensees • Bass Strait Scallop Fishery: 4 licensees 19 licences over the last 10 years: • Southern and Eastern Scalefish and Shark Fishery: 13 licensees • Bass Strait Scallop Fishery: 6 licensees	Information from AFMA detailed that there were current and previous licence holders in the Southern and Eastern Scalefish and Shark Fishery and Bass Strait Scallop Fishery within the Trefoil and White Ibis areas. Based on data from ABARES reports from 2014-2019 it is unlikely that the Bass Strait Scallop Fishery is active in the Trefoil area and that these records are associated with the White Ibis area which is not part of this EP (Figure B-10-8). See Appendix B.4.6.
Australian Fisheries Management Authority (AFMA)	30/01/2020	AFMA_13 AFMA_13_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Australian Fisheries Management Authority (AFMA)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Australian Southern Bluefin Tuna Industry Association	29/11/2019	ASBT_03 ASBT_03_Continuing development of the Bass offshore natural gas reserves email.pdf; GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au	Provision of information

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
Australian Southern Bluefin Tuna Industry Association	30/01/2020	ASBT_04 ASBT_04_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Australian Southern Bluefin Tuna Industry Association	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Bunurong Land Council Aboriginal Corporation	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Bass Strait Scallop Industry Association	23/12/2019	BSSIA_01 BSSIA_01_Bass activities email.pdf; GD19-0146_Bass Offshore Project_November 2019.pdf	Follow-up after phone call to introduce Beach and Bass Offshore Project including the Trefoil seabed assessment. As we discussed, we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation. Early in 2020 we will provide detailed information on potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. We have undertaken assessments of VIC and TAS fishing activity in the Trefoil area and both State agencies have confirmed there's been no fishing activity over the last several years. We're currently undertaking an assessment of Commonwealth fishing activity in that area and expect that to be finalized in January 2020. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact me on 0448 236 121 or reply to this email at community@beachenergy.com.au.	Provision of information
Bass Strait Scallop Industry Association	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Blue Whale Study	29/11/2019	BWS_05 BWS_05_Continuing development Bass offshore gas email.pdf; GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Blue Whale Study	30/01/2020	BWS_09 BWS_09_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will	Provision of information

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
			provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	
Blue Whale Study	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Commonwealth Fisheries Association (CFA)	29/11/2019	CFA_05 CFA_05_Continuing development Bass offshore gas email.pdf; GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
	30/01/2020	CFA_07 CFA_07_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Commonwealth Fisheries Association (CFA)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
Department of Jobs, Precincts and Regions (DJPR): Earth Resources Regulation	29/11/2019	ERR_13 ERR_13_Continuing development Bass offshore gas email.pdf GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Department of Jobs, Precincts and Regions (DJPR): Earth Resources Regulation	30/01/2020	ERR_15 ERR_15_Bass Project Update Trefoil Seabed email.pdf	This email is to provide an update on our Bass Offshore Project in the Bass basin. The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed, we will provide a further update. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Department of Jobs, Precincts and Regions (DJPR): Earth Resources Regulation	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Department of Jobs, Precincts and Regions (DJPR): Marine Pollution	30/01/2020	MP_21 MP_21_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Department of Jobs, Precincts and Regions (DJPR): Marine Pollution	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Department of Jobs, Precincts and Regions (DJPR): Victorian Gas Program	29/11/2019	VGP_04 VGP_04_Continuing development Bass offshore gas email.pdf; VGP_04_Continuing development Bass offshore gas reply.pdf GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information.

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
			Department of Jobs, Precincts and Regions (DJPR): Victorian Gas Program replied thanking Beach Energy for their advice.	
Department of Jobs, Precincts and Regions (DJPR): Victorian Gas Program	30/01/2020	VGP 06 VGP_06_Offshore Project Updates Bass & Otway email.pdf; VGP_06_Offshore Updates Bass & Otway undeliverable email01.pdf; VGP_06_Offshore Updates Bass & Otway undeliverable email02.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au. Email was sent to 12 people and with two of the twelve having undeliverable emails.	Provision of information Email was undeliverable to two recipients. Beach have updated their stakeholder database.
Gazak Holdings (SESSF fishery)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
King Island Council	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Lang Lang Gas Plant Environment Liaison Group	20/11/2019	LANG_01 LANG_01_Minutes Meeting.pdf	At the Lang Lang Gas Plant Environment Liaison Group meeting Beach provided an overview of the Bass Offshore Development Project including the seabed assessments to be undertaken to determine the suitability of the seabed for drilling and infrastructure facilities.	Provision of information.
Mersey Yacht Club	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Marinus Link	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Mullo Fishing (SESSF fishery)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Mures Fishing (SESSF fishery)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Ocean Racing Club of Victoria	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
	20/11/2019	ORCV_06 GD19-0146_Bass Offshore Project_November 2019.pdf; ORCV_06_Conti development of Bass offshore gas email.pdf; ORCV_06_Conti development of Bass offshore gas reply.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au. ORCV replied on 29/11/2019ORCV informed Beach energy of the updated contact to use when consulting.	Provision of information. ORCV contact details updated.
Ocean Racing Club of Victoria	30/01/2020	ORCV_09 ORCV_09_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will	Provision of information

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
			provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	
Ocean Racing Club of Victoria	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Petuna Sealord Deepwater Fishing (SESSF fishery)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Portland Professional Fisherman's Association	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Royal Yacht Club of Tasmania	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Scallop Fishermen's Association of Tasmania Inc and Bass Strait Scallop Industry Management Committee	23/12/2019	SFAT_1 SFAT_1_Bass email.pdf; GD19-0146_Bass Offshore Project_November 2019.pdf	Follow-up after phone call to introduce Beach and Bass Offshore Project including the Trefoil seabed assessment. As we discussed, we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation. Early in 2020 we will provide detailed information on potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. We have undertaken assessments of VIC and TAS fishing activity in the Trefoil area and both State agencies have confirmed there's been no fishing activity over the last several years. We're currently undertaking an assessment of Commonwealth fishing activity in that area and expect that to be finalized in January 2020.In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact me on 0448 236 121 or reply to this email at community@beachenergy.com.au.	Provision of information.
Scallop Fishermen's Association of Tasmania Inc and Bass Strait Scallop Industry Management Committee	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Seafood Industry Victoria (SIV)	3/12/2019	SIV_52 SIV_52_updates on development of offshore permits licences email.pdf; SIV_52_updates on development of offshore permits licences reply.pdf	As mentioned last week we are planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities, including a seismic survey within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. Victorian Fisheries Authority has confirmed that there is no Victorian fishing in the Trefoil area. However, if you believe it is appropriate to issue this information to you members please let me know. Note, I have also arranged to discuss these matters with Toby Jeavons on 17 December. And I will also be consulting with Julian Hartington at TSIC. SIV and Beach organised a time for a face-to-face meeting for 13/12/2019.	Provision of information

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
Seafood Industry Victoria (SIV)	13/12/2019	SIV_53 SIV x Beach - Meeting Agenda 13 December 2019.pdf; Otway Offshore T30P Seabed Info-Sheet_November 2019.pdf; GD19-0146_Bass Offshore Project_November 2019.pdf; Otway Offshore Project_Seabed Assessment Locations_17 Oct 2019.pdf; SIV_53_Beach meeting agenda and materials.pdf	Beach sent meeting agenda and materials with information attachments regarding projects within the Otway and Bass Basin.	Provision of information
Seafood Industry Victoria (SIV)	13/12/2019	SIV_54	Beach/SIV Meeting. Beach inquired: Whether SIV wishes to advise their members of the Trefoil seabed assessment and future White Ibis seismic survey projects. Whether SIV represents any scallop fishers in Beach's proposed activity areas. SIV advised: Good to know about all Beach's activities. Don't need to send out information to members on Trefoil and White Ibis, given Beach is consulting the Commonwealth and relevant Tasmanian fisheries industry representatives. SIV won't represent abalone fishers from January 2020. Victorian licenced scallop fishing can go out to 20 nm, as with Tasmanian, then the middle is the Commonwealth, Bass Straight Scallop Fishing Association – Andrew Sullivan is CEO.	Information on the Bass Offshore Project including the Trefoil seabed assessment provided to Bass Straight Scallop Fishing Association and Scallop Fishermen's Association of Tasmania Inc and Bass Strait Scallop Industry Management Committee.
Seafood Industry Victoria (SIV)	30/01/2020	SIV_58 SIV_58_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Seafood Industry Victoria (SIV)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
SeaRoad Holdings Pty Ltd	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
South Australian Rock Lobster Advisory Council Inc. (SARLAC) & South Eastern Professional Fishermen's Association Inc. (SEPFA)	29/11/2019	SARLAC_SEPFA_01 SARLAC_SEPFA_01_Continuing development Bass offshore gas email.pdf GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
South Australian Rock Lobster Advisory Council Inc. (SARLAC) & South Eastern Professional Fishermen's Association Inc. (SEPFA)	30/01/2020	SARLAC_SEPFA_03 SARLAC_SEPFA_03_Bass Offshore Project Update Trefoil Seabed Assessment email.pdf	This email is to provide an update on our Bass Offshore Project in the Bass basin. The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed, we will provide a further	Provision of information

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
			update. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	
South Australian Rock Lobster Advisory Council Inc. (SARLAC) & South Eastern Professional Fishermen's Association Inc. (SEPFA)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
South East Trawl Fishing Industry Association (SETFIA)	29/10/2019 to 13/12/2019	SETFIA_85 SETFIA_85 Bass Fishing Effort Report	Beach has engaged SETFIA to provide a report on fishing intensity within the Bass Project Area which includes the seabed assessment area.	Request for information. Beach working with SETFIA to finalise report.
South East Trawl Fishing Industry Association (SETFIA)	30/01/2020	SETFIA_88 SETFIA_88_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
South East Trawl Fishing Industry Association (SETFIA)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Southern Rock lobster Limited (SRL)	29/11/2019	SRL_01 SRL_01_Continuing development Bass offshore gas email.pdf GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Southern Rock lobster Limited (SRL)	30/01/2020	SRL 03 SRL_03_Bass Offshore Project Update Trefoil Seabed Assessment email.pdf	This email is to provide an update on our Bass Offshore Project in the Bass basin. The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed, we will provide a further update. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Southern Rock lobster Limited (SRL)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
Spirit of Tasmania	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Surfrider Foundation Australia	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Sustainable Shark Fishing Inc (SSFI)	29/11/2019	SSFI_10 SSFI_10_Continuing development Bass offshore gas email.pdf; GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Sustainable Shark Fishing Inc (SSFI)	30/01/2020	SSFI_12 SSFI_12_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/. Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Sustainable Shark Fishing Inc (SSFI)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Tasmanian Abalone Council Limited (TACL)	29/11/2019	TACL_08 TACL_08_Continuing development Bass offshore gas email.pdf GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Tasmanian Abalone Council Limited (TACL)	30/01/2020	TACL_10 TACL_10_Offshore Project Updates Bass&Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation.	Provision of information

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
			Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	
Tasmanian Abalone Council Limited (TACL)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Tasmanian Aboriginal Centre (TAC) (Burnie)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE)	27/09/2019	TDPIPWE_26 TDPIPWE_26_Fishing Data Request Trefoil.pdf TDPIPWE_26_BG19-0003_R3.pdf	Beach requested data in relation to Tasmanian fisheries that may potentially fish in the Trefoil area. TDPIPWE replied that they had run several reports dating 1 January 2016 to date and checked with the Wild Fisheries Managers to ensure the reports agreed with their information. We do not have any fishing that has taken place in the area you are considering. Your initial review of our waters is correct. Our reports indicate that there is no overlap in any of the fisheries you thought might have. The scallop fishery is closed, and it is not known whether the fishery will open again next season.	Table 4-2: Presence of ecological receptors within the EMBA and operational area updated to detail that there are no Tasmanian fishing in the seabed assessment area.
Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE)	29/11/2019	TDPIPWE_27 TDPIPWE_27_Development_Bass offshore email.pdf; GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE)	30/01/2020	TDPIPWE_29 TDPIPWE_29_Offshore Updates Bass & Otway email.pdf; TDPIPWE_29_Offshore Updates Bass&Otway reply.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au. TDPIPWE replied on 30/01/2020: Out of office received.	Provision of information
Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE)	07/02/2020	TDPIPWE_30 TDPIPWE_30_Tasmanian Fishing data request email.pdf; TDPIPWE_30_Tasmanian Fishing data request reply.pdf; TDPIPWE_30_Scalefish Map	Beach requested for data in the grid areas; P27, P28, P29, Q26, Q27, Q28, Q29, N26, N27, N28 for the following fisheries: • Abalone fishery – No overlap as fish in water depths less than 50 m. • Commercial Dive fishery – no overlap due to water depths they operate in. • Giant crab fishery – potential for overlap. • Rock Lobster Fishery - potential for overlap. • Scalefish Fishery - potential for overlap. • Scallop Fishery – currently closed. Is it likely to reopen? • Seaweed Fishery - no overlap based on water depths. • Shellfish fishery – no overlap as occurs on the east coast of Tasmania TDPIPWE replied and confirmed there was no overlap with any of the fisheries.	Table 4-2: Presence of ecological receptors within the EMBA and operational area updated to detail that there are no Tasmanian fishing in the seabed assessment area.

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
			Beach requested for the block structure TDPIPWE use as the project area changed and would be easier for both parties and for in the future to have a look at the block structure the department uses. Beach sent the updated project area and requested catch data and confirmation of any fishers present in the new area. TDPIPWE confirmed there was no catch information in the Scalefish map structure 3e3 and 3e4 for the new area.	
Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Tasmanian Rock Lobster Fisherman's Association	29/11/2019	TRLFA_09 TRLFA_09_Continuing development Bass offshore gas email.pdf GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Tasmanian Rock Lobster Fisherman's Association	30/01/2020	TRLFA_11 TRLFA_11_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Tasmanian Seafood Industry Council (TSIC)	29/11/2019	TSIC_08 TSIC_08_Continuing development Bass offshore gas email.pdf GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Tasmanian Seafood Industry Council (TSIC)	23/12/2019	TSIC_09 TSIC_09_Bass Strait activities email.pdf	Thanks for your time on the phone today. On 2nd December, we sent you information on our Trefoil seabed assessment project which involves geophysical assessments at low sound levels and doesn't require seismic surveys. I've attached again for your convenience. We are at very early stages of planning a seismic survey in the White Ibis permit area (which was also marked on the map in the Trefoil information sheet). We're still	Provision of information

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
			planning the exact area and methodology and are preparing in information sheet to explain the activity and start consultation. We hope to send that in early January and then meet with you at the beginning of February when you return from leave.	
Tasmanian Seafood Industry Council (TSIC)	30/01/2020	TSIC_11 TSIC_11_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Tasmanian Seafood Industry Council (TSIC)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Tasmanian Association for Recreational Fishing (TARFish)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Telstra	27/11/2019	TELS_01 TELS_01_Subsea cables information email.pdf; TELS_01_Subsea cables information reply.pdf; BG19-0003D cables.pdf	Beach are trying to determine if our project will overlap any subsea cables. We are planning the Trefoil site survey (map attached) which includes taking some seabed core samples so we would like to ensure that the location of any subsea cables is verified. The information received from Telstra says that there are no cables within the location. However, I would like to ensure this is correct based on the map of the Telstra cables we have - see attached. Could you please have a look at the attached map and let me know whether the information we have on the location of the subsea cables is correct. If it is not correct could you let me know how we obtain the correct location of the cables so we can update our records. Telstra replied on 03/12/2019:Telstra acknowledged they received the email and would look into the location of the subsea cables. Beach sent a follow-up email on the 06/12/2019 and on the 20/12/2019.	Provision of information
Telstra	17/02/2020	TELS_02 TELS_02_Telstra Subsea Cables Location-URGENT.pdf; TELS_02Telstra Subsea Cables Location- URGENT reply.pdf; TELS_02_BS2 section 1a MAP.pdf; TELS_02_BS2 section 4 MAP.pdf	Beach sent Telstra an email regarding the Bass Strait-2 subsea cable location. Telstra replied that it is a telecommunications cable buried in the seafloor. The exact location could not be identified; however, an approximate location was given with Telstra giving Beach an exclusion zone around the cable and that no drilling Borehole and Piezo Cone Penetration sampling should be undertaken in the exclusion zone. Beach has since asked for further clarification about the exclusion zone being 2 km either side of the cable or 1 km on either side that makes up the 2 km exclusion zone. They have also asked for an estimate on the depth that the cable is buried at. Telstra confirmed: That exclusion zone is total width 2 km (1 km each side of the cable). Depth that the cable is buried varies along the cable depending on the seabed substrate but looks to have been around 1.5 metres in this region. However, this may have changed with ocean currents.	Appendix B.4.7 Subsea cables updated with information provided by Telstra. Control Measure #12 Telstra Cable Buffer added and associated performance standard of "No borehole or piezocone penetration sampling will be undertaken within 1 km either side of the known Telstra subsea cable location" included in EPO and EPS Table 6.18.
Telstra	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Tasmanian Association for Recreational Fishing (TARFish)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
Tuna Australia - ETBF Industry Association	30/01/2020	TA_11 TA_11_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Tuna Australia - ETBF Industry Association	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Toll Group	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
TopFish Tasmania	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Trinsand Fisheries	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Victorian Fisheries Authority (VFA)	11/10/2019	VFA_53 VFA_53 Request for Fishing Data.pdf	Beach requested fishing data from VFA for the following VFA grid areas which the Trefoil site survey area overlaps or is adjacent: P27, P28, P29 Q27, Q28, Q29. Data requested: catch data in each of the above blocks / per block: By month of year, for the last five years By species caught / tonnage of each By number of vessels operating If number of fishers < 5, return a "yes" in output field VFA replied Blocks P and Q have no catch reported.	Table 4-2: Presence of ecological receptors within the EMBA and operational area updated to detail that there are no Victorian fishing in the seabed assessment area. Note the change to the Trefoil seabed assessment area to a larger operational area is within the Victorian fishery grids of P and Q (see Figure B-10-8).
Victorian Fisheries Authority (VFA)	29/11/2019	VFA_55 VFA_55_Continuing development Bass offshore gas email.pdf GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Victorian Fisheries Authority (VFA)	17/12/2019	VFA_56	Beach and VFA Meeting notes: Beach advised: Thanked VFA for their support in providing fishing effort information. No fishing activity identified by fishery authorities in our Bass offshore project areas, and currently undertaking assessment of Commonwealth fishing activity.	Provision of information and confirm no Victorian fishing effort within the seabed assessment area.
Victorian Fisheries Authority (VFA)	30/01/2020	VFA_59	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021.	Provision of information.

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
		VFA_59_Offshore Project Updates Bass & Otway email.pdf; VFA_59_Offshore Project Updates Bass & Otway reply.pdf; VFA_59_Offshore Project Updates Bass & Otway email2.pdf	You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	
Victorian Fisheries Authority (VFA)	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Victorian Scallop Fishermen's Association Inc.	29/11/2019	VSFA_09 VSFA_09_Continuing development Bass offshore gas email.pdf; GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field. Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Victorian Scallop Fishermen's Association Inc.	07/12/19	VSFA_10 VSFA_10_Communication.pdf	VSFA 07/12/19: Thank you for let us know it is very important that we've got to work together please send us more information and location where you operate. Beach replied on 11/12/2019: Thanks for being in touch regarding our Bass Offshore Project. The Trefoil seabed assessment is the first activity that will be undertaken in 2020 for a maximum of 25 days. The area of the survey is shown on page 3 of the information sheet and coordinates on page 2. Is there specific information you would like regarding the project? We have added you to our mailing listing for further project updates.	Request and provision of information.
Victorian Scallop Fishermen's Association Inc.	30/01/2020	VSFA_12 VSFA_12_Offshore Project Updates Bass & Otway email.pdf	The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/.Once the timings are confirmed on each project, we will provide a further update. In preparation of our Environment Plans we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	Provision of information
Victorian Scallop Fishermen's Association Inc.	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
VRFish	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.
Watersure, Victorian Desalination Plant	02/12/2019	WS-VDP_01 WS-VDP_01_Continuing development Bass offshore gas email.pdf; GD19-0146_Bass Offshore Project_November 2019.pdf	We would like to inform you that we're planning further development of our Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses. The 'Bass Offshore Project' will see further development of the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields. Activities carried out in the Bass Basin will include seabed site assessments, drilling of offshore gas wells, subsea infrastructure installation and potential additional exploration activities within the White Ibis field.	Provision of information

Stakeholder Name	Date	Record #	Description	Assessment of Objection or Claim
			Planning has commenced for Seabed Assessments in the Trefoil field, located approximately 150 km from the Victorian coast. Seabed Assessments will take approximately 25 days to complete and are expected to start on February 2020, depending on regulatory approvals, weather windows and availability of contractors. I've attached an information sheet with a map for further details. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au.	
Watersure, Victorian Desalination Plant	30/01/2020	WS-VDP_02 WS-VDP_02_Bass Offshore Project Update Trefoil Seabed Assessment email.pdf	This email is to provide an update on our Bass Offshore Project in the Bass basin. The Trefoil Seabed Assessment has been increased and will now take approximately 55 days to complete, subject to weather. The activity will be undertaken sometime between February 2020 and December 2021. You can find the updated information sheet with area map and coordinates here https://www.beachenergy.com.au/bass-basin/. Once the timings are confirmed, we will provide a further update. In preparation of our Environment Plan we are keen to understand if you have any questions, concerns or feedback or require any further consultation. Please don't hesitate to contact us on 1800 797 011 or reply to this email at community@beachenergy.com.au	Provision of information
Watersure, Victorian Desalination Plant	6/10/2021 17/11/2021	email	Project summary and update on timings.	Provision of information.

10 References

Atlas of Living Australia. 2020. White-Faced Storm-Petrel. Available at: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:1f384ad4-0de3-4b8b-9330-f05025c8b392

Australian Maritime Safety Authority. 2015. Technical Guideline for the Preparation of Marine Pollution Contingency Plans for Marine and Coastal Facilities. Australian Maritime Safety Authority. Canberra.

Australian Maritime Safety Authority. 2019. National Plan for Maritime Environmental Emergencies. Australian Maritime Safety Authority. Canberra.

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Available from: http://www.waterquality.gov.au/anz-guidelines/Documents/ANZECC-ARMCANZ-2000-guidelines-vol1.pdf.

Australian Petroleum Production and Exploration Association. 2016. Principles of Conduct. Available from: https://www.appea.com.au/wp-content/uploads/2016/03/APPEA_Principles-of-Conduct-2016_signed.pdf.

Bluhm, H. (2001): Re-establishment of an abyssal megabenthic community after experimental physical disturbance of the *seafloor*. *Deep-Sea* Res. II, Volume 48, Issues 17–18, 2001, Pages 3841-3868

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.

Commonwealth of Australia. 2015. *Conservation Management Plan for the Blue Whale 2015–2025*. Available from: https://www.environment.gov.au/system/files/resources/9c058c02-afd1 -4e5d-abff-11cac2ebc486/files/blue-whale-conservation-management-plan.pdf.

Commonwealth of Australia. 2015a. South-east Marine Region Profile: A description of the ecosystems,conservation values and uses of the South-east Marine Region.

Commonwealth of Australia. 2017a. *Recovery Plan for Marine Turtles in Australia*. Available from: http://www.environment.gov.au/system/files/resources/46eedcfc-204b-43de-99c5-4d6f6e72704f/files/recovery-plan-marine-turtles-2017.pdf.

Commonwealth of Australia. 2017b. *Australian National Guidelines for Whale and Dolphin Watching*. Available from: http://www.environment.gov.au/system/files/resources/7f15bfc1-ed3d-40b6-a177-c81349028ef6/files/aust-national-guidelines-whale-dolphin-watching-2017.pdf.

Commonwealth of Australia. 2017c. National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna 2017.

Commonwealth of Australia. 2019. Draft National Recovery Plan for the Australian Fairy Tern (*Sternula nereis nereis*).

Commonwealth of Australia. 2020. National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Commonwealth of Australia 2020.

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.

Department of Agriculture and Water Resources. 2017. Australian Ballast Water Management Requirements. Available from: http://www.agriculture.gov.au/biosecurity/avm/vessels/ballast/australian-ballast-water-management-requirements

Department of Agriculture and Water Resources (DAWR). 2018. Marine Pest Plan 2018–2023: the National Strategic Plan for Marine Pest Biosecurity, Department of Agriculture and Water Resources, Canberra, May. CC BY 4.0.

Department of the Environment (DoE) 2015a. Conservation Advice for *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) 2015b. Conservation Advice for *Numenius madagascariensis* (eastern curlew). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/847-conservation-advice.pdf

Department of Environment and Conservation (NSW) (DoEC (NSW)). 2006. Gould's petrel (*Pterodroma leucoptera leucoptera)* Recovery Plan. Department of the Environment and Conservation (NSW), Huntsville, NSW.

Department of Environment and Climate Change (NSW) (DoECC (NSW)). 2007. Lord Howe Island Biodiversity Management Plan. Department of Environment and Climate Change, (NSW) Sydney. Available from: http://www.environment.gov.au/resource/lord-howe-island-biodiversity-management-plan.

Department of the Environment and Energy. (DotEE) 2019 SPRAT Profile: Bonney Coast Upwelling. Accessed 25/6/2019 https://www.environment.gov.au/sprat-public/action/kef/view/89;jsessionid=01AD87551D0DE1B0248C8722BE137004

Department of the Environment and Energy. (DotEE) 2019a SPRAT Profile: Caperea marginata — Pygmy Right Whale. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=39

Department of Environment, Land, Water and Planning. (DELWP) 2016. National Recovery Plan for the Orange-bellied Parrot *(Neophema chrysogaster).* Australian Government, Canberra.

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 Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1768-conservation-advice.pdf.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). 2013. Recovery Plan for the White Shark (*Carcharodon carcharias*). Department of Sustainability, Environment, Water, Population and Communities. Canberra.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). 2012. Conservation Management Plan for the Southern Right Whale: A Recovery Plan under the Environment Protection and Biodiveristy Conservation Act 1999, 2011-2021. Department of Sustainability, Environment, Water, Population and Communities. Canberra.

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. Approved Conservation Advice for *Sternula nereis nereis* (fairy tern). Department of Sustainability, Environment, Water, Population and Communities. Canberra, ACT.

Director of National Parks. 2013. South-East Commonwealth Marine Reserves Network Management Plan 2013–23. Department of Environment Canberra. Available from: http://www.environment.gov.au/system/files/pages/de2de49a-7eed-4a70-bfbb-463f8d00f2ca/files/se-networkmanagement-plan2013-23.pdf.

Duncan, A., A. Gavrilov, and F. Li. 2009. Acoustic propagation over limestone seabeds. ACOUSTICS. University of Adelaide. pp. 1-6.

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

Ellis, J and Schneider, D.C. 1997. *Evaluation of a gradient sampling design for environmental impact assessment*. Environmental Monitoring and Assessment 48(2):157-172.

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.

Georgeson, L., Stobutzki, I. & Curtotti, R. (eds) 2014, Fishery status reports 2013–14, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

Hannay, D., MacGillivray, A., Laurinolli, M. and Racca, R. 2004. Source Level Measurements from 2004 Acoustics Programme, Sakhalin Energy, pp. 66.

Ingole, B. S. Goltekar, R., Gonsalves, S and Ansari, Z. A. (2005) Recovery of Deep-sea Meiofauna after Artificial Disturbance in the Central Indian Basin. Marine Georesources & Geotechnology Vol. 23(4).

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.

Keough, M.J and Mapstone, B.D. 1995. *Designing environmental monitoring for pulp mills in Australia*. Water Science and Technology. 35 (2-3): 397-404

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.

Marine Pest Sectoral Committee. 2018. National biofouling management guidelines for the petroleum production and exploration industry, Department of Agriculture and Water Resources, Canberra, December. CC BY 4.0.

McCauley, R.D. 1998. Radiated underwater noise measured from the drilling rig ocean general, rig tenders Pacific Ariki and Pacific Frontier, fishing vessel Reef Venture and natural sources in the Timor Sea, Northern Australia. Prepared by Rob McCauley for Shell Australia.

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 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.

McCauley, R.D. and Duncan, A. 2001. Marine Acoustic Effects Study, Blue Whale Feeding Aggregations, Otway Basin, Bass Strait Victoria, Centre for Marine Science and Technology, Curtin University March 2001. For Ecos Consulting.

McCauley, R.D. and 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., 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.

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.

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.

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 Offshore Petroleum Safety and Environmental Management Authority. 2015. ALARP Guidance Note. Document number: N-04300-GN0166, Rev 6, June 2015.

National Offshore Petroleum Safety and Environmental Management Authority. 2016. Environment Plan Content Requirements. Document number: GN1344, Rev 4, April 2019.

National Offshore Petroleum Safety and Environmental Management Authority. 2018. Oil Pollution Risk Management. Document number: IP1488, Rev 2, February 2018.

National Offshore Petroleum Safety and Environmental Management Authority. 2018. Environment Plan Decision Making Guideline. Document number: GL1721, Rev 6, November 2019.

Oil & Gas UK. 2014. The UK offshore oil and gas industry guidance on risk-related decision making.

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.

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.

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W. T., Gentry, R., Halvorsen, M. B., Løkkeborg, S., Rogers, P., Southall, B. L., Zeddies, D., and Tavolga, W. N. 2014. “Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report,” ASA S3/SC1.4 TR-201.4 prepared by ANSI Accredited Standards Committee Rationale and Background Information (Chapter 8).

RPS. 2017. Otway Basin Operations: Geographe and Thylacine - Quantitative Oil Spill Modelling. Prepared for Lattice Energy on 31 July 2017. Document MAQ0532J.

Santos. 2018. Bethany 3D Seismic Survey Environment Plan Summary.

Simmonds, M.P., Dolman, S.J. and Weilgart, L. (eds). 2004. Oceans of Noise [Online]. Available from: http://www.wdcs.org/submissions_bin/OceansofNoise.pdf. AWDCS Science Report Published by the Whale and Dolphin Conservation Society.

Thales Geosolutions. 2001. "BassGas Project: Offshore Shallow Geotechnical Survey Report", Report No. 3259C.

Threatened Species Scientific Committee (TSSC) 2014. Conservation Advice *Ardenna carneipes* (flesh-footed shearwater). Available from: http://www.environment.gov.au/biodiversity/threatened/conservation-advices/adrenna-carneipes

Threatened Species Scientific Committee (TSSC) 2016. Conservation Advice *Calidris canutus* (red knot). 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) 2015a. Conservation Advice for *Halobaena caerulea* (blue petrel). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1059-conservation-advice-01102015.pdf.

Threatened Species Scientific Committee (TSSC) 2015b. Conservation Advice for *Pachyptila turtur subantarctica* (fairy prion). Canberra: 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) 2015c. Conservation Advice for *Pterodroma mollis* (soft-plumaged petrel). Canberra: Department of the Environment. http://www.environment.gov.au/biodiversity/threatened/species/pubs/1036-conservation-advice-01102015.pdf.

Threatened Species Scientific Committee (TSSC) 2015d. Conservation Advice for *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). 2015e. Conservation Advice for *Megaptera novaeangliae* (humpback whale). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf

Threatened Species Scientific Committee (TSSC). 2015f. Conservation Advice for *Balaenoptera physalus* (fin whale). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservation-advice-01102015.pdf

URS. 2001. Review of Environmental Impacts of Petroleum Exploration and Appraisal Activities in Commonwealth Waters. Report prepared for the Department of Science and Resources.

UNEP. 1985. GESAMP: Thermal discharges in the marine environment. UNEP Regional Seas Reports and Studies No. 45. Victoria, Rev 2 (Project No: Q0036).

Wood, M. and McPherson, C. 2019. Technical Note: Supplemental modelling results for Otway Basin Geophysical Operations Acoustic Modelling: Acoustic Modelling for Assessing Marine Fauna Sound Exposures. Prepared for Beach Energy on 2 April 2019. Document 01777.

Appendix A EPBC Act Protected Matters Search Tool Report

Australian Government
Department of Agriculture, Water and the Environment

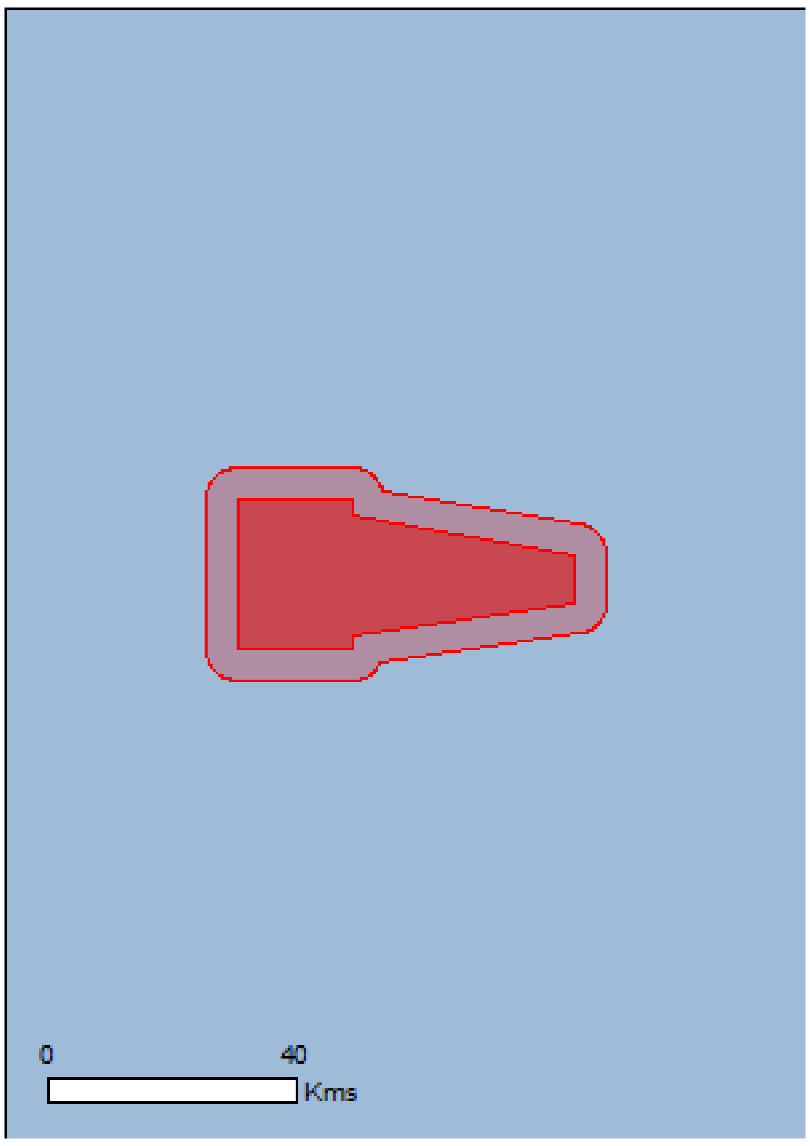
EPBC Act Protected Matters Report

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.

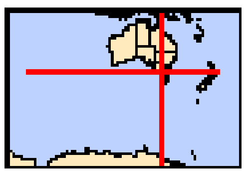
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 08/10/21 14:38:18



Coordinates
Buffer: 5.0Km



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:	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:	45
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 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
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
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		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 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	Species or species habitat may occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may 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
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Status	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely 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 known 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]		Foraging, feeding or related behaviour 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

Name	Threatened	Type of Presence
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may 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	Species or species habitat likely 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

Name	Threatened	Type of Presence
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 known 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

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

Name	Threatened	Type of Presence
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 gibsoni Gibson's Albatross [64466]	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
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]		Foraging, feeding or related behaviour 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	Species or species habitat may 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

Name	Threatened	Type of Presence
		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*	Species or species habitat may 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 minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		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
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
Vanacampus phillipi Port Phillip Pipefish [66284]		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

Name	Threatened	Type of Presence
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	Species or species habitat likely 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 known 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

-39.74777 145.32377,-39.74765 145.49037,-39.76759 145.49039,-39.80962 145.81228,-39.86381 145.81259,-39.90042 145.49007,-39.91525 145.49037,-39.91517 145.32377,-39.74777 145.32377

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Appendix B Existing Environment

The physical, ecological and socio-economic environment of the EMBA, which includes the operational area, are described in this section, with any values or sensitivities identified. The EMBA and operational area are shown in Figure 4-1, with Section 6.3 detailing the methodology for defining the EMBA boundary.

A search of the EPBC Act Protected Matters Search Tool (PMST) was undertaken in September 2021 to identify the conservation values within the EMBA and operational area. The PMST Report for the EMBA is in Appendix A.

Appendix B.1 Conservation values and sensitivities

The following was identified from the EMBA PMST Report (Appendix A).

The EMBA and operational area do not overlap:

- World Heritage Properties
- National Heritage Places
- Wetlands of Importance
- Great Barrier Reef Maine Park
- Listed Threatened Ecological Communities
- Commonwealth Land
- Commonwealth Heritage Areas
- Critical Habitats
- Terrestrial Commonwealth Reserves
- Australian Marine Parks (Figure B-10-1)
- Key Ecological Features
- State and Territory Reserves
- Nationally Important Westlands

The EMBA and operational area do overlap:

- Commonwealth Marine Area (Appendix B.1)
- Listed Threatened, Migratory and Marine Species (Appendix B.3.3)

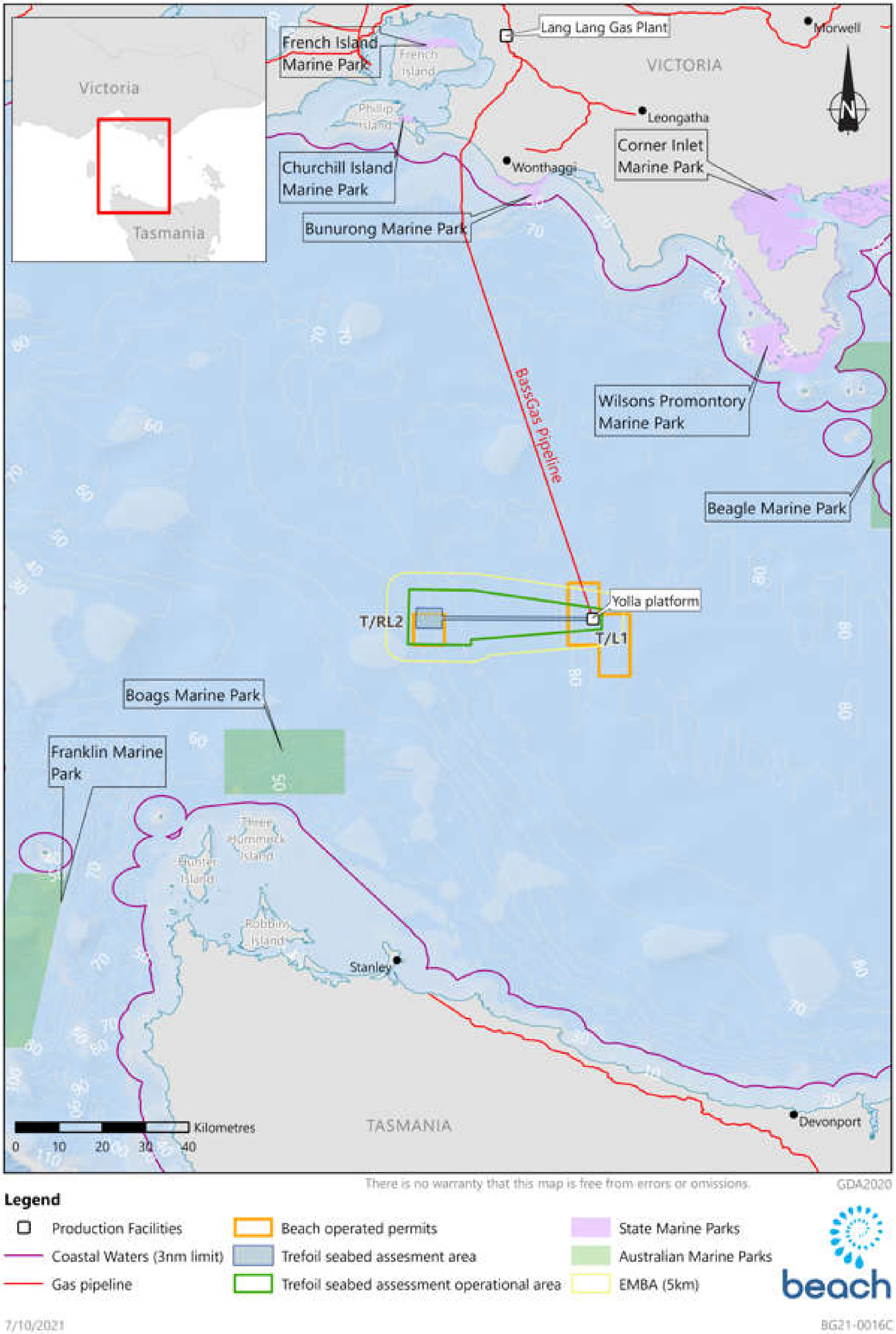


Figure B-10-1: Commonwealth and State Protected Areas

Appendix B.2 Physical environment

The physical marine environment of the Bass Strait region is characterised by relatively shallow water and tidal currents on the continental shelf, that connects the Southern Ocean and the Tasman Sea.

Appendix B.2.1 Geomorphology, geology, bathymetry and sediments

The bathymetry of Bass Strait illustrates that the seafloor is gently sloping with water depths increasing gradually from the shore to reach a maximum of about 80 m at the Yolla-A platform. Sedimentation in Bass Strait is generally low due to the low supply from rivers and the relatively low productivity of carbonate.

Origin Energy, as the previous Operator of BassGas, undertook several geotechnical surveys in and around the Yolla-A platform (Thales GeoSolutions, 2001; Benthic, 2001; Fugro, 2002; Benthic, 2009; Benthic, 2013). These surveys indicate that there are no obstructions or wrecks in the area. The seabed is flat and featureless, with surveys prior to construction indicating the seabed has very soft to soft alternating layers of silty carbonate clay and silty sands containing fragile white shell fragments (Thales GeoSolutions, 2001; 2003).

Appendix B 2.2 Metocean conditions

Appendix B.2.2.1 Climate

Bass Strait 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 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. (Figure B-10-2). 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.

Appendix B.2.2.2 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.

Appendix B.2.2.3 Tides

Tides are semi-diurnal with the magnitude and timing of the Bass Strait tides relatively uniform and predictable (Sandery and Kampf, 2005). Tidal waves enter the Bass Strait from both the east and west, with speeds generally varying from <0.05 ms^{-1} to 0.5 ms^{-1} (IMCRA Technical Group, 1998). 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).

Appendix B.2.2.4 Ocean currents

Ocean currents in Bass Strait are primarily driven by tides, winds and density-driven flows. 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.

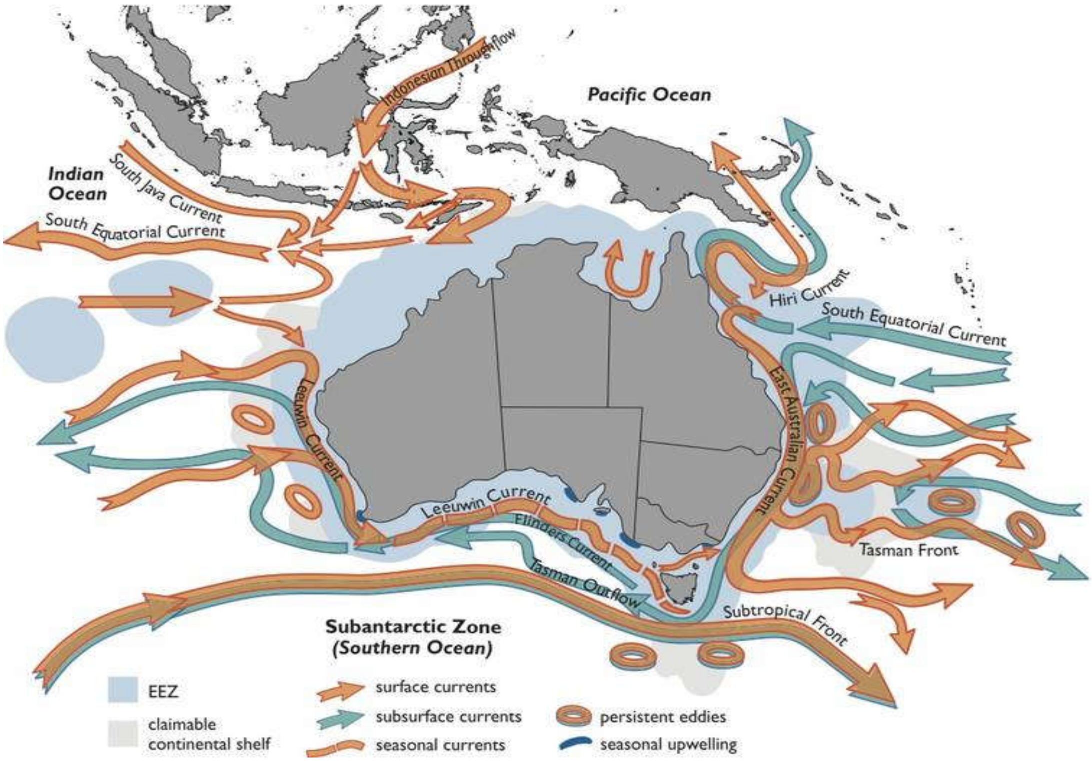


Figure B-10-2: Australian ocean currents

Appendix B.2.2.5 Sea temperature

RPS (2017) reports that sea surface temperature in the region (based on the World Ocean Atlas) varies from an average minimum of 12.7°C in winter to a maximum of 18.1°C in late summer. However, in summer weak stratification can occur causing a thermocline separating the wind-driven motions of the upper well-mixed layer of Bass Strait from the bottom well-mixed layer (DotEE, 2015).

Appendix B 2.3 Ambient sound levels

Ambient noise within the EMBA and operational area offshore Bass Strait region is expected to be dominated by naturally occurring physical (e.g. wind, waves, rain) and biological (e.g. echo-location and communication noises generated by cetaceans and fish) sources. Anthropogenic noise sources are also likely to be experienced in the area and include low-frequency noise from vessels.

Appendix B.2.4 Air quality

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 goals and standards being met for carbon monoxide (CO), nitrogen dioxide (NO_2), Ozone (O_3) and sulfur dioxide (SO_2). There were some exceedances for particles.

The Geelong South monitoring station is the closest to the EMBA and operational area; however, it is situated in an urban environment. The EMBA and operational area is within the offshore Bass Strait region which is relatively remote and therefore air quality is expected to be high. Air quality in the Bass Strait is expected to vary in response to anthropogenic activity (e.g. vessels, industry developments) however, these changes in air quality are expected to be experienced locally and for short duration.

Appendix B.3 Ecological environment

To characterise the ecological environment in which the seabed assessment is to be conducted, a literature search and online resources and databases have been reviewed to identify and assess flora and fauna species known to be present or potentially present in the EMBA and operational area. 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 PMST Report for Matters of National Environmental Significance (MNES) protected under the EPBC Act.
- published observations, data and statistics on marine mammals.
- Beach and public environment plans for activities in the region.
- National Conservation Values Atlas.
- relevant environmental guidelines and publicly available scientific literature on individual species.

Appendix B.3.1 Benthic habitats and species assemblages

The Bass Strait exists on the Tasmanian continental shelf. The region is characterised by a mixture of basins, terraces, plateaus, banks, deep escarpments, areas of continental rise and an eastern ridge (DEH, 2006).

Surveys of the seabed near the Yolla-A platform prior to drilling and construction showed sparsely scattered clumps of solitary sponges, sea cucumbers, sea squirts and predatory snails (whelk) (Thales GeoSolutions, 2001). As the EMBA and operational area is within a similar water depth as the Yolla-A platform it is likely that the benthic habitat would be similar.

Whilst there is little information available on the nature or distribution of epibiota in central Bass Strait, data is available for eastern Bass Strait from the Museum of Victoria biological sampling programs conducted from 1979 to 1984 (Wilson and Poore 1987), from scientific dredging conducted in 1989 (Parry et al., 1990), and from targeted investigations for pipeline and power link proposals in the area. This information can be used to extrapolate existing conditions for central Bass Strait. Generally, the epibiota of the region is sparse and characterised by scallops and other large bivalve molluscs, crabs, seasquirts, seapens, sponges and bryozoans. A variety of mobile crabs, prawns and brittle stars are also relatively common. Many of the mobile epibiota appear to occur in aggregations from time to time (scallops, prawns and crabs) while some of the fixed epibiota occur in patches (sponges and bryozoans).

Appendix B.3.1.1 Invasive Marine Species

It is widely recognised that marine pests can become invasive (invasive marine species) 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 and Grosholz, 2007).

A review of Parks Victoria Marine Pests in Victoria (Parks Victoria 2015) did not identify any marine pests that have been identified in the offshore areas within the EMBA or operational area (Table B-9-3). The PMST Report for the EMBA and operational area (Appendix A.1 and A.2) did not identify any invasive species.

Table B-10-1: Marine pests known to occur in Victorian waters

Species	Description	Likely presence in EMBA and operational area
Pacific oyster (*Crassostrea gigas*)	Small number of this oyster species are reported to occur in Western Port Bay and at Tidal River in the Wilsons Promontory National Park.	No
Northern pacific seastar (*Asterias amurensis*)	Prefer soft sediment habitat, but also use artificial structures and rocky reefs, living in water depths usually less than 25 m (but up to 200 m water depths). Well established in Port Phillip Bay but currently not present in other Victorian locations.	No
New Zealand screw shell (*Maoricolpus roseus*)	Lies on or partially buried in sand, mud or gravel in waters up to 130 m deep. It can densely blanket the sea floor with live and dead shells and compete with native scallops and other shellfish for food. This species is widespread in coastal areas of Eastern Victoria, including Corner Inlet and has been found west of Wilsons Promontory in Waratah Bay and Shallow Inlet. This species is known to be present in the Port Phillip and the Western Port region.	No
European shore crab (*Carcinus maenas*)	Prefers intertidal areas, bays, estuaries, mudflats and subtidal seagrass beds, but occurs in waters up to 60 m deep. It is widespread across Victorian intertidal reef and common in Port Phillip and Western Port.	No
Dead man's fingers (*Codium fragile ssp. fragile*)	Widespread in Port Phillip and known to inhabit San Remo and Newhaven in Western Port. It grows rapidly to shade out native vegetation and can regenerate from a broken fragment enabling easy transfer from one area to another. Attaches to subtidal rocky reed and other hard surfaces.	No
Asian date mussel (*Musculista senhousia*	Prefers soft sediments in waters up to 20 m deep, forming mats and altering food availability for marine fauna. Found in Port Phillip and Western Port, including Yaringa and French Island Marine National Parks; some records from eastern Victoria, particularly the Gippsland Lakes.	No
Cord grass (*Spartina anglica* and *Spartina x townsendii sp*)	Found at the mouth of Bass River and in drain outlets near Tooradin in Western Port. Widespread in South Gippsland including Anderson's Inlet and Corner Inlet. Invades native saltmarsh, mangroves and mudflats, altering the mud habitat and excluding other species.	No

Appendix B.3.2 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 comprise 13 divisions of mainly microscopic algae, including diatoms, dinoflagellates, gold-brown flagellates, green flagellates and cyanobacteria and prochlorophytes (McLeay et al., 2003) Phytoplankton 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.

As part of a marine seismic survey undertaken in early 2018, the CarbonNet Project commissioned plankton sampling across nine sites in shallow waters off Golden Beach, Gippsland (227 km to the north-east of the Yolla-A platform). The results of this work (CarbonNet, 2018) found that:

- the composition of zooplankton was a typical healthy example of those expected for temperate coastal waters.

- copepods were the dominant group, with varying proportions of appendicularians, cladocerans and doliolids. Numerous other groups occurred in small numbers, including siphonophores, fish larvae, fish eggs, polychaetes, ghost shrimps and cnidarians (jellies).

Although this work was undertaken to the north-east of the EMBA and operational area, it is likely that a similar plankton assemblage would occur in the EMBA and operational area given the well-mixed nature of Bass Strait waters.

Appendix B.3.3 Threatened and Migratory species

The PMST Reports identified the listed Threatened and Migratory species that may be present in the EMBA and operational area (Appendix A). A total of 35 listed Threatened species and 36 listed Migratory species were identified in both PMST Reports as potentially occurring within the EMBA and operational area. There were also 45 Listed marine species and 13 cetaceans that were identified as potentially occurring within the EMBA and operational area.

Appendix B.3.4.1 Birds

A diverse array of seabirds utilise the Bass Strait region and may potentially forage within or fly over the EMBA and operational area.

The EMBA and operational area PMST Reports identified 32 bird species as Threatened or Migratory that may occur, forage or migrate within or over the EMBA and operational area (Table B-10-2). Three of these bird species are listed as critically endangered, five are endangered and 19 are listed as vulnerable.

Many of these bird species are protected by international agreements (Bonn Convention, JAMBA, CAMBA and ROKAMBA) and periodically pass through Bass Strait to and from the Bass Strait islands, mainland Victoria and Tasmania (DotEE, 2015).

Several species listed in Table B-10-2 use coastal shoreline habitats such as common sandpiper, curlew sandpiper, eastern curlew, fairy prion, pectoral sandpiper, red knot and sharp-tailed sandpiper. These species are commonly found on coastal shores including beaches and rocky shores (Parks Victoria, 2016). These species are unlikely to be present within the EMBA and operational area due to the distance offshore.

The EMBA and operational area intersect foraging BIAs for several albatross (black-browed albatross, Buller's albatross, Campbell albatross, Indian yellow-nosed albatross, shy albatross, wandering albatross); common diving-petrel, short-tailed shearwater and white-faced storm-petrel. The common diving-petrel, short-tailed shearwater, white-faced storm-petrel and Indian yellow-nosed albatross were not identified in the PMST Reports.

The PMST reports identified foraging behaviour likely for the flesh-footed shearwater, antipodean albatross, black-browed albatross, Campbell albatross, Gibson's albatross, Northern royal albatross, Salvin's albatross, shy albatross, Southern royal albatross, wandering albatross, white-capped albatross and Australian fairy tern.

The PMST reports identified migratory route likely for the orange-bellied parrot.

Table B-10-2: Listed bird species identified in the EMBA and operational area PMST Reports

Common name	Species name	EPBC Act status			Type of presence	BIA overlap EMBA and operational area
		Listed Threatened	Listed Migratory	Listed marine		
Albatross'						

Common name	Species name	EPBC Act status			Type of presence	BIA overlap EMBA and operational area
		Listed Threatened	Listed Migratory	Listed marine		
Antipodean albatross	*Diomedea antipodensis*	V	M	L	FL	
Black-browed albatross	*Thalassarche melanophris*	V	M	L	FL	Yes
Buller's albatross	*Thalassarche bulleri*	V	M	L	SHM	Yes
Campbell albatross	*Thalassarche impavida*	V	M	L	FL	Yes
Gibson’s albatross	*Diomedea antipodensis gibsoni*	V	-	L	FL	
Grey-headed albatross	*Thalassarche chrysostoma*	E	M	L	SHM	
Northern Buller’s albatross	*Thalassarche bulleri platei*	V	-	-	SHM	
Northern royal albatross	*Diomedea sanfordi*	E	M	L	FL	
Salvin's albatross	*Thalassarche salvini*	V	M	L	FL	
Shy albatross	*Thalassarche cauta cauta*	V	M	L	FL	Yes
Sooty albatross	*Phoebetris fusca*	V	M	L	SHL	
Southern royal albatross	*Diomedea epomophora*	V	M	L	FL	
Wandering albatross	*Diomedea exulans*	V	M	L	FL	Yes
White-capped albatross	*Thalassarche cauti steadi*	V	M	-	FL	
	Thalassarche steadi	V	M	L	FL	
Petrels						
Blue petrel	*Halobaena caerulea*	V	-	L	SHM	
Gould's petrel	*Pterodroma leucoptera*	E	-	-	SHM	
Northern giant-petrel	*Macronectes halli*	V	M	L	SHM	
Soft-plumaged petrel	*Pterodroma mollis*	V	-	L	SHM	
Southern giant-petrel	*Macronectes giganteus*	E	M	L	SHM	

Common name	Species name	EPBC Act status			Type of presence	BIA overlap EMBA and operational area
		Listed Threatened	Listed Migratory	Listed marine		
White-bellied storm-petrel	*Fregetta grallaria grallaria*	V	-	L	SHM	
Shearwaters						
Flesh-footed shearwater	*Ardenna carneipes (Puffinus carneipes in marine listing)*	-	M	L	FL	
Sooty shearwater	*Puffinus griseus*	-	M	L	SHM	
Other						
Australian fairy tern	*Sternula nereis*	V	-	L	FL	
Common sandpiper	*Actitius hypoleucos*	-	M	L	SHM	
Curlew sandpiper	*Calidris ferruginea*	CE	M	L	SHM	
Eastern curlew	*Numenius madagacariensis*	CE	M	L	SHM	
Fairy prion	*Pachyptila turtur subantactica*	V	-	L	SHM	
Great skua	*Catharacta skua*	-	-	L	SHM	
Orange-bellied parrot	*Neophema chrysogaster*	CE	-	L	ML	
Pectoral sandpiper	*Calidris melanotos*	-	M	L	SHM	
Red knot	*Calidris canutus*	E	M	L	SHM	
Sharp-tailed sandpiper	*Calidris acuminata*	-	M	L	SHM	

Listed Threatened
CE: Critically Endangered
E: Endangered
V: Vulnerable
Listed Migratory
M: Migratory
Listed Marine
L: Listed

Likely Presence
SHM: Species or species habitat may occur within area.
SHL: Species or species habitat likely to occur within area.
SHK: Species or species habitat known to occur within area.
FL: Foraging, feeding or related behaviour likely to occur within area.
ML: Migratory route likely to occur in area.

Albatrosses and giant 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. There is a National Recovery Plan for threatened albatross and giant petrels (DESWPaC, 2011a).

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 black-browed albatross, Buller's albatross, Campbell albatross, Indian yellow-nosed albatross, shy albatross, wandering albatross, common diving-petrel and white-faced storm-petrel have foraging BIAs that overlap the EMBA and operational area. These BIAs cover either most or all the South-East Marine Region (Commonwealth of Australia, 2015b). In addition, the PMST reports identified foraging behaviour likely for the antipodean albatross, Gibson's albatross, Northern royal albatross, Salvin's albatross, Southern royal albatross and wandering albatross, white-capped albatross and Australian fairy tern.

It is likely that several albatross species will be present and may forage in the EMBA and operational area.

Shearwaters

Two shearwater species were identified in PMST Reports, the flesh-footed shearwater and sooty shearwater. The PMST Reports identified that foraging maybe likely for the flesh-footed shearwater. No shearwater BIAs overlap the EMBA or operational area.

Shearwaters are medium-sized long-winged seabirds most common in temperate and cold waters. They come to islands and coastal cliffs to breed, nesting in burrows and laying a single white egg. Shearwaters feed on small fish, cephalopod molluscs (squid, cuttlefish, nautilus and argonauts), crustaceans (barnacles and shrimp), and other soft-bodied invertebrates and offal. These species forage almost entirely at sea and very rarely on land (TSSC, 2014).

The flesh-footed shearwater 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, 2019n). They feed on small fish, cephalopod molluscs (squid, cuttlefish, nautilus and argonauts), crustaceans (barnacles and shrimp), other soft-bodied invertebrates) and offal and routinely attends fishing vessels to feed on baited hooks, discarded scraps and prey attracted to the surface by such vessels (DotEE, 2019n).

It is likely that the sooty shearwater and flesh-footed shearwater will be present in the EMBA and operational area and the flesh-footed shearwater may potentially forage in the EMBA and operational area.

Australian fairy tern

The PMST Reports identify foraging, feeding or related behaviour likely to occur within the EMBA and operational area.

The Australian fairy tern occurs along the coasts of New South Wales, Victoria, Tasmania, South Australia and Western Australia. The area of occupancy is estimated to be 1150 km2 . The total number of mature individuals of the Fairy Tern is estimated to be less than 5000 individuals (Birdlife International, 2008 in DSEWPaC, 2011b). Fairy terns utilise a variety of habitats including offshore, estuarine or lacustrine (lake) islands, wetlands, beaches and spits (DSEWPaC, 2011b).

Australian fairy terns hover and then dive into shallow waters in order to catch small baitfish; however, they may scavenge from shoals of feeding predatory fish (Higgins and Davies 1996; Dunlop 2018 in Commonwealth of Australia, 2019). Australian Fairy Terns feed almost entirely on fish in near-shore waters adjacent to nesting colonies and around island archipelagos (Higgins and Davis 1996 in Commonwealth of Australia, 2019).

Due to the distant from near-shore waters it is unlikely that the Australian fairy tern will be present and foraging in the EMBA and operational area.

Great skua

The great skua is a large migratory seabird distributed throughout all southern Australian waters (though not listed as migratory under the EPBC Act). This species breeds in summer on nested elevated grasslands or sheltered rocky areas on sub-Antarctic islands, with most adult birds leaving their colonies in winter. Great skuas feed on other seabirds, fish, molluscs and crustaceans, and may be present in the EMBA and operational area, though scarce, during winter (Flegg, 2002).

Orange-bellied parrot

Orange-bellied parrot (*Neophema chrysogaster*) (critically endangered) breeds in Tasmania during summer, migrates north across Bass Strait in autumn and spends winters on the mainland (DotEE, 2019a). Birds depart the mainland for Tasmania from September to November (Green, 1969).

The orange-bellied parrot is protected under the National Recovery Plan for the Orange-bellied Parrot (DELWP, 2016). The parrot's breeding habitat is restricted to south-west in Victoria, they mostly occur in sheltered coastal habitats, such as bays, lagoons and estuaries. The orange bellied parrot may overfly the EMBA and operational area as it migrates from Tasmania to Victoria.

Appendix B.3.4.2 Fish

Fish species present in the EMBA and operational area are either pelagic (living in the water column), or demersal (benthic) fish. Fish species inhabiting the region are largely cool temperate species, common within the South Eastern Marine Region. The PMST Reports identified 14 listed fish species (11 of which are seahorses, seadragons and pipefish) that may potentially occur in the EMBA and operational area. Table B-10-3 details the listed fish species identified in the EMBA and operational area PMST Reports.

The EMBA overlaps a distribution BIA for the white shark.

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. 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 EMBA and operational area in low numbers.

Table B-10-3: Listed fish species identified in the EMBA and operational area PMST Reports

Common name	Species name	EPBC Act status			Likely presence
		Listed Threatened	Listed Migratory	Listed marine	
Sharks					
Porbeagle, mackerel shark	*Lamna nasus*	-	M	-	SHL
Shortfin mako	*Isurus oxyrinchus*	-	M	-	SHL
White shark	*Carcharodon carcharias*	V	M	-	SHK
Syngnathids					
Big-belly seahorse	*Hippocampus abdominalis*	-	-	L	SHM
Bullneck seahorse	*Hippocampus minotaur*			L	SHM
Common seadragon	*Phyllopteryx taeniolatus*	-	-	L	SHM
Leafy seadragon	*Phycodurus eques*	-	-	L	SHM
Port Phillip pipefish	*Vanacampus phillipi*	-	-	L	SHM
Red pipefish	*Notiocampus ruber*	-	-	L	SHM
Robust pipehorse	*Solegnathus robustus*	-	-	L	SHM
Sawtooth pipefish	*Maroubra perserrata*	-	-	L	SHM
Spiny pipehorse	*Solegnathus spinosissimus*	-	-	L	SHM
Trawl pipefish	*Kimblaeus bassensis*	-	-	L	SHM
Upside-down pipefish	*Heraldia nocturna*	-	-	L	SHM

Listed Threatened
V: Vulnerable
Listed Migratory
M: Migratory
Listed Marine
L: Listed

Likely Presence
SHM: Species or species habitat may occur within area.
SHL: Species or species habitat likely to occur within area.
SHK: Species or species habitat known to occur within area.

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). Due to their widespread distribution in Australian waters, shortfin mako sharks are likely to be present in the EMBA and operational area 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, 2019p). 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).

The distribution BIA for the white shark intersects the EMBA and operational area, therefore it is likely that white sharks will be present in these areas.

Syngnathids

All the marine ray-finned fish species identified in the PMST Reports are syngnathids, which includes seahorses and their relatives (sea dragon, pipehorse and pipefish). Most of these fish species are found in water depths less than 50m.

Of the 11 species of syngnathids identified, only one (*Hippocampus abdominalis*, big-belly seahorse) has a documented species 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 EMBA and operational area are widely distributed throughout southern, south-eastern and south-western Australian waters. Therefore, it is unlikely that these species will be present in the EMBA and operational as water depths are greater than 50 m.

Appendix B.3.4.3 Cetaceans

The PMST Reports identified 13 cetaceans that potentially occur in the EMBA and operational area; nine whales and four dolphins (Table B-10-4). Details of these cetaceans are discussed further in this section.

The EMBA overlaps a foraging BIA for the pygmy blue whale and a distribution BIA for the southern right whale.

The PMST reports identified foraging behaviour likely for the fin and sei whale and foraging behaviour may occur for the pygmy right whale.

Table B-10-4: Listed cetacean species identified in the EMBA and operational area PMST Reports

Common name	Species name	EPBC Act status			Likely presence
		Listed threatened	Listed migratory	Listed marine	
Whales					
Blue whale	*Balaenoptera musculus*	E	M	L	SHL
False killer whale	*Pseudorca crassidens*	-	-	L	SHL
Fin whale	*Balaenoptera physalus*	V	M	L	FL
Humpback whale	*Megaptera novaeangliae*	V	M	L	SHK
Killer whale, orca	*Orcinus orca*	-	M	L	SHL
Minke whale	*Balaenoptera acutorostrata*	-	-	L	SHM
Pygmy right whale	*Caperea marginata*	-	M	L	FM
Sei whale	*Balaenoptera borealis*	V	M	L	FL
Southern right whale	*Balaena glacialis australis*	E	M	L	SHK
Dolphins					
Bottlenose dolphin	*Tursiops truncates*	-	-	L	SHM
Common dolphin	*Delphinus delphis*	-	-	L	SHM
Dusky dolphin	*Lagenorhynchus obscures*	-	M	L	SHM
Risso's dolphin	*Grampus griseus*	-	-	L	SHM

Listed Threatened
E: Endangered
V: Vulnerable
Listed Migratory
M: Migratory
Listed Marine
L: Listed

Likely Presence
SHM: Species or species habitat may occur within area.
SHL: Species or species habitat likely to occur within area.
SHK: Species or species habitat known to occur within area.
FK: Foraging, feeding or related behaviour known to occur within area.
FL: Foraging, feeding or related behaviour likely to occur within area.
FM: Foraging, feeding or related behaviour may to occur within area.

Whales

Blue whale

The blue whale (*Balaenoptera musculus*) is currently listed as an endangered species under the EPBC Act. 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*). The pygmy blue whale has uncertainty in the number's pre-exploitation, and their current numbers are not known. 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, 2015a).

The recovery plan (Commonwealth of Australia, 2015) recognises three overlapping populations:

- Antarctic blue whale population (*Balaenoptera musculus intermedia*) are those blue whales occupying or passing through Australian waters that feed on krill predominantly if not exclusively in Antarctic waters.
- Indo-Australian pygmy blue whales (*B. musculus brevicauda*) are those pygmy blue whales occupying or passing through waters from Indonesia to western and southern Australia and are not generally found in Antarctic waters and appear to feed in more temperate waters.
- Tasman-Pacific pygmy blue whales (*B. musculus brevicauda*) are those pygmy blue whales generally considered to be occupying or passing through waters in southeast Australia and the Pacific Ocean and are not generally found in Antarctic waters and appear to feed in more temperate waters.

The Antarctic subspecies has been acoustically detected off the west and north coasts of Tasmania predominately from May to December. Based on the seasonality of recordings, these areas possibly form part of their migratory route, breeding habitat or a combination of the two (Commonwealth of Australia, 2015).

Indo-Australian pygmy blue whales inhabit Australian waters as far north as Scott Reef, the Kimberley region and west of the Pilbara and as far south as southwest Australia across to the Great Australian Bight and the Bonney Upwelling, and to waters as far east off Tasmania (Figure B-10-3). They have known feeding grounds in the Perth Canyon off Western Australia and the Bonney Upwelling System and adjacent waters off Victoria, South Australia and Tasmania. These areas are utilised from November to May. They migrate between these feeding aggregation areas, northwards and southwards along the west coast of Australia, to breeding grounds that are likely to include Indonesia.

The Tasman-Pacific pygmy blue whale is the sub-species that migrates through Bass Strait, found in waters north of 55°S (Commonwealth of Australia, 2015). Blue whales are a highly mobile species that feed on krill (euphausids, *Nyctiphane australis*). A foraging BIA for the pygmy blue whale covers most of Bass Strait, including the EMBA and operational, with known foraging areas (abundant food source/annual high use area) occurring off the south-west Victorian coast (Figure B-10-3 and Figure B-10-4).

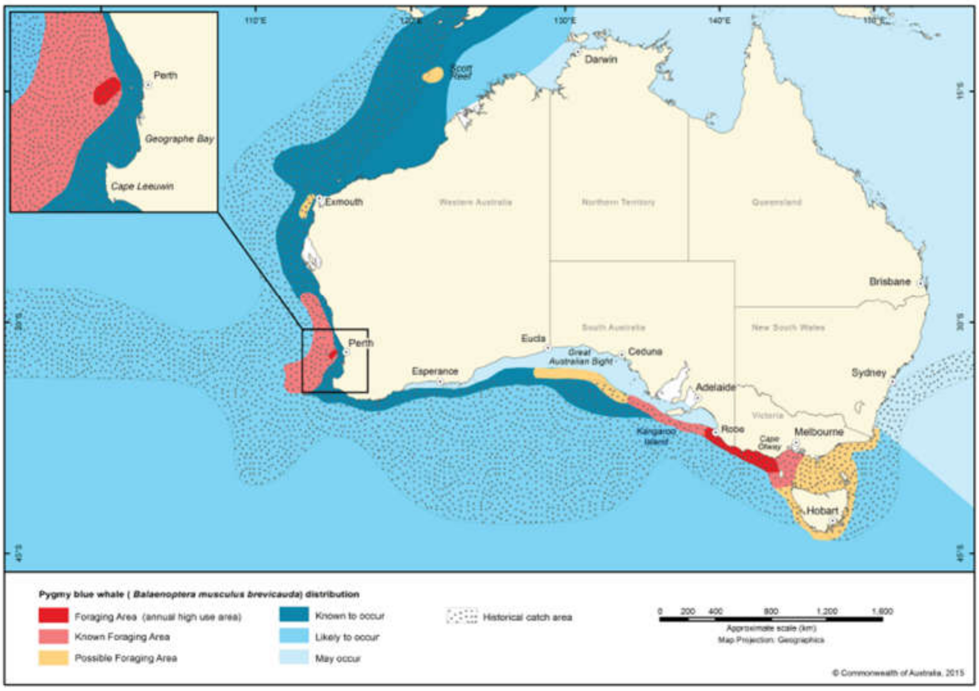
The time and location of the appearance of blue whales in the South-east Marine Region generally coincides with the upwelling of cold water in summer and autumn along the southeast South Australian and southwest Victoria coast (the Bonney Upwelling) and the associated aggregations of krill that they feed on (Commonwealth of Australia, 2015; Gill and Morrice, 2003). This is a key feeding area for the species. 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 sub-tropical high-pressure cell creates favourable winds for upwelling. Pygmy blue whales predominately occupy the western area of the Bonney Upwelling from November to December, and then move southeast during January to April, though the within-season distribution trends in Bass Strait are unknown (DoE, 2015d).

The recovery plan (Commonwealth of Australia, 2015) states that migratory routes for pygmy blue whales off the east coast of Australia are unknown. However, blue whale migration patterns are thought to be like those of the humpback whale, with the species feeding in mid-to high-latitudes (south of Australia) during the summer months and moving to temperate/tropical waters in the winter for breeding and calving. Pygmy blue whale migration is oceanic and no specific migration routes have been identified in the Australasian region (Commonwealth of Australia, 2015).

The Tasman-Pacific pygmy blue whale, which only occupies waters north of 55°S, potentially migrates through Bass Strait although there is little information about this as migratory route for pygmy blue whales off the east coast of Australia are unknown (Commonwealth of Australia, 2015).

A sea noise logger was deployed near to the Yolla-A platform from April to October 2004 during the facility's construction period. The presence of several whale species was evident in the recordings although the proximity of the whales could not be determined; blue whales were mainly evident in winter; and in late autumn pygmy blue whales passed through Bass Strait.

It is likely that blue whales will be present in the EMBA and operational area. The likelihood and extent are dependent on broad scale environmental factors affecting the abundance and distribution of blue whale feeding resources.



Foraging Area (Annual high use area)	Blue whales are regularly observed feeding on a seasonal basis
Known Foraging Area	Known foraging occurs in these areas but is highly variable both between and within seasons
Possible Foraging Area	Evidence for feeding is based on limited direct observations or through indirect evidence, such as occurrence of krill in close proximity of whales, or satellite tagged whales showing circling tracks. Blue whales travel through on a seasonal basis, possibly as part of their migratory route

Known to occur	Blue whales are known to occur based on direct observations, satellite tagged whales or based on acoustic detections
Likely to occur	Blue whales are likely to occur based on occasional observations in the area and nearby areas
May occur	Evidence for the presence of blue whales through strandings or rare observations
Historical catch area	Blue whales were caught during the whaling period based on whaling data

Figure B-10-3: Pygmy blue whale foraging areas around Australia (DotEE 2019b)

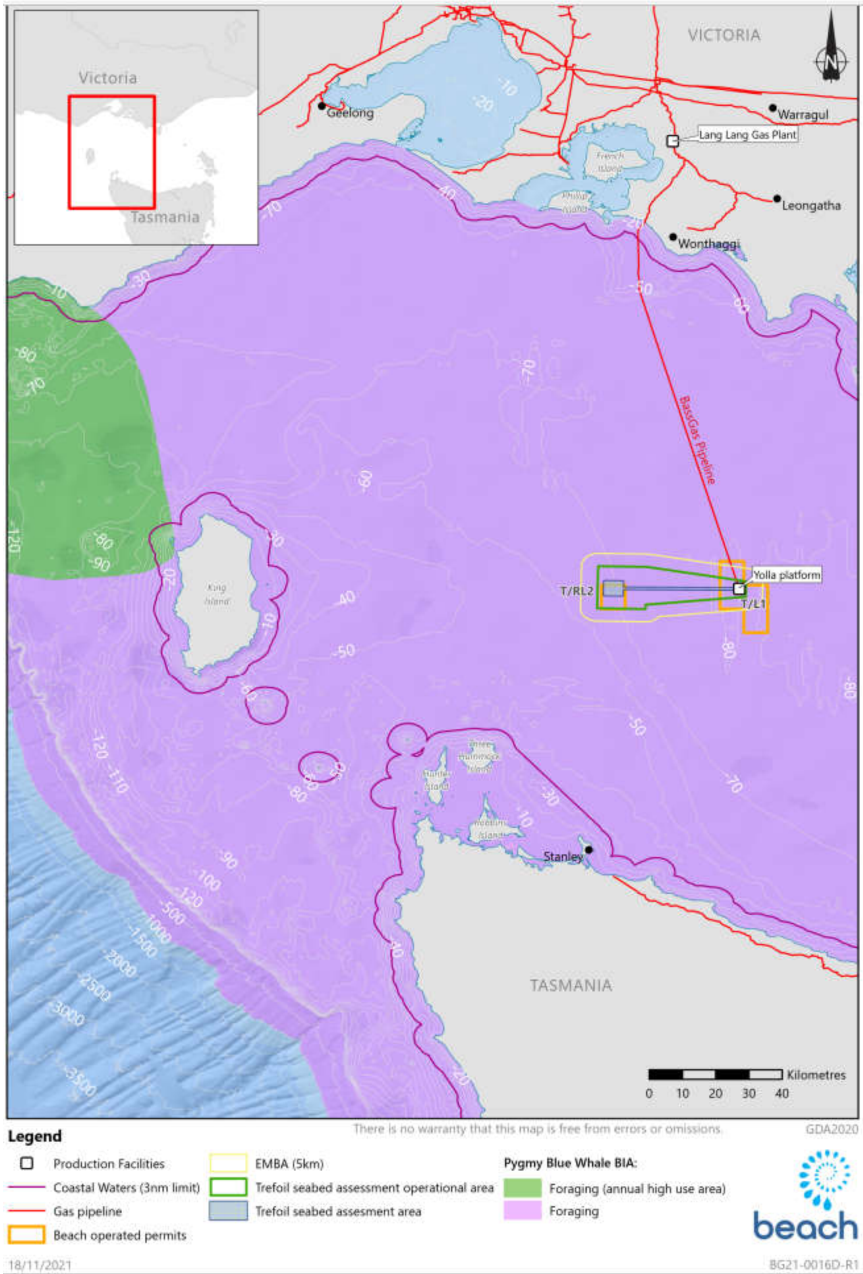


Figure B-10-4: Pygmy blue whale foraging BIA

False killer whale

False killer whale *(Pseudorca crassidens)* are highly gregarious, occurring in socially cohesive herds of about 20–50 animals (DotEE, 2019c). Large aggregations of between 100 to 800 individuals also occur, apparently representing temporary associations of several smaller herds that have congregated to exploit locally abundant prey (DotEE, 2019c).

False killer whales are found worldwide in deep tropical and temperate waters (DotEE, 2019c). They are distributed circumglobally between 45° S and 45° N, though do not show significant abundant anywhere (DotEE, 2019c). They are reported to prefer deep, offshore waters and sometimes deep coastal waters (DotEE, 2019c). They approach close to land only where the continental shelf is narrow, possibly attracted to zones of enhanced prey abundance along the continental slope (DotEE, 2019c).

There are no estimates of false killer whale population size, either globally or for Australia, so the proportion of the global population in Australian waters is unknown. Australian population abundance is thought to be low and likely that the total number of mature false killer whales within Australian waters is less than 10,000 (DotEE, 2019c).

Large-scale movements of false killer whales have been reported, however, genetic research is required to confirm whether distinct stocks exist within ocean basins. (DotEE, 2019c). The movement patterns of false killer whales off Australia are primarily based on stranding data. The trends in stranding's suggest there may be a seasonal movement inshore or along the continental shelf on the southern and south-eastern coasts between May and September (DotEE, 2019c). Mating and calving occur throughout the year, with no known seasonal pattern, and no calving areas are known for Australian waters (DotEE, 2019c).

Due to limited sightings and distribution data of within the South-eastern marine regions, it is difficult to determine likely presence. However, given no BIAs overlapping the EMBA or operational area, it is therefore likely that they would be uncommon in the EMBA and operational area.

Fin whale

The fin whale is currently listed as a vulnerable species under the EPBC Act. There is currently an Approved Conservation Advice for the fin whale that identifies threats and establishes actions for assisting the recovery of fin whales (TSSC, 2015a). 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.

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, however, there have been a few sightings of them feeding between November and 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).

Based on the fin whale is considered rare in Australian waters, the absence of a BIA in Australian waters and few sightings in Bass Strait it is considered unlikely that this species occurs within the EMBA and operational area.

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 (DotEE, 2019d). 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 EMBA. 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 (DotEE, 2019d). Feeding occurs where there is a high krill density, and during the migration this primarily occurs in Southern Ocean waters south of 55°S (DotEE, 2019d).

The recovery of humpback whale populations following whaling has been rapid. Under the EPBC Act an Approved Conservation Advice is in place for the recovery of humpback whales (TSSC, 2015b). 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.

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 humpback whale BIAs identified in the EMBA and operational area. Therefore, if present it is likely to be transient within the EMBA and operational area.

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 habitat of killer whales includes oceanic, pelagic and neritic (relatively shallow waters over the continental shelf) regions, in both warm and cold waters (DotEE, 2019e).

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, 2004; Mustoe, 2004).

The breeding season is variable, and the species moves seasonally to areas of food supply (Bannister et al., 1996; Morrice et al., 2004).

The killer whale has been observed within the region, however, there are no BIAs or known seal colonies in the EMBA and operational area. Therefore, it is unlikely to be present in significant numbers within the EMBA and operational area.

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 (DotEE, 2019f).

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).

The minke whale has been observed within the region, however, there are no BIAs in the EMBA and operational area. Therefore, it is unlikely to be present in significant numbers within the EMBA and operational area.

Pygmy right whale

Pygmy right whales (*Caperea marginate)* are a little-studied baleen whale species 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).

There are few confirmed sightings of pygmy right whales at sea (Reilly et al., 2008), with few or no records from eastern Victoria and no population estimates available for Australian waters. The largest reported group sighted (100+) occurred near Portland in June 2007 (Gill et al., 2008).

Based upon the lack of sightings off eastern Victoria and the absence of a BIA in Australian waters it is considered unlikely that this species occurs within the EMBA and operational area.

Sei whale

Sei whales are primarily found in deep water oceanic habitats and their distribution, abundance and latitudinal migrations are largely determined by seasonal feeding and breeding cycles (Horwood 2009 in TSSC, 2015d).

Sei whale global population is estimated to have declined by 80 % over the previous three generation period (TSSC, 2015d). Sei whales were the most commonly observed whales during Australian National Antarctic Research Expedition voyages in the 1960s and 1970s, with the majority recorded south of 60°S in the Southern Ocean (TSSC, 2015d).

These whales are thought to complete long annual seasonal migrations from subpolar summer feeding grounds to lower latitude winter breeding grounds (TSSC, 2015d); details of this migration and whether it involves the entire population are unknown.

In the Australian region, sei whales occur within Australian Antarctic Territory waters and Commonwealth waters, and have been infrequently recorded off Tasmania, New South Wales, Queensland, the Great Australian Bight, Northern Territory and Western Australia (TSSC, 2015d).

Sightings of sei whales within Australian waters includes areas such as the Bonney Upwelling off South Australia (TSSC, 2015d), where opportunistic feeding has been observed between November and May (TSSC, 2015d).

Based upon the species preference for offshore waters, the absence of a BIA for the species in Australia and the small number of sei whale sightings in southeast Australia, it is considered unlikely that this species occurs within the EMBA and operational area.

Southern right whale

The Southern right whale (*Eubalaena australis*) is listed as endangered under the EPBC Act because they have undergone a severe reduction in numbers as a result of commercial whaling (DotEE, 2019h). There is currently a Recovery Plan in place for the southern right whale that identifies threats and establishes actions for assisting the recovery of southern right whales (DSEWPaC, 2012) Southern right whales were hunted extensively with total number processed between 1770 and 1900 is conservatively estimated at about 150,000, of which 48,000-60,000 were taken in the 1830s alone. By the start of modern whaling at the beginning of the 20th century, the species was already rare. The southern hemispheric population in 1770 is estimated at 55,000-70,000 and is estimated to have been depleted to a low of about 300 animals by the 1920s.

Southern right whales are distributed in the southern hemisphere with a circumpolar distribution between latitudes of 16°S and at least 65°S. The species is pelagic in summer foraging in the open Southern Ocean (Bannister et al., 1996) between 40° and 65°S and migrates from the sub Antarctic to lower latitude coastal waters during winter to calve and mate (Bannister et al., 1996). Southern right males inhibit coastal inshore habitats to mate (Bannister, 1996; DSEWPaC, 2012).

Peak periods for mating in Australian coastal waters are from mid-July through August (DSEWPaC, 2012). 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).

As the EMBA overlaps a southern right whale distribution BIA this species may transit though the EMBA and operational area.

Dolphins

Bottlenose dolphin

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, 2019i). 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, 2019i). 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 EMBA and operational area. Therefore, it is unlikely to be present in significant numbers within the EMBA and operational area.

Common dolphin

The common dolphin (*Delphinus delphis*) is an abundant species, widely distributed from tropical to cool temperate waters, generally found in areas where surface-water temperatures are between 10°C and 20°C. Also, they are generally found further offshore than the bottlenose dolphin, although small groups may venture close to the coast. Stranding statistics indicate that common dolphins are active in Bass Strait at all times of the year, though less so in winter (DotEE, 2019j).

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, 2019j). Due to known stranding statistics and limited distribution data within the South-eastern marine regions, it is difficult to determine likely presence. However, given no BIAs overlapping the EMBA and operational area, it is unlikely to be present in significant numbers within the EMBA and operational area.

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 (DotEE, 2019k). 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). They are considered to be primarily an inshore species but can also be oceanic when cold currents are present (DotEE, 2019k).

Given the lack of sightings in Australian waters it is unlikely that significant numbers of dusky dolphins are present in the EMBA and operational area.

Risso's dolphin

Risso's dolphin (*Grampus griseus*) is a widely distributed species found in deep waters of the continental slope 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. Risso's dolphin has been observed in the region, however no BIAs have been identified in the EMBA and operational area. Therefore, it is unlikely to be present in significant numbers within the EMBA and operational area.

Appendix B 3.4.4 Pinnipeds

The PMST Reports identified two pinnipeds that potentially occur in the EMBA and operational area (Table B-10-5).

Table B-10-5: Listed pinniped species identified in the EMBA and operational area PMST Reports

Common name	Species name	EPBC Act status			Likely presence
		Listed threatened	Listed migratory	Listed marine	
Australian fur-seal	*Arctocephalus pusillus*	-	-	L	SHM
New Zealand fur-seal	*Arctocephalus forsteri*	-	-	L	SHM
Listed Marine L: Listed		Likely Presence SHM: Species or species habitat may occur within 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 New South Wales. 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, with a preferred breeding habitat being rocky islands with boulder or pebble beaches and gradually sloping rocky ledges. Australian fur-seals are present in the region all year, with breeding taking place during November and December.

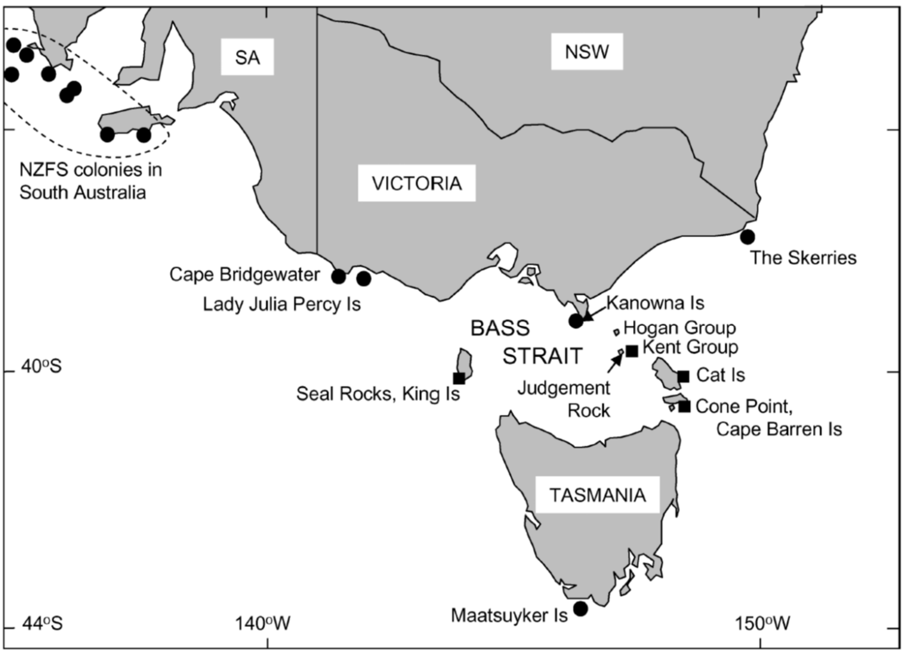
During the summer months, Australian fur-seals travel between northern Bass Strait islands and southern Tasmania waters following the Tasmanian east coast, however, lactating female fur-seals and some territorial males are restricted to foraging ranges within Bass Strait waters. Lactating female Australian 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 no breeding or haul out sites within the EMBA and operational area it is unlikely that Australian fur-seal would be present in the EMBA and operational area in significant numbers.

New Zealand fur-seal

New Zealand fur-seals (*Arctocephalus forsteri*) are found in the coastal waters and offshore islands of South and Western Australia, Victoria, New South Wales and New Zealand. Population studies for New Zealand fur-seals in Australia carried out in 1990 estimated an increasing population of about 35,000.

Figure B-10-5 illustrates the current and historic distribution of New Zealand fur-seal colonies (Kirkwood et al., 2009). Pups are born from mid-November to January, with most pups born in December (Goldsworthy, 2008). As there are no breeding or haul out sites within the EMBA operational area it is unlikely that New Zealand fur-seals would be present in the EMBA operational area in significant numbers.



Filled circles = early 1800s distribution. Filled squares = current distribution

Figure B-10-5: Locations of New Zealand fur-seal breeding colonies in the early 1800s and current colonies (Kirkwood et al., 2009)

Appendix B.3.4.5 Marine reptiles

The PMST Reports identified three marine turtle species that potentially occur in the EMBA and operational area (Table B-10-6). All three species of marine turtles are protected by the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017). There are no identified BIAs for these reptiles in the EMBA and operational area.

Table B-10-6: Listed turtle species identified in the PMST Report

Common name	Species name	EPBC Act status			Likely presence
		Listed threatened	Listed migratory	Listed marine	
Green turtle	*Chelonia mydas*	V	M	L	SHL
Leatherback turtle	*Dermochelys coriacea*	E	M	L	SHL
Loggerhead turtle	*Caretta caretta*	E	M	L	SHL
Listed Threatened E: Endangered V: Vulnerable Listed Migratory M: Migratory Listed Marine L: Listed		Likely Presence SHL: Species or species habitat likely to occur within area.			

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 New South Wales, 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, 2019l), therefore it is expected they would only be occasional visitors in the EMBA and operational area.

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, 2017).

No major nesting has been recorded in Australia, (DotEE, 2017), but they only nest in the tropics. The DotEE (2017) maps the leatherback turtles as having a known or likely range within Bass Strait and a migration pathway in southern waters. The EMBA and operational area are not a critical habitat for the species; it may occur in low numbers during migration, therefore expected to be only an occasional visitor in the EMBA and operational area.

Loggerhead turtle

The loggerhead turtle (*Caretta caretta*) are 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). 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). (DotEE, 2017) in tidal and subtidal habitats, reefs, seagrass beds and bays (DotEE, 2017). Loggerhead turtles forage in all coastal states but are uncommon in South Australia, Victoria and Tasmania (Commonwealth of Australia, 2017). Due to them being uncommon in Victorian waters and the depth they favour, it is unlikely they would be present within the EMBA and operational area.

Appendix B.4 Socio-economic and cultural environment

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

Appendix B.4.1 Shipping

The south-east marine region is one of the busiest shipping regions in Australia and Bass Strait is one of Australia's busiest shipping routes (Figure B-10-6). 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.

Agricultural products and woodchips are transported from the Port of Portland to receiving ports in the Gulf of St Vincent, South Australia, and through Bass Strait to Melbourne and Sydney (NOO, 2014). Bass Strait is also transited by commercial vessels that may not call into ports on the south coast. There are also numerous minor shipping routes in the area, such as those that service King Island. Grassy is the main shipping port on King Island and is the destination for a weekly shipping service from Melbourne and Devonport.

Appendix B.4.2 Petroleum exploration and production

In 2018, Victoria accounted for 11% of Australia's crude oil production, 11% of Australia's condensate production, 49% of Australia's LPG production and 10% of Australia's conventional gas production (APPEA, 2019). Production has been trending down since it peaked in 2000.

The Beach Yolla platform is within the EMBA and operational area.

No other petroleum production activities within the EMBA and operational area were identified from review of the NOPSEMA website and engagement with other oil and gas exploration companies.

Appendix B.4.3 Tourism

Marine-based tourism and recreation in Bass Strait is primarily associated with recreational fishing and boating. Seaside towns are the primary destinations that attract tourists and holidaymakers to the region.
Consultation has identified that the key areas of tourism are marine-based tourism and recreation in Bass Strait that is primarily associated with recreational fishing and boating.

It is estimated that the tourism industry in Bass Coast has generated approximately $245 million and supports approximately 1,426 jobs in the region (Remplan, 2019).

Appendix B.4.4 Recreational diving

Recreational diving is a popular activity with a diverse range of sites in around the Victorian and Tasmanian coast. Due to the preferred depth recreational divers use (<60 m) and distance offshore recreational divers is unlikely to occur in the EMBA and operational area.

Appendix B.4.5 Recreational fishing

Recreational fishing is popular in Victoria and is largely centred within Port Phillip Bay and Western Port, although beach and boat-based fishing occurs along much of the Victorian coastline. Recreational fishing is unlikely to occur in the EMBA and operational area due to the distance offshore.

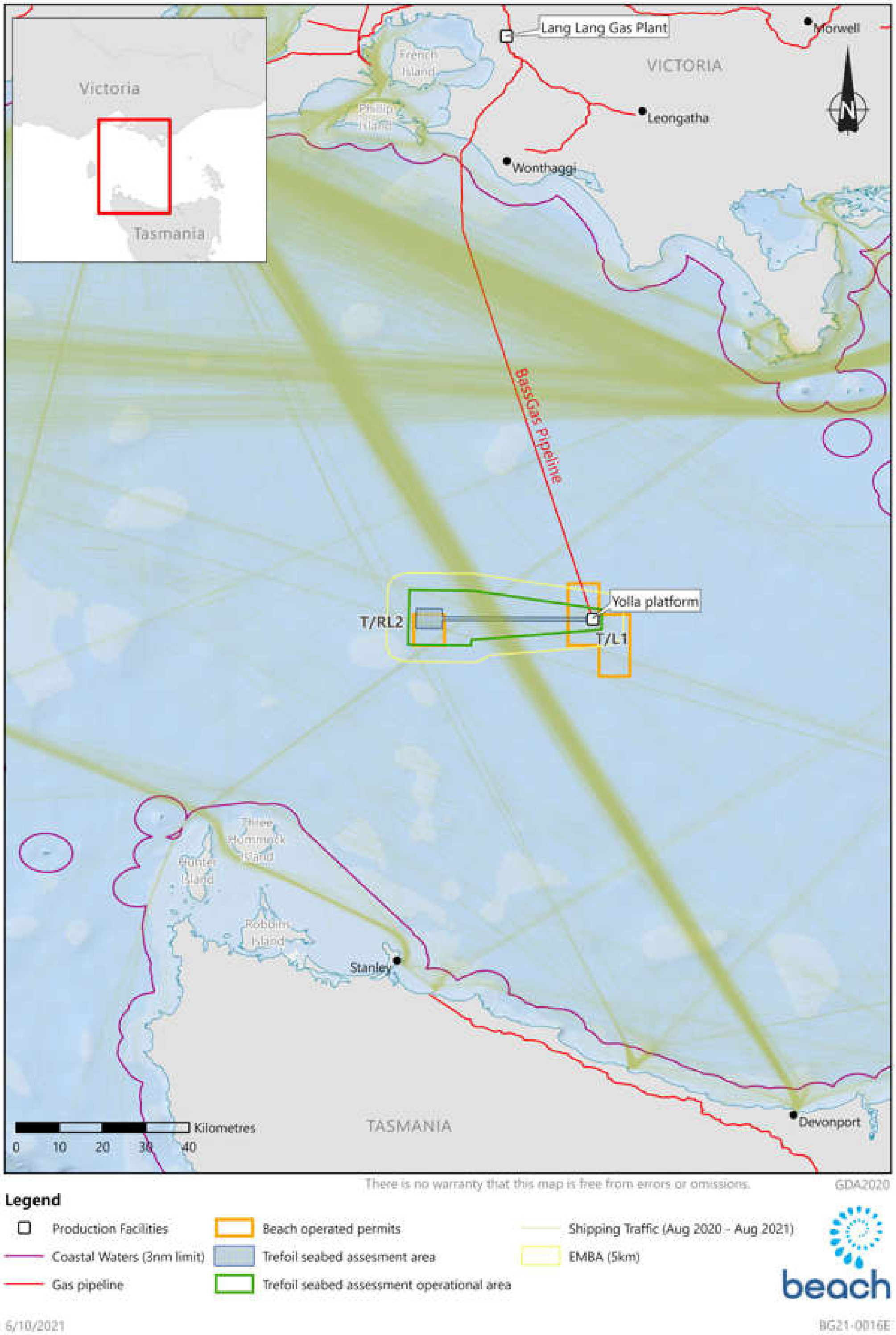


Figure B-10-6: Shipping lanes within the EMBA and operational area

Appendix B.4.6 Commonwealth and State managed fisheries

A review of the AFMA website identified that the following Commonwealth managed fisheries overlap the EMBA and operational area:

- Bass Strait Central Zone Scallop Fishery

- Eastern Tuna and Billfish Fishery
- Skipjack Tuna Fishery
- Small Pelagic Fishery
- Southern Bluefin Tuna Fishery
- Southern and Eastern Scalefish and Shark Fishery
- Southern Squid Jig Fishery.

Of these fisheries, the EMBA overlaps the following fisheries where there is catch effort based on ABARES reports from 2014-2019 (Table B-10-7):

- Southern and Eastern Scalefish and Shark Fishery
  - Trawl sector – Danish seine only
  - Shark gillnet and shark hook sectors
- Southern Squid Jig Fishery.

Information relating to the target species, fishing locations, landed catch, value and other relevant aspects of each fishery is included in Table B-10-7.

Engagement with AFMA was undertaken in relation to providing licensing information for any Commonwealth fishers who are active within the operational area (See Stakeholder record AFMA_10). AFMA provided the following combined records for two Beach areas the White Ibis and Trefoil seabed assessment area:

- 13 current licences:
  - Southern and Eastern Scalefish and Shark Fishery: 9 licensees
  - Bass Strait Scallop Fishery: 4 licensees
- 19 licences over the last 10 years:
  - Southern and Eastern Scalefish and Shark Fishery: 13 licensees
  - Bass Strait Scallop Fishery: 6 licensees

Based on data from ABARES reports from 2014-2019 it is likely that the Southern and Eastern Scalefish and Shark Fishery in the EMBA and operational area (Table B-10-7).

Based on data from ABARES reports from 2014-2019 it is unlikely that the Bass Strait Scallop Fishery is active in the EMBA and operational area and that these records are associated with the White Ibis area which is not part of this EP (Table B-10-7, Figure B-10-7, Figure B-10-8).

Through consultation with DPIPWE it has been identified that the only Tasmanian Fishery that may overlap the operational area is the Tasmanian Octopus Fishery (See Figure B-10-18).

Table B-10-7: Commonwealth managed fisheries within the EMBA and operational area

Fishery	Target species	Description	Fishing Effort
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. Fishing effort is concentrated around King and Flinders Islands. In 2017 and 2018 there were 12 active boats using towed dredges and the fishing season was from 19 July to 31 December. Total catch was 2,964 t ($6.7 million) in 2017 and 3,253 t in 2018 (value not available). Primary landing ports in Victoria are Apollo Bay, Melbourne, San Remo and Queenscliff and Devonport and Stanley in Tasmania. Fishing mortality: not subject to overfishing. Biomass: Not over fished. There has been no fishing effort in the EMBA and operational area based on ABARES data 2013 – 2018. See Figure B-10-7 and Figure B-10-8.	No
Eastern Tuna and Billfish Fishery	Swordfish, Yellowfin tuna (primary) Albacore tuna, Bigeye tuna, Broadbill, Striped marlin (secondary)	A longline and minor line fishery that operates in water depths > 200 m from Cape York to Victoria. The number of active vessels in the fishery has decreased in the past decade (from around 150 in 2002 to 37 in 2016), likely associated with a decline in economic conditions and the removal of vessels through the Securing our Fishing Future structural adjustment package in 2006–07 (Patterson et. al., 2019). Fishery effort is typically concentrated along the NSW coast and southern Queensland coast. No Victorian ports are used. Catch declined from 4,624 tonnes in 2017 to 4,046 tonnes in 2018. Swordfish and yellowfin tuna continue to be the main target species. Fishing mortality: Not subject to overfishing. Biomass: Not over fished. There has been no fishing effort within the EMBA and operational area based on ABARES data 2013 – 2018. See Figure B-10-9.	No
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
Small Pelagic Fishery (Western sub-area)	Jack mackerel (west) Blue mackerel (west) Redbait (west) Australian sardine	The Small Pelagic Fishery extends from 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 of the western sub-area was 17,750 tonnes in the 2018-19 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 and operational area based on ABARES data 2013 – 2018. See Figure B-10-10.	No
Southern Bluefin Tuna	Southern bluefin tuna	The fishery extends throughout all waters of the Australian Fishing Zone. The nearest fishing effort is concentrated along the NSW south coast around the 200 m depth contour. Fishing mortality: Not subject to overfishing. Biomass: Overfished. There has been no fishing effort in the EMBA and operational area based on ABARES data 2013 – 2018. See Figure B-10-11.	No

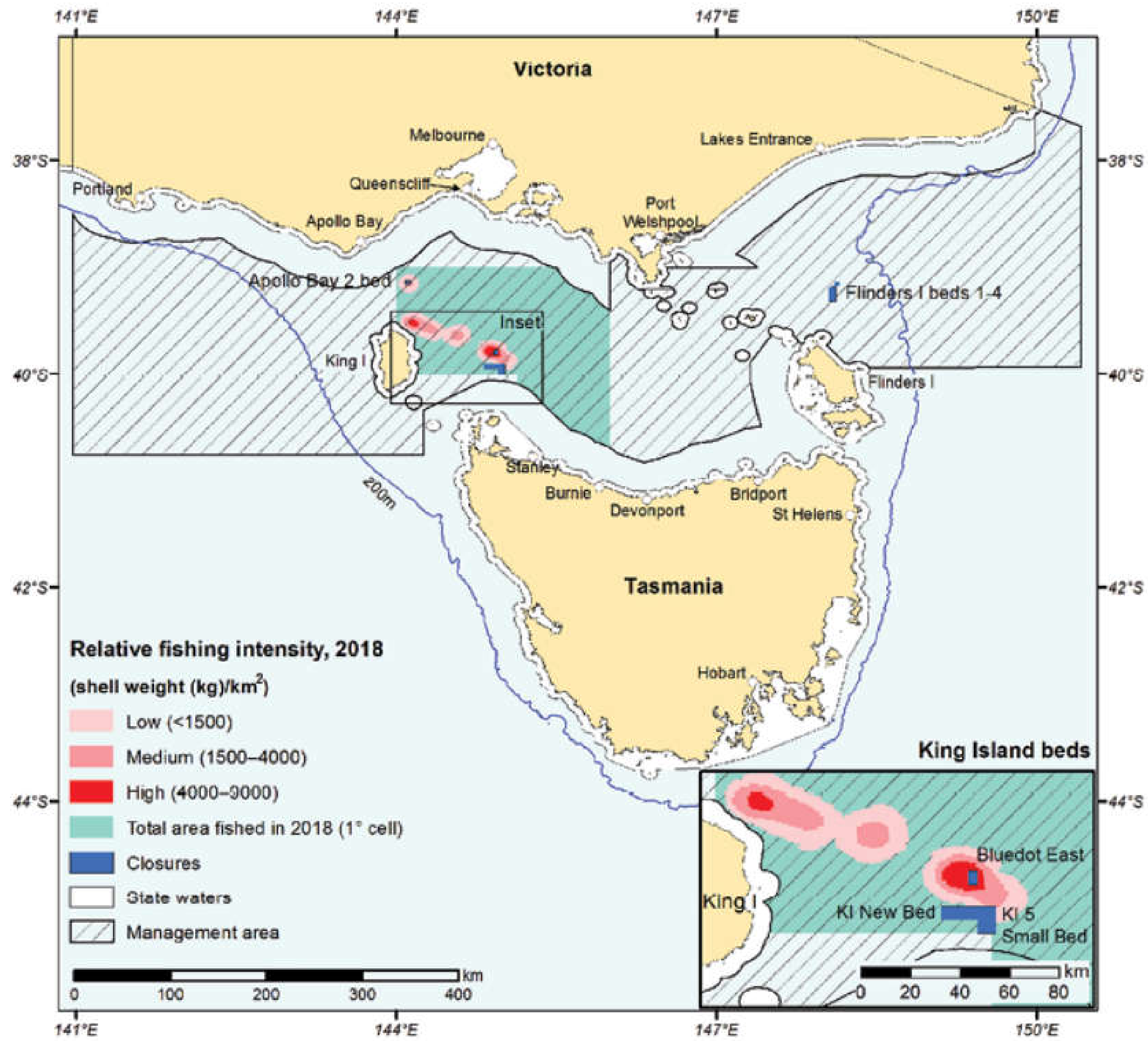
Fishery	Target species	Description	Fishing Effort
Southern and Eastern Scalefish and Shark Fishery (Commonwealth South East Trawl Sector, Scalefish Hook Sector and the Shark Hook and Shark Gillnet Sectors)	Blue grenadier Tiger flathead Pink ling Silver warehou Gummy shark Eastern school whiting	The Southern 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 South East Trawl Sector (Figure B-10-12 and Figure B-10-13), Scalefish Hook Sector (Figure B-10-14) and the Shark Hook (Figure B-10-15) and Shark Gillnet Sectors Figure B-10-16). In 2016-17, the fishery value was A$46.4 million. Fishing mortality: not subject to overfishing. Biomass: Not over fished. The EMBA and operational area overlap the Trawl Section Danish Seine and Shark Hook and Shark Gillnet Sectors where there is catch effort based on ABARES data 2013 – 2018.	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. In 2017 there were 6 active vessels and in 2018 there were 9 active vessels. In 2017 the catch of 828 tonnes was worth A$2.24 million and in 2018 the catch of 1,649 tonnes was worth $5.26 million. Squid jigging is the fishing method used, mainly at night time and in water depths of 60 to 120 m. AFMA licence data did not identify any squid licenced fishers that fish in the EMBA and operational area. There is potentially fishing effort in the EMBA and operational area based on ABARES data 2013 – 2018 (Figure B-10-17).	Yes

Data/information sources: Patterson et al. 2019

Table B-10-8: State managed fisheries within the EMBA and operational area

Fishery	Target species	Description	Fishing Effort
Tasmanian Octopus Fishery	Octopus	The Tasmanian Octopus Fishery (TOF) operates off the north coast of Tasmania and in the Bass Strait, primarily targeting Pale Octops (Octopus pallidus), with Maori Octopus (Macroctopus maorum) and Gloomy Octopus (Octopus tetricus) landed as by-product. The fishery remains a sole operator fishery with the same operator since commencement in 1980 with two vessels. The 2019/20 fishing season catch exceeded 100 t, and almost all of the catch (90%) occurred in only two fishing blocks east of King Island. Such a high local concentration of effort and catch is unlikely to be sustainable and might indicate a lack of productivity elsewhere. However, with only two vessels in operation, fleet behaviour is likely to be influenced also by individual decisions that might be independent of catch rates. Biomass: Depleting. Some fishing may occur in the EMBA and operational based on catch data 2019/2020. See Figure B-10-18	Yes

Data/information sources: Krueck et al. 2021



Source: Patterson et al. (2019)

Figure B-10-7: Jurisdiction of and fishing intensity in the Commonwealth Bass Strait Central Zone Scallop Fishery

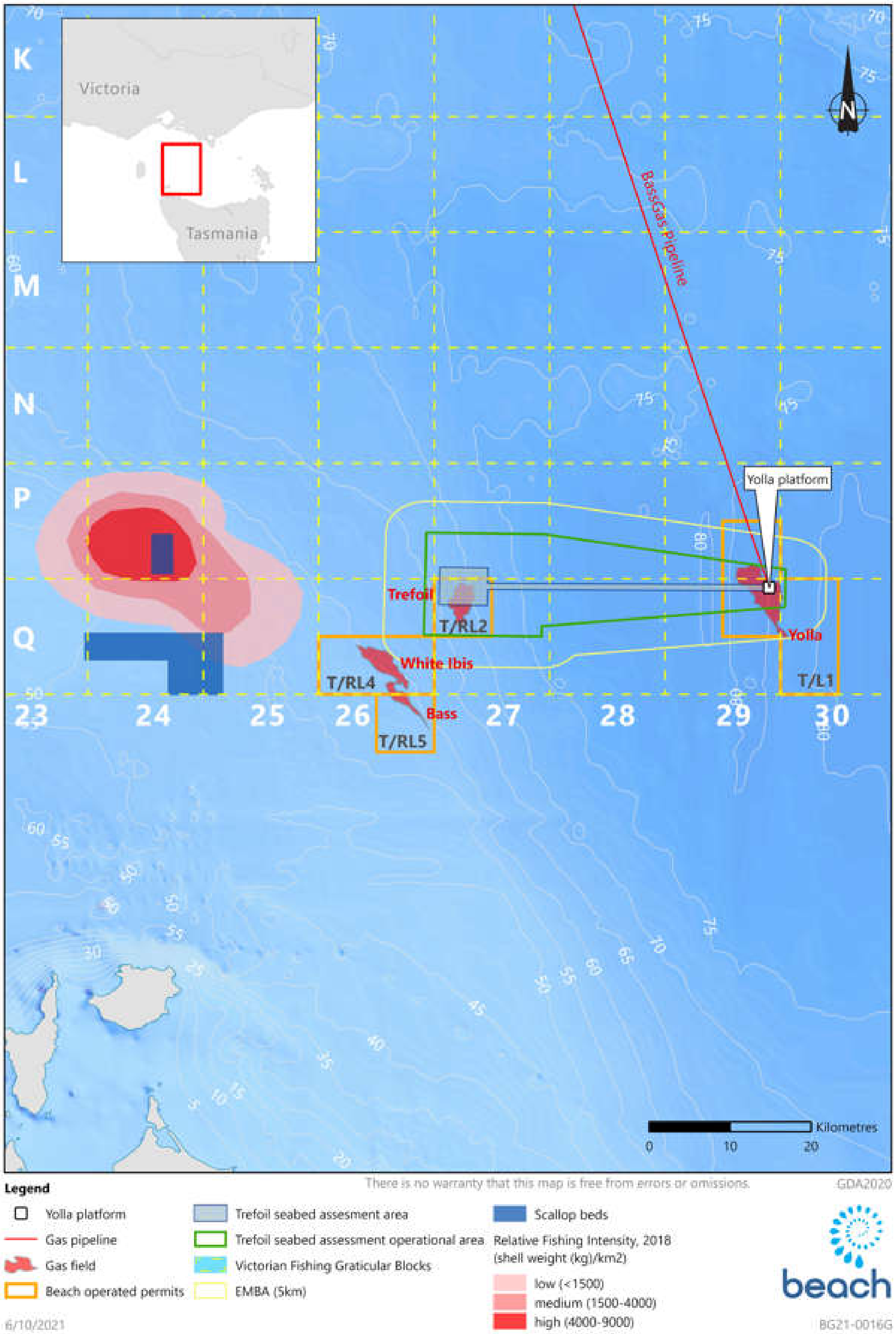
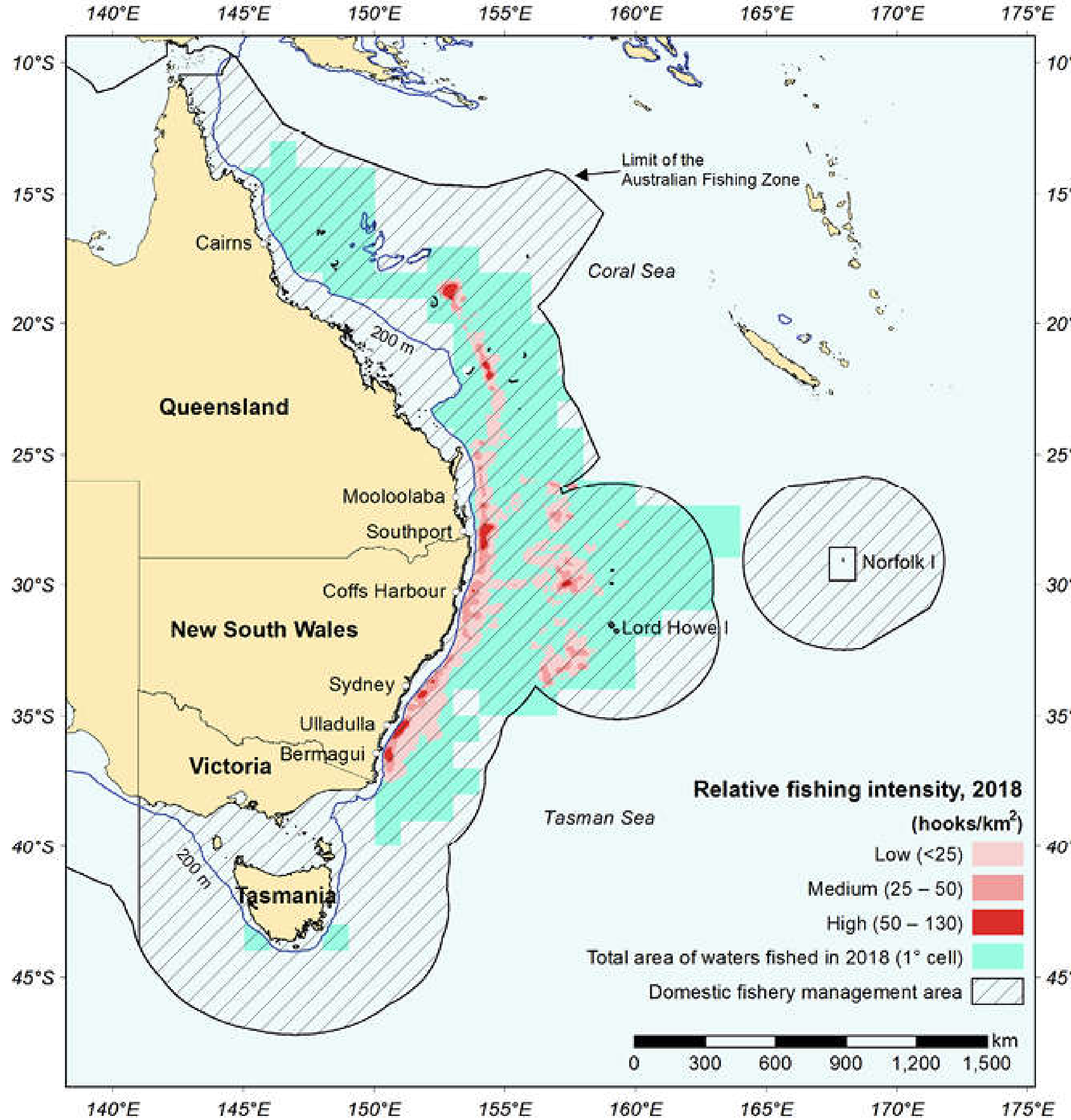
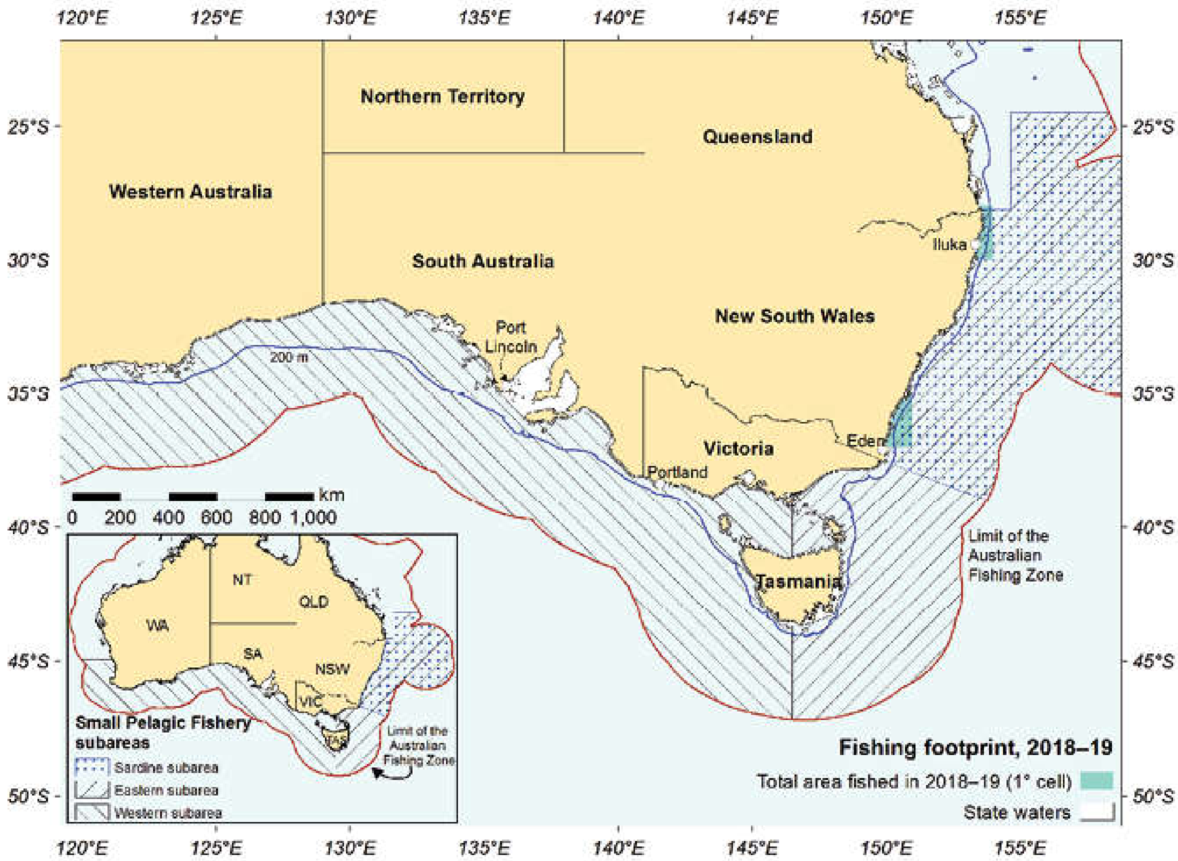


Figure B-10-8: Bass Strait Central Zone Scallop Fishery with Trefoil EMBA and operational area



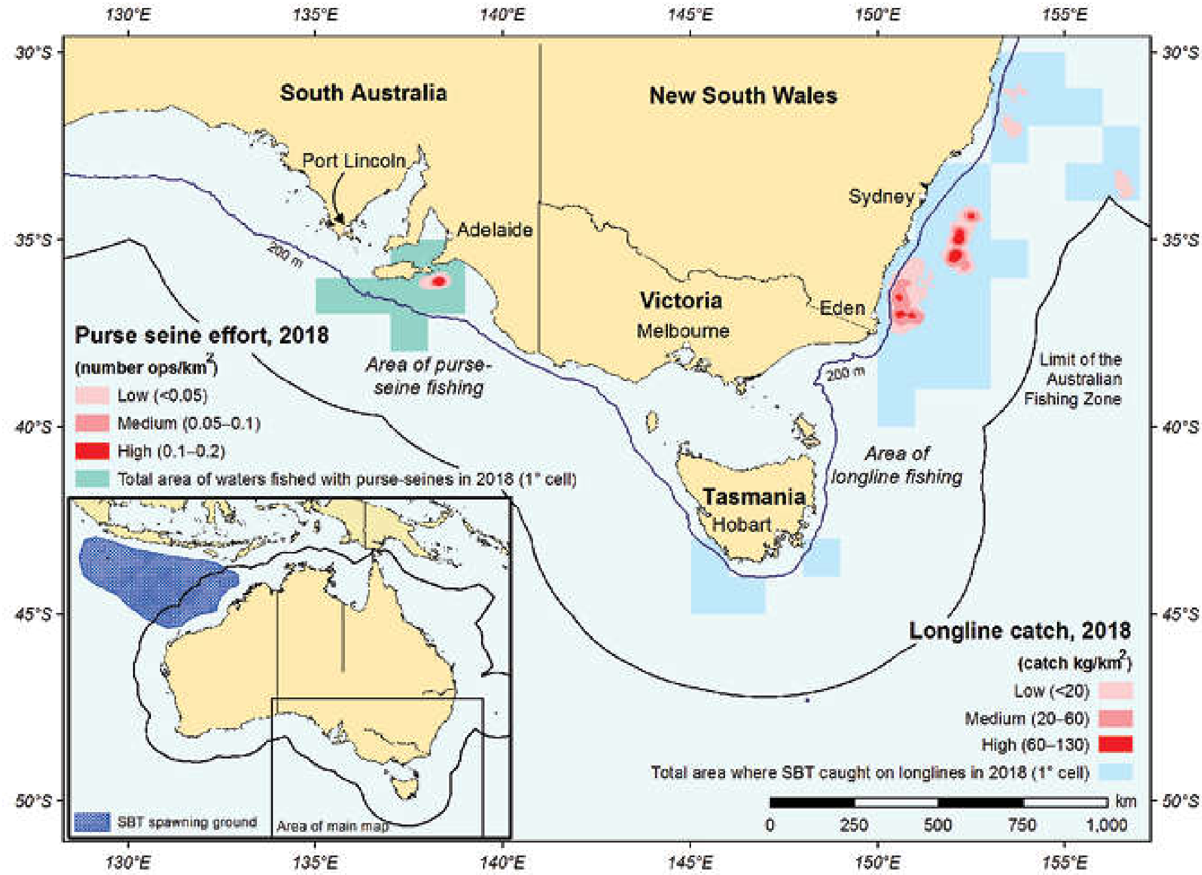
Source: Patterson et al. (2019)

Figure B-10-9: Jurisdiction of and fishing intensity in the Commonwealth Eastern Tuna and Billfish Fishery



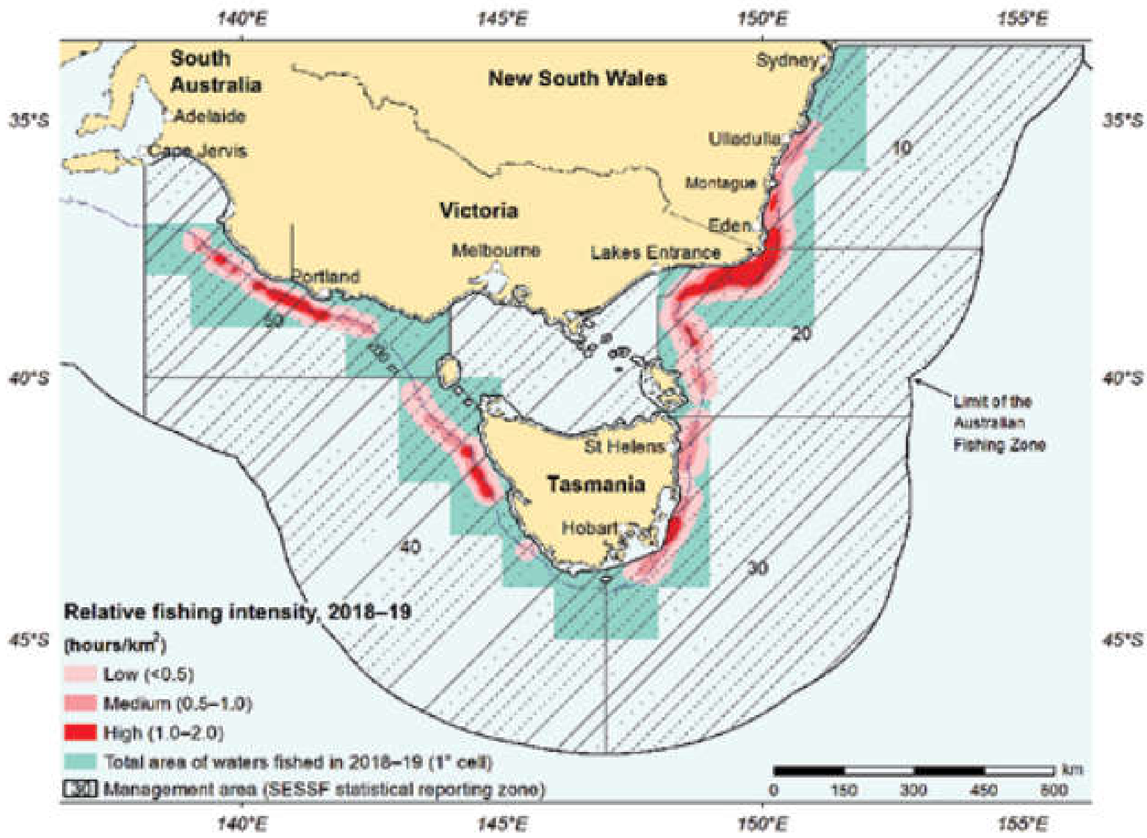
Source: Patterson et al. (2019)

Figure B-10-10: Jurisdiction of and fishing intensity in the Commonwealth Small Pelagic Fishery



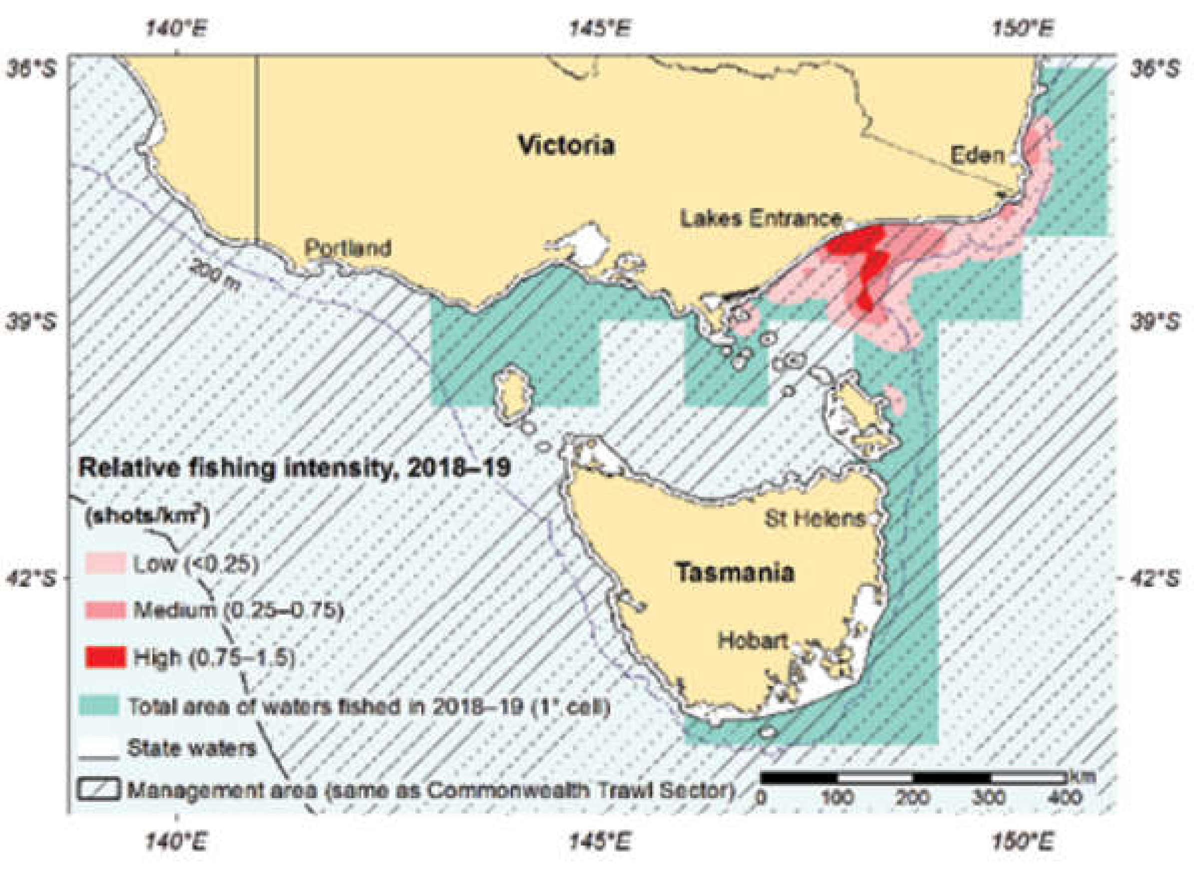
Source: Patterson et al. (2019)

Figure B-10-11: Jurisdiction of and fishing intensity in the Commonwealth Southern Bluefin Tuna Fishery



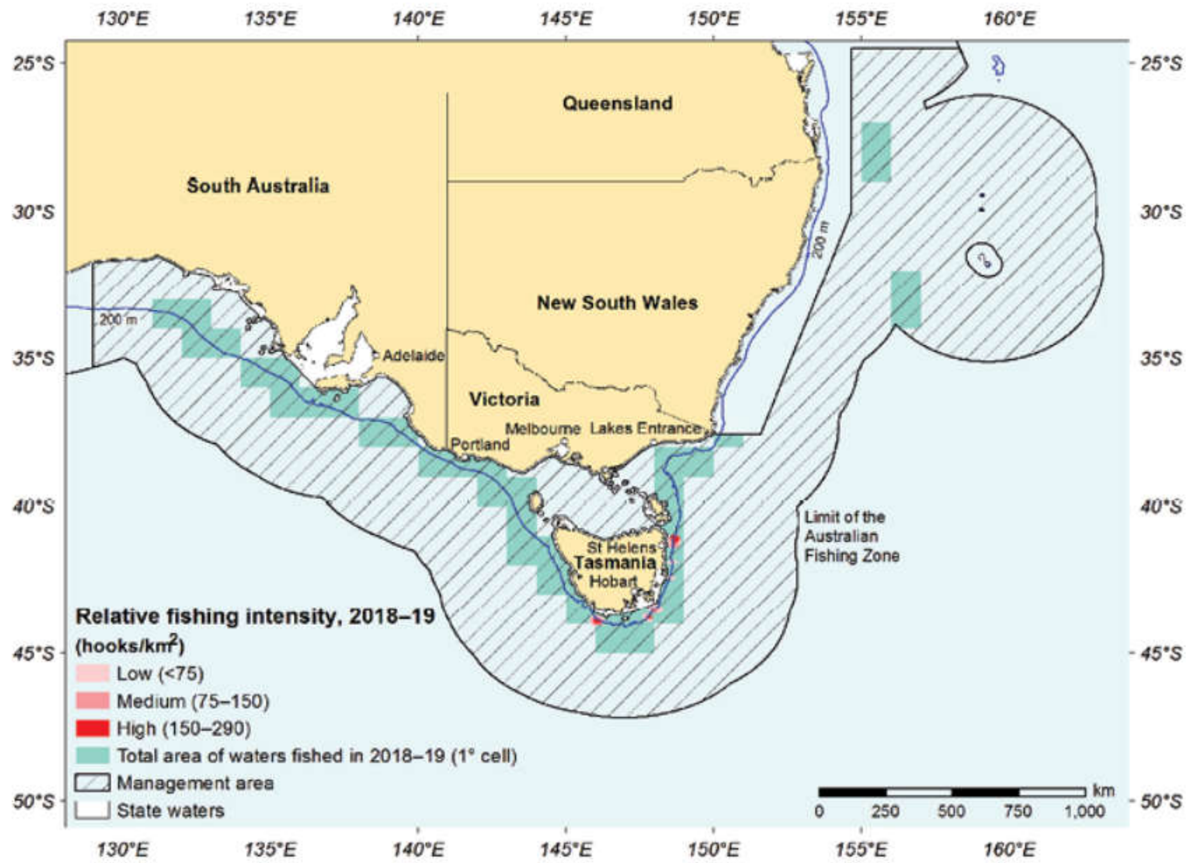
Source: Patterson et al. (2019)

Figure B-10-12: Jurisdiction of and fishing intensity in the Commonwealth SESSF – Commonwealth Trawl Sector



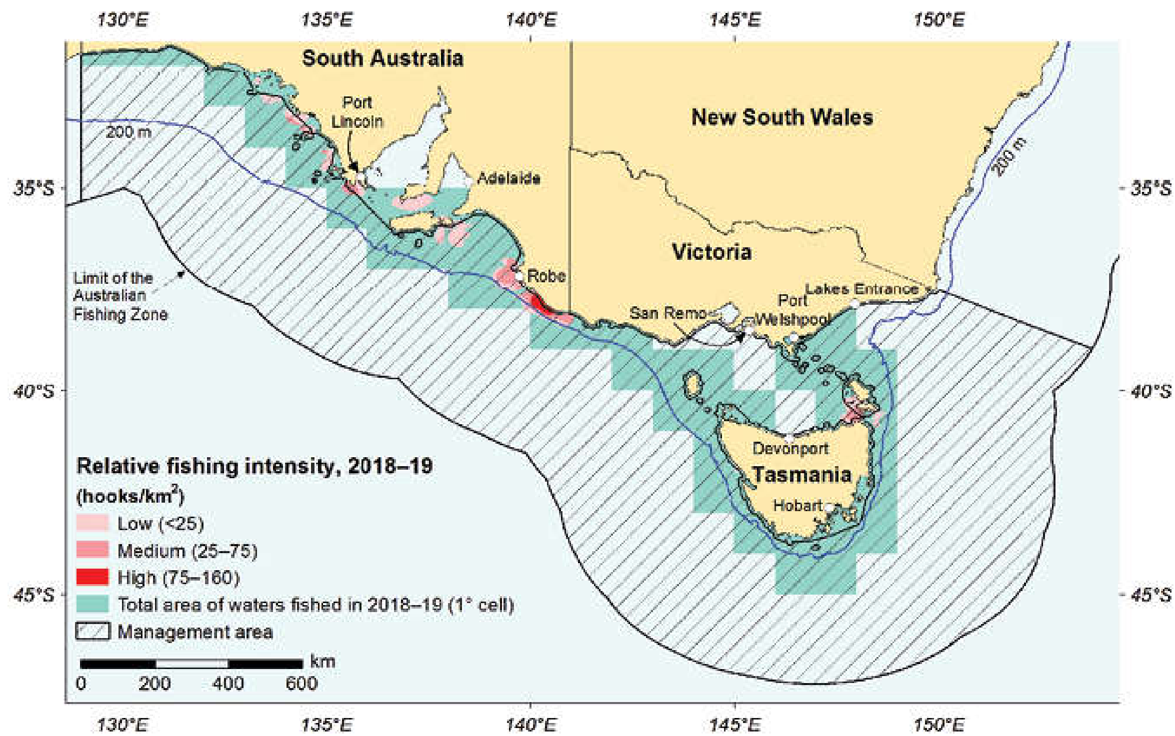
Source: Patterson et al. (2019)

Figure B-10-13: Jurisdiction of and fishing intensity in the Commonwealth SESSF – Commonwealth Trawl Sector Danish-seine operations



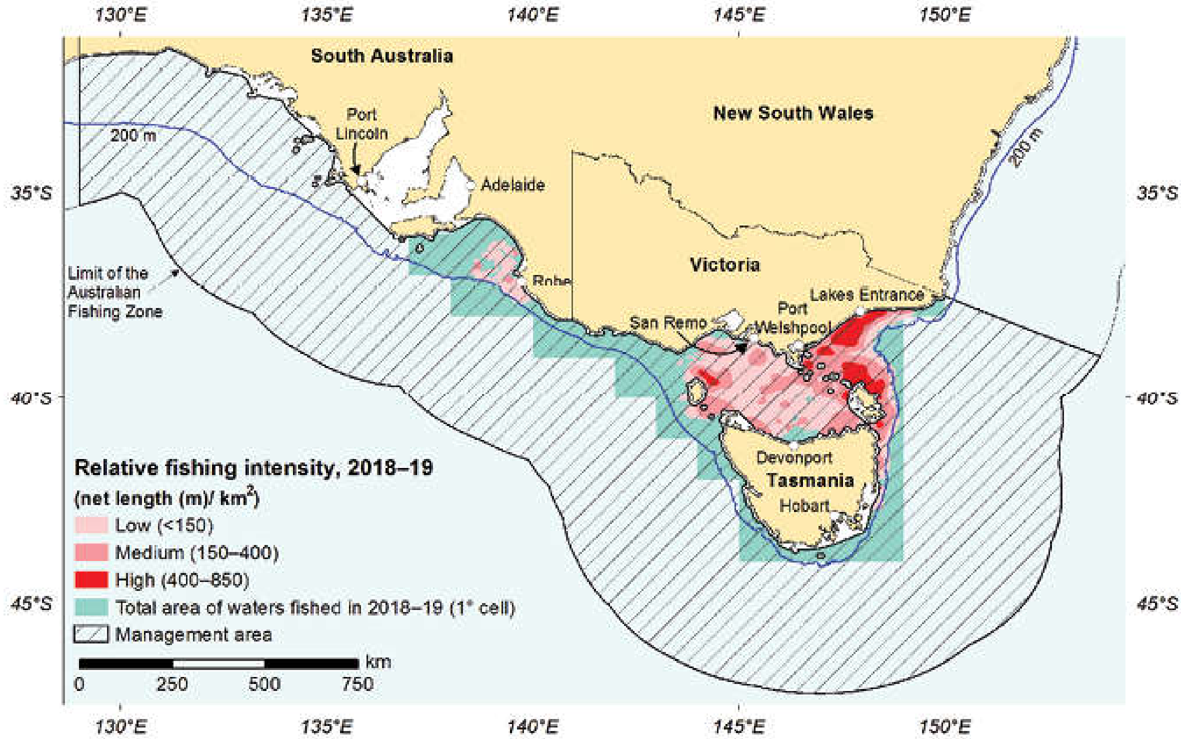
Source: Patterson et al. (2019)

Figure B-10-14: Jurisdiction of and fishing intensity in the Commonwealth SESSF – Scalefish Hook Sector



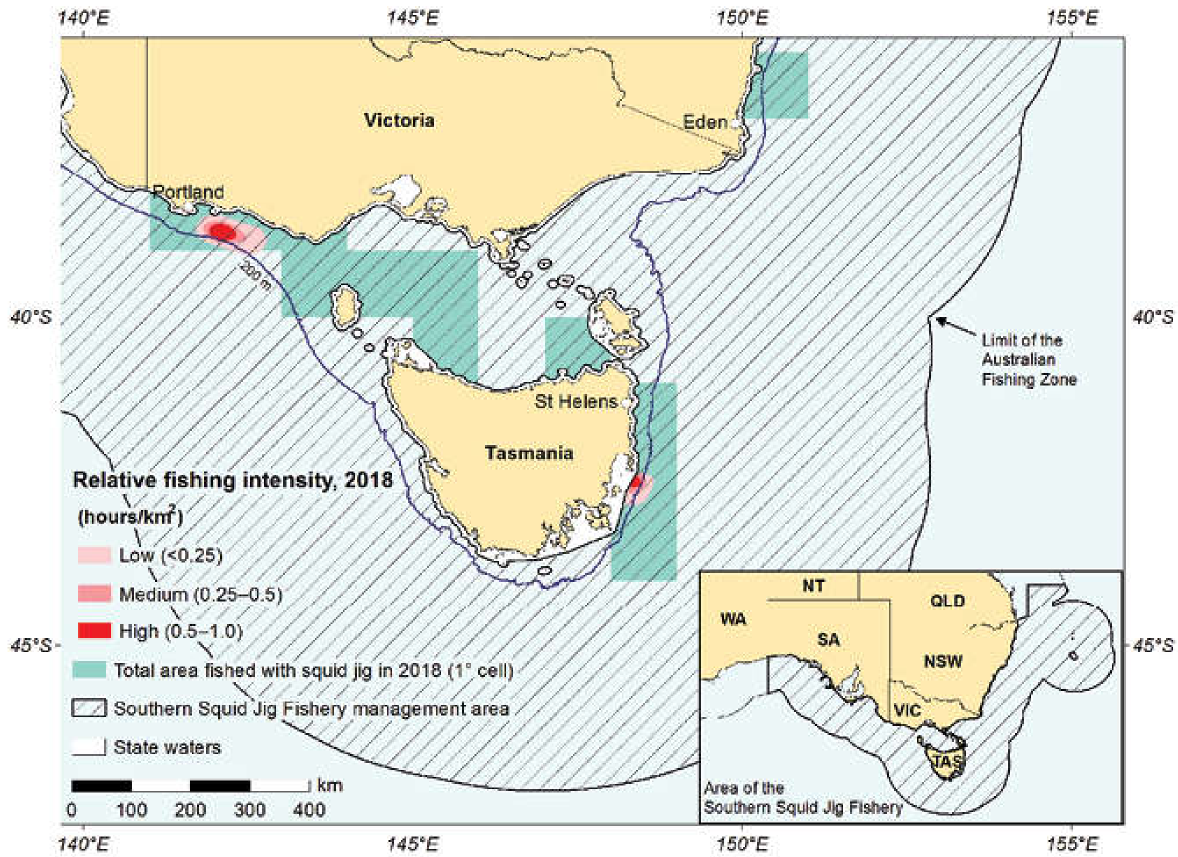
Source: Patterson et al. (2019)

Figure B-10-15: Jurisdiction of and fishing intensity in the Commonwealth SESSF – Shark Hook Sector



Source: Patterson et al. (2019)

Figure B-10-16: Jurisdiction of and fishing intensity in the Commonwealth SESSF – Shark Gillnet Sector



Source: Patterson et al. (2019)

Figure B-10-17: Jurisdiction of and fishing intensity in the Commonwealth Southern Squid Jig Fishery

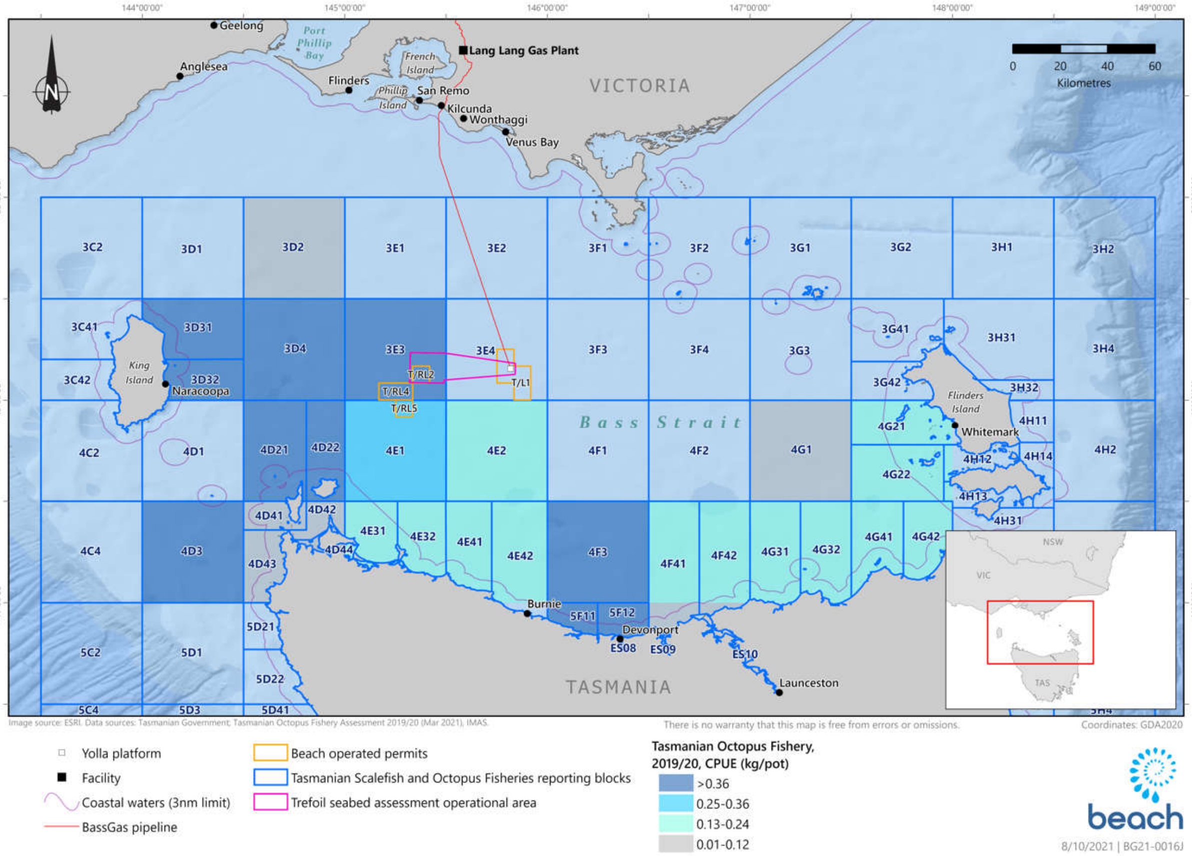


Figure B-10-18: Tasmanian Octopus Fishery

Appendix B.4.7 Subsea Cables

The EMBA and operational area overlap the buried Telstra Bass Strait 2 subsea cable (Figure B-10-19). Contact has been made with Telstra and the coordinates of the location of the cable have obtained (Stakeholder Record TELS_02).

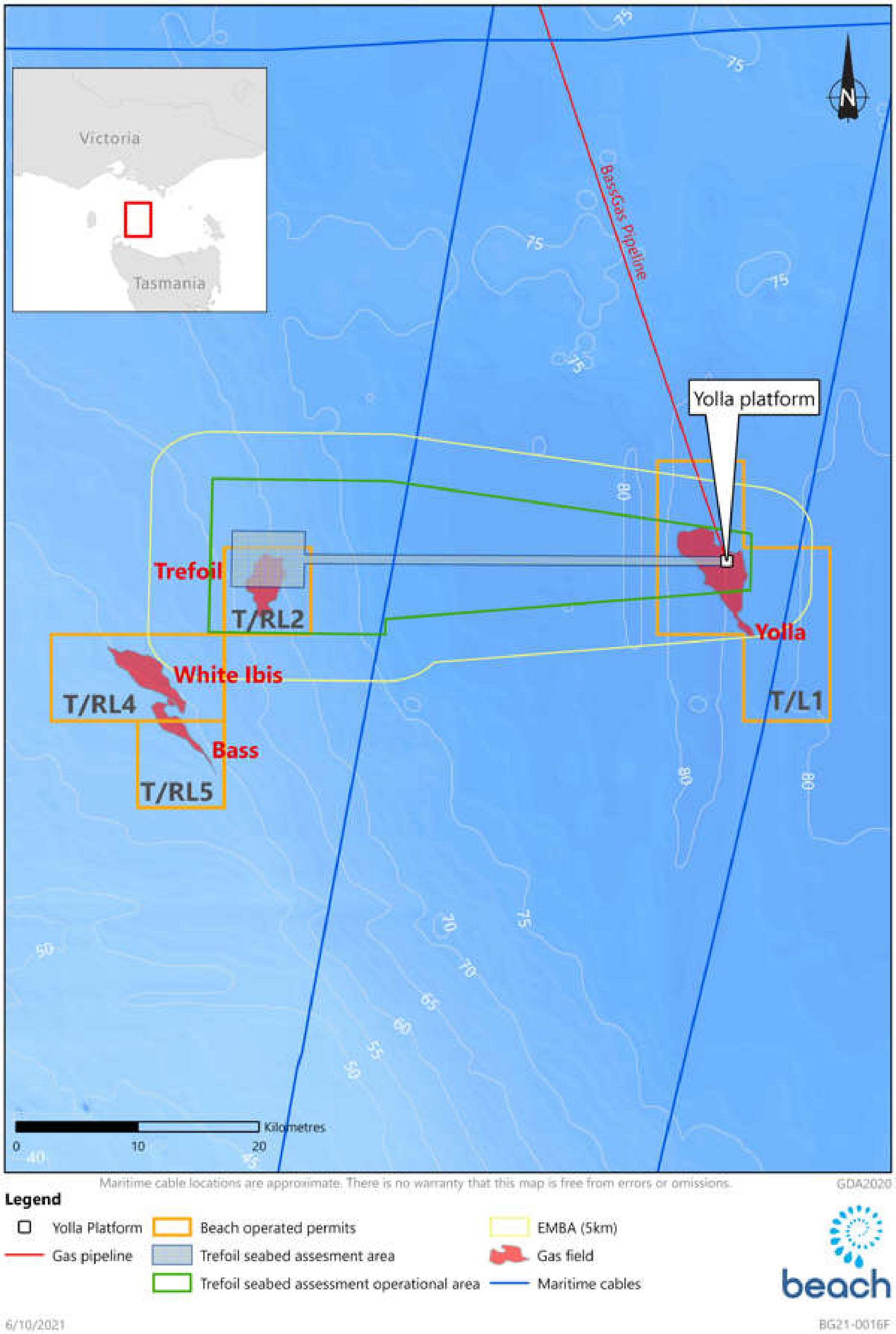


Figure B-10-19: Telstra Bass Strait 2 Subsea Cable within the seabed assessment area.

Appendix B.5 References

Baker, A. 1985. Pygmy right whale *Caperea marginata* (Gray, 1846). In: Ridgway, S H and Harrison, R. (eds.) Handbook of Marine Mammals Vol. 3: The Sirenians and Baleen Whales. Academic Press, London.

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.

Butler, A., Althanus, F., Furlani, D., & Ridgway, K. 2002. Assessment of the conservation values of the Bass Strait sponge beds area: A component of the Commonwealth Marine Conservation Assessment Program: report to Environment Australia. 2002-2004. CSIRO Marine Research.

CarbonNet, 2018. Geophysical and Geotechnical Investigations Environment Plan Summary (VIC-GIP-002). Department of Industry, Innovation and Science.

Charlton, C. Ward, R., McCauley, R.D., Brownell, R.L., Kent, C.S. and Burnell, S. 2019. *Southern right whale (Eubalaena australis), seasonal abundance and distribution at Head of Bight, South Australia*. Aquatic Conservation: Marine Freshwater Ecosystems:1–13.

Commonwealth of Australia. 2015a. *Conservation Management Plan for the Blue Whale 2015–2025*. Available from: https://www.environment.gov.au/system/files/resources/9c058c02-afd1 -4e5d-abff-11cac2ebc486/files/blue-whale-conservation-management-plan.pdf.

Commonwealth of Australia. 2015b. National Conservation Values Atlas. Commonwealth of Australia, Canberra, viewed 1 August 2017, http://www.environment.gov.au/webgisframework/apps/ncva/ncva.jsf.

Commonwealth of Australia. 2017. Recovery Plan for Marine Turtles in Australia. Australian Government, Canberra. Available from: http://www.environment.gov.au/marine/publications/recovery-plan-marine-turtles-australia-2017.

Commonwealth of Australia. 2018. Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans, Commonwealth of Australia 2018.

Commonwealth of Australia. 2019. Draft National Recovery Plan for the Australian Fairy Tern (*Sternula nereis nereis*). Available from: https://www.environment.gov.au/biodiversity/threatened/recovery-plans/comment/draft-recovery-plan-australian-fairy-tern

Department of the Environment and Energy (DotEE). 2015. South-east marine region profile: A description of the ecosystems, conservation values and uses of the South-east Marine Region. Commonwealth of Australia, Canberra, Australia.

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 (*Pseudorca crassidens*- False killer whale) Available from:http://www.environment.gov.au/sprat.

Department of the Environment and Energy (DotEE). 2019d. SPRAT Profile (*Megaptera novaeangliae* — Humpback Whale). Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=38

Department of the Environment and Energy (DotEE). 2019e. 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). 2019f. 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). 2019g. SPRAT Database. (*Globicephala macrorhynchus*- short finned pilot whale) Available from: http://www.environment.gov.au/sprat.

Department of the Environment and Energy (DotEE). 2019h. SPRAT Database: (*Eubalaena australis*- Southern right whale) Available from: http://www.environment.gov.au/sprat.

Department of the Environment and Energy (DotEE). 2019i. 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). 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). 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 (Ardenna carneipes — Flesh-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). 2019p. SPRAT Profile (*Carcharodon carcharias* — White Shark, Great White Shark). Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64470

Department of Environment, Land, Water and Planning. (DELWP) 2016. National Recovery Plan for the Orange-bellied Parrot *(Neophema chrysogaster).* Australian Government, Canberra.

Department of the Environment and Heritage (DEH). 2006. A guide to the Integrated Marine and Coastal Regionalisation of Australia Version 4.0. Department of the Environment and Heritage, Canberra, Australia.

Department of Primary Industries, Water and Environment (DPIPWE)-Resource Management and Conservation Division. 2010. Vulnerability of Tasmania's Natural Environment to Climate Change: An Overview. Unpublished report. Department of Primary Industries, Parks, Water and Environment, Hobart.

Department of Sustainability, Environment, Water, Population and Communities (DESWPaC). 2012. Conservation Management Plan for the Southern Right Whale.

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. Approved Conservation Advice for *Sternula nereis nereis* (fairy tern). Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/82950-conservation-advice.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.

Flegg, J. 2002. Photographic Field Guide Birds of Australia. Second Edition. Reed New Holland. Sydney.

Gill, P.C., R. Pirzl, M.G. Morrice & K. Lawton (2015). Cetacean diversity of the continental shelf and slope off southern Australia. The Journal of Wildlife Management.

Gill, P. and Morrice, M. 2003. Cetacean Observations. Blue Whale Compliance Aerial Surveys. Santos Ltd Seismic Survey Program Vic/P51 and P52. November-December 2002. Report to Santos Ltd.

Gill, P.C., Kemper, C.M., Talbot, M. and Lyons, S.A. 2008. Large group of pygmy right whales seen in a shelf upwelling region off Victoria, Australia. Marine Mammal Science 24(4): 962-968.

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.

Hofmeyr, G. and Gales, N. (2008). *Arctocephalus pusillus*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2.

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.

IMCRA Technical Group. (1998). Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based classification for marine and coastal environments. Version 3.3. Environment Australia, Commonwealth Department of the Environment. Canberra.

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.

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.

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.

Krueck, N., Hill, N., Hartmann, K. and Fraser, K. (2021). Tasmanian Octopus Fishery Assessment 2019/20. IMAS Fishery Assessment Report.

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.

McLeay, L., Sorokin, S., Rogers, P. and Ward, T. 2003. Benthic Protection Zone of the Great Australian Bight Marine Park: 1. Literature review. South Australian Research and Development Institute (Aquatic Sciences). Final report to: National Parks and Wildlife South Australia and the Commonwealth Department of the Environment and heritage. McInnes, K. L. and Hubbert, G. D. (2003). A numerical modelling study of storm surges in Bass Strait. Australian Meteorological Magazine 52(3).

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.

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. 2002. Ecosystems - Nature's Diversity. The South-East Regional Marine Plan Assessment Reports. National Oceans Office. HobartO'Hara, T., McShane, P. E., and Norman, M. (1999) cited in Andrew (1999).

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.

Parks Victoria (2016). Enviroactive. Available from: http://www.enviroactive.com.au/wetlands/shorebirds.

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., Williams, A., Woodhams, J. and Curtotti, R. 2019. Fishery Status Reports 2019, Australian Bureau of Agriculture and Resource Economics and Sciences, Canberra, CC BY 4.0. https://doi.org/10.25814/5d80431de3fae.

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 physalus*. In: IUCN 2008. 2008 IUCN Red List of Threatened Species.

Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr, R.L., Butterworth, D.S, Clapham, D.J., Cooke, J., Donovan, G.P., Urbán, J. and Zerbini, A.N. 2008. Caperea marginata. In: IUCN Red List of Threatened Species. Version 2011.2.

Remplan, 2019. Bass Coast economy profile. A WWW database accessed at https://www.economyprofile.com.au/basscoast/tourism/value-added. Remplan Economy.

RPS. 2017. Yolla Oil Spill Modelling; Quantitative Oil Spill Modelling. Prepared by RPS for Origin Energy Resources Ltd. Queensland.

Sandery P.A. and Kampf J. 2005. Winter Spring flushing of Bass Strait, South Eastern Australia; Numerical modelling study. Estuarine and coastal shelf science 63.

Santos. 2004. Casino Gas Field Development Environment Report. Prepared by Enesar Consulting Pty Ltd. Hawthorn East, Victoria.

Thales Geosolutions. 2001. "BassGas Project: Offshore Shallow Geotechnical Survey Report", Report No. 3259C.

Threatened Species Scientific Committee (TSSC) 2014. Conservation Advice *Ardenna carneipes* (flesh-footed shearwater). Available from: http://www.environment.gov.au/biodiversity/threatened/conservation-advices/adrenna-carneipes

Threatened Species Scientific Committee (TSSC). 2015a. Conservation Advice for *Balaenoptera physalus* (fin whale). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservation-advice-01102015.pdf

Threatened Species Scientific Committee (TSSC). 2015b. Conservation Advice for *Megaptera novaeangliae* (humpback whale). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf

Wilson, R. and Poore, G. 1987. The Bass Strait survey: biological sampling stations, 1979-1984. Occasional papers from the Museum of Victoria 3, 1–14.

Appendix C Geophysical Survey JASCO Acoustic Modelling Report

Otway Basin Geophysical Operations Acoustic Modelling

Acoustic Modelling for Assessing Marine Fauna Sound Exposures

Submitted to:
Lattice Energy

Authors:
Craig McPherson
Michael Wood

10 May 2019

P001359-001
Document 01473
Version 1.0

JASCO Applied Sciences (Australia) Pty Ltd
Unit 1, 14 Hook Street
Capalaba, Queensland, 4157
Tel: +61 7 3823 2620
Mob: +61 4 3812 8179
www.jasco.com

Document Version Control

Version	Date	Name	Change
1.0	2017 November 02	C. McPherson	Final submitted to client

Suggested citation:

McPherson, C., M. Wood. 2017. *Otway Basin Geophysical Operations Acoustic Modelling: Acoustic Modelling for Assessing Marine Fauna Sound Exposures*. Document 01473, Version 1.0. Technical report by JASCO Applied Sciences for Lattice Energy.

Disclaimer:

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

Contents

Figures

Tables

Executive Summary

Sound models were used to assess underwater noise levels during the proposed Otway Basin Geophysical Survey by Lattice Energy. The modelling approach accounted for the acoustic emission characteristics of a representative boomer and sub-bottom profiler (SBP) both towed at 3 m depth, along with a 450 in^3 vertical seismic profiler (VSP) array operated at a centroid depth of 6 m. The boomer and SBP geophysical survey sources planned for use had not been decided at the time of the modelling study, therefore JASCO chose commonly-used representative systems for each source, with levels derived from previous JASCO field measurement campaigns of such sources. The modelled per-pulse in-beam SEL and SPL source levels of the boomer were 180.0 dB re 1 $\mu Pa^2 \cdot s$ @ 1 m and 200.5 dB re 1 µPa @ 1 m respectively, and for the sub-bottom profiler they were 171.4 dB re 1 $\mu Pa^2 \cdot s$ @ 1 m and 191.7 dB re 1 µPa @ 1 m. The modelling considered source directivity and the area's range-dependent environmental properties.

The modelling study assessed six sites for the representative boomer and sub-bottom profiler, and one site for the VSP operations, focusing on the metrics relevant to benthic invertebrates. Accumulated SEL was modelled for four full surveys of the boomer and SBP operating in tandem. The scenarios considered operational periods of either 51 or 40.2 hours, including turn times.

The analysis considered the maximum distances away from a given source or survey lines at which several effects criteria were reached. The results are summarised below for representative single pulse sites and for accumulated sound exposure level (SEL) scenarios.

Benthic Invertebrates and Fish

- Sound fields from the representative boomer and SBP do not reach any of the assessed thresholds for benthic crustaceans or fish at the seafloor for either single pulse or accumulated SEL scenarios. The sound level drops below the lowest relevant peak-to-peak pressure level (PK-PK) isopleth of 202 dB re 1 µPa at a vertical distance of 11 m below the source, and below the lowest relevant peak pressure level (PK) of 207 dB re 1 µPa within 1.6 m, while the maximum per-pulse SEL isopleth predicted to occur at the seafloor is 155 dB re 1 $\mu Pa^2 \cdot s$ at a maximum horizontal distance of 1 m from the source.
- The SBP is a higher-frequency, more directional, and lower energy source than the boomer; consequently, the ranges are consistently lower. The PK-PK isopleth of 202 dB re 1 µPa is predicted to occur at 1.4 m vertically below the source, while the maximum per-pulse SEL isopleth predicted to occur at the seafloor is 130 dB re 1 $\mu Pa^2 \cdot s$ at a maximum horizontal distance of 6 m.
- The maximum accumulated SEL from the combined operations of the boomer and SBP at the seafloor is not predicted to exceed 170 dB re 1 $\mu Pa^2 \cdot s$ for any single survey. This is below any of the relevant isopleths for benthic invertebrates, including the 183 dB re 1 $\mu Pa^2 \cdot s$ 'no effect' accumulated SEL (McCauley and Duncan 2016). It is also below the threshold for temporary hearing impairment (TTS) in fish. The predicted ranges for the four surveys modelled at similar, due to the identical sources, sound speed profiles, similar depths and geoacoustics.
- The VSP source was modelled with models capable of accounting for all environmental parameters and high propagation angles. The results show that the lowest PK-PK isopleths of interest derived from Day et al. (2016b), 209 dB re 1 µPa, is not reached at the seafloor; and the horizontal range along the seafloor to the 202 dB re 1 µPa PK-PK level from Payne et al. (2007) is 185 m. PK metrics relevant to the Popper et al. (2014) criteria for fish and turtles are also not reached at the seafloor. The maximum per-pulse SEL on the seafloor below the array is 181 dB re 1 $\mu Pa^2 \cdot s$, below the lowest level from Day et al. (2016b) of 186 dB re 1 $\mu Pa^2 \cdot s$.

Marine Mammals and Turtle Behaviour

- Considering the United States (US) National Marine Fisheries Service (NMFS; 2013) acoustic threshold for behavioural effects in marine mammals of 160 dB re 1 µPa (SPL), the boomer could potentially disturb marine mammals at horizontal distances of up to 145 m, and the SBP at 2 m.
- Considering the US NMFS criterion for behavioural effects in turtles of 166 dB re 1 µPa (SPL), the boomer could potentially disturb turtles are horizontal distances of up to 36 m, while this level is not reached for the SBP.

- For the VSP array, sounds exceeded the unweighted per-pulse SEL criterion for the 1 km low-power zone of 160 dB re 1 µPa^2·s (DEWHA 2008) within 1.03 km of the 450 in^3 array ($R_{95\%}$ distance). The maximum ranges to the marine mammal and turtle behavioural thresholds of 160 and 166 dB re 1 µPa SPL are 2.56 and 1.55 km respectively.

1. Introduction

JASCO Applied Sciences (JASCO) performed a numerical estimation study of underwater sound levels associated with the Otway Basin Geotechnical Operations proposed by Lattice Energy in the Otway Basin. The acoustic modelling evaluated the effects of sounds produced by three sources on marine fauna, with a specific focus on benthic invertebrates. The three sources considered in the modelling were a representative boomer and sub-bottom profiler (SBP) both towed at 3 m, along with a 450 in^3 vertical seismic profiler (VSP) array operated at a centroid depth of 6 m. The boomer and SBP geophysical survey sources planned for use had not been decided at the time of the modelling study, therefore JASCO proposed a commonly used representative for each source, with levels derived from a previous JASCO measurement campaign of such sources. The results are presented as sound pressure levels (SPL), zero-to-peak pressure levels (PK), peak-to-peak pressure levels (PK-PK) and either per-pulse (i.e., per-pulse) or accumulated sound exposure levels (SEL), as appropriate to each scenario.

Single pulse sound fields for each source were modelled at six representative locations (Table 1, Figure 1), although it is likely that the boomer and SBP will not operate at Site 5. The VSP will only be operated at Site 5. Accumulated SEL was modelled for four full surveys of the boomer and SBP operating in tandem, using the single pulse modelling results from Sites 1, 3, 4 and 6.

Table 1. Location details for modelled sites (UTM zone 54S).

Site #	Site Name	Site Name Acronym	Water depth (m)	Latitude	Longitude	Easting	Northing
1	Thylacine Midpoint	THY MID	100.5	-39.2168	142.8665	661137	5657503
2	Murchinson Downdip	MURCH DDIP	129.5	-39.2249	142.7614	652042	5656787
3	Geographe 3	G3	85	-39.1082	142.9517	668752	5669398
4	Artisan	ARTISAN	71.6	-38.8909	142.8829	663300	5693640
5	Block VICP69, North	VICP69 NTH	72.8	-38.8829	143.1359	685264	5694052
6	Block VICP69, Meeki	VICP69 MEEKI	79.1	-38.9881	143.051	677633	5682538

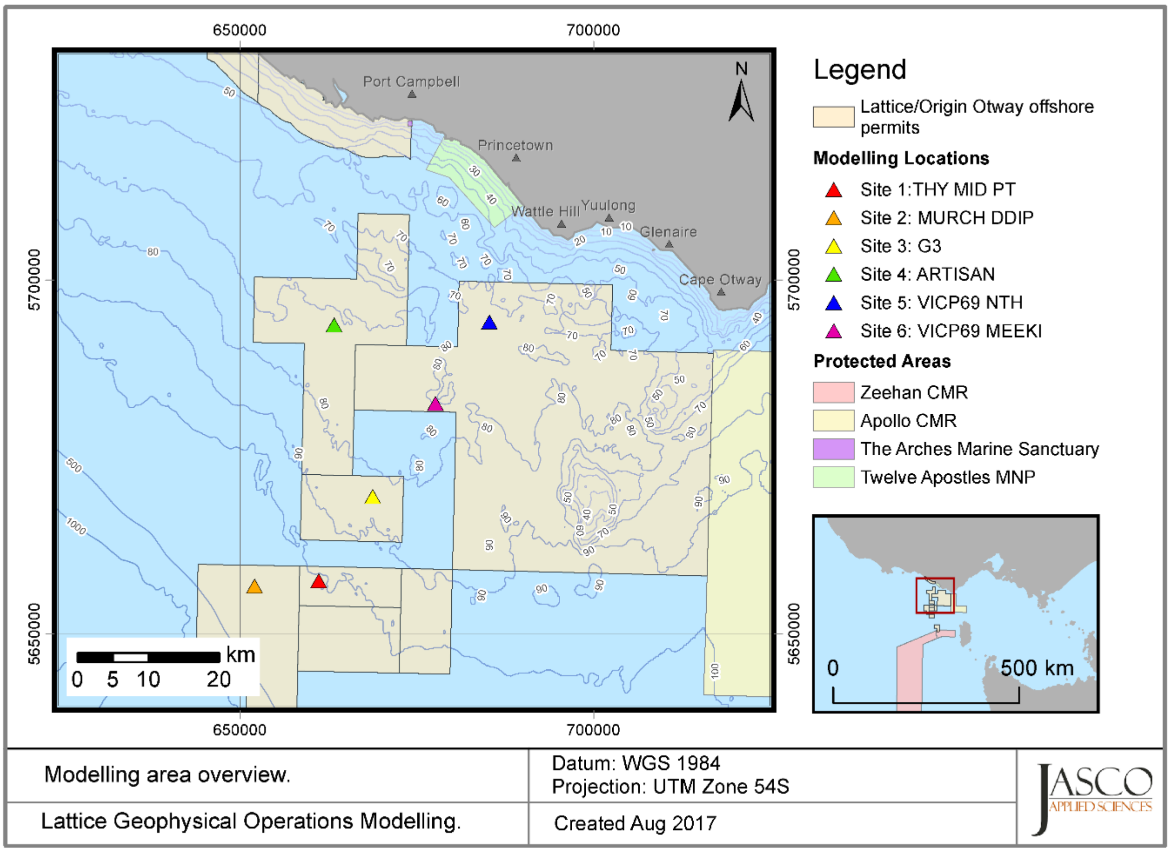


Figure 1. Single pulse modelling site locations and relevant features, including Commonwealth Marine Reserves (CMR), and Marine National Parks (MNP)

2. Noise Effects Criteria

The perceived loudness of sound, especially impulsive noise such as from seismic airguns, is not generally proportional to the instantaneous acoustic pressure. Rather, perceived loudness depends on the time over which the pulse rises, how long this occurs for, and its frequency content. Thus, several sound level metrics are commonly used to evaluate noise and its effects on marine life. The metrics applied in this report, including peak pressure level (PK), peak-peak pressure (PK-PK), sound pressure level (SPL), and sound exposure level (SEL), are defined in Appendix A. Appropriate subscripts indicate any applied frequency weighting; unweighted SEL is defined as required. The acoustic metrics in this report reflect the updated ANSI and ISO standards for acoustic terminology, ANSI-ASA S1.1 (R2013) and ISO/DIS 18405.2:2017 (2016).

Whether acoustic exposure levels might injure or disturb marine fauna is an active research topic. Since 2007, several expert groups have investigated an SEL-based assessment approach for injury in marine mammals, with a handful of key papers published on the topic. The number of studies that investigated the level of disturbance to marine animals by underwater noise has also increased substantially.

We chose the following noise criteria for this study because they include requested thresholds, standard thresholds, thresholds suggested by the best available science (Sections 2.1, 2.2 and 2.3):

1. For comparison to results in Payne et al. (2008), and Day et al. (2016a), the following metrics are reported for benthic crustaceans:
   - Seafloor per-pulse SEL: 186–190 dB re 1 µPa^2.s
   - Seafloor SEL_{24h}: 192–199 dB re 1 µPa^2.s
   - Peak-peak pressure: 202, 209–212 dB re 1 µPa
2. 'No effect on lobster' accumulated SEL for the Crowes Foot MSS of 183 dB re 1 µPa^2.s (McCauley and Duncan 2016).
3. Per-pulse threshold for cetaceans (unweighted per-pulse SEL of 160 dB re 1 µPa^2·s) outlined in the Australian Environment Protection and Biodiversity Conservation (EPBC) Act Policy Statement 2.1, Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008).
4. Marine mammal behavioural threshold based on the current interim U.S. National Marine Fisheries Service (NMFS) criterion (NMFS 2013) for marine mammals of 160 dB re 1 µPa SPL for impulsive sound sources.
5. Sound exposure guidelines for fish, fish eggs and larvae, and turtles (Popper et al. 2014).
6. Threshold for turtle behavioural response 166 dB re 1 µPa (SPL) (NSF 2011), applied by the US NMFS.

2.1. Benthic Invertebrates (Crustaceans)

Research is ongoing into the relationship between sound and its effects on crustaceans, including the relevant metrics for both effect and impact. Available literature suggests particle motion, rather than sound pressure, is a more important factor for crustacean and bivalve hearing. Water depth and airgun array size are related to the particle motion levels at the seafloor, with larger arrays and shallower water being related to higher particle motion levels, more likely relevant to effects on bivalves. Although some impact assessments have estimated areas of potential impacts from seismic surveys based on the results in Day et al. (2016b), current literature does not clearly define an appropriate metric or identify relevant sound levels for an assessment. This includes the consideration of what particle motion levels lead to a behavioural response, or mortality.

At the seafloor interface bivalves are subject to particle motion stimuli from several acoustic or acoustically-induced waves. These include the particle motion associated with an impinging sound pressure wave in the water column (the incident, reflected, and transmitted portions), substrate acoustic waves, and interface waves of the Scholte type. However, it is unclear which aspect(s) of these waves is/are most relevant to the animals, either when they normally sense the environment or their physiological responses to loud sounds so there is not enough information to establish similar criteria and thresholds as done for marine mammals and fish. Therefore, at this stage, JASCO is not able to define thresholds to inform the impact assessment. Additionally, prediction of particle motion from sources such as low-energy geophysical sources including boomers and sub-bottom profilers is not possible currently due to the lack of source models.

Despite this, the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) has publicly stated that the seafloor levels, sound levels at the seafloor derived from Day et al. (2016b) should be used to assist in the assessment of impacts on scallops and lobster. Therefore, JASCO has used the following metrics in its evaluation:

- Per-pulse SEL: 186–190 dB re 1 μPa^2.s
- Accumulated SEL: 192–199 dB re 1 μPa^2.s
- Peak-peak pressure: 209–212 dB re 1 μPa

Additionally a PK-PK of 202 dB re 1 μPa from Payne et al. (2007) has been included along with an accumulated SEL of 183 dB re 1 μPa^2.s as specified by Lattice Energy based on McCauley and Duncan (2016).

2.2. Marine Mammals

The criteria applied in this study to assess possible effects of impulsive noise on marine mammals are summarised in Table 2 and detailed in Sections 2.2.1 and 2.2.2.

Table 2. The SPL and per-pulse SEL thresholds for acoustic effects on marine mammals.

Hearing group	DEWHA (2008)	NMFS (2013)
	Unweighted per-pulse SEL (dB re 1 μPa^2·s)	Behaviour SPL (dB re 1 μPa)
Low-frequency cetaceans	160	160
Mid-frequency cetaceans		
High-frequency cetaceans		
Phocid pinnipeds in water	Not Applicable	
Otariid pinnipeds in water	Not Applicable	

2.2.1. Injury and Hearing Sensitivity Changes

There are two categories of auditory threshold shifts representing reduced hearing ability: permanent threshold shift (PTS), considered a physical injury to an animal's hearing organs, and temporary threshold shift (TTS), a temporary reduction in an animal's hearing sensitivity, understood to be partly a result of receptor hair cells in the cochlea becoming fatigued.

For seismic surveys in Australian waters, the EPBC Act Policy Statement 2.1 determines suitable exclusion zones with an unweighted per-pulse SEL threshold of 160 dB re 1 μPa^2·s (DEWHA 2008). This threshold minimises the likelihood of TTS in mysticetes and large odontocetes. The Policy Statement does not apply to smaller dolphins and porpoises as DEWHA assessed these cetaceans as having relatively low hearing sensitivity to the low frequencies produced by seismic airgun arrays.

2.2.2. Behavioural Response

Southall et al. (2007) extensively reviewed marine mammal behavioural responses to sounds. Their review found that most marine mammals exhibited varying responses between 140 and

180 dB re 1 µPa SPL, but inconsistent results between studies makes choosing a single behavioural threshold difficult. Studies varied in their lack of control groups, imprecise measurements, inconsistent metrics, and that animal responses depended on study context, which included the animal's activity state. To create meaningful quantitative data from the collected information, Southall et al. (2007) proposed a severity scale that increased with increasing sound levels.

NMFS has historically used a relatively simple sound level criterion for potentially disturbing a marine mammal. For impulsive sounds, this threshold is 160 dB re 1 µPa SPL for pinnipeds and cetaceans (NMFS 2013).

2.3. Fish, Turtles, Fish Eggs, and Fish Larvae

In 2006, the Working Group on the Effects of Sound on Fish and Turtles was formed to continue developing noise exposure criteria for fish and turtles, work begun by a NOAA panel two years earlier. The resulting guidelines included specific thresholds for different levels of effects and for different groups of species (Popper et al. 2014). These guidelines defined quantitative thresholds for three types of immediate effects:

- Mortality, including injury leading to death.
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma.
- TTS

Masking and behavioural effects can be assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds. These effects are not assessed in this report. Because the presence or absence of a swim bladder has a role in hearing, fish's susceptibility to injury from noise exposure varies depending on the species and the presence and possible role of a swim bladder in hearing. Thus, different thresholds were proposed for fish without a swim bladder (also appropriate for sharks and applied to whale sharks in the absence of other information), fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing. Turtles, fish eggs, and fish larvae are considered separately.

Table 3 lists relevant effects thresholds from Popper et al. (2014). In general, any adverse effects of seismic sound on fish behaviour depends on the species, the state of the individuals exposed, and other factors. We note that, despite mortality being a possibility for fish exposed to airgun sounds, Popper et al. (2014) do not reference an actual occurrence of this effect. Since the publication of that work, newer studies have further examined the question of possible mortality. Popper et al. (2016) adds further information to the possible levels of impulsive seismic airgun sound to which adult fish can be exposed without immediate mortality. They found that the two fish species in their study, with body masses in the range 200–400 g, exposed to a per-pulse of a maximum received level of either 231 dB re 1 µPa (PK) or 205 dB re 1 µPa^2·s (SEL), remained alive for 7 days after exposure and that the probability of mortal injury did not differ between exposed and control fish.

The SEL metric integrates noise intensity over some period of exposure. Because the period of integration for regulatory assessments is not well defined for sounds that do not have a clear start or end time, or for very long-lasting exposures, it is required to define a time period. This is done for marine mammals in the Southall et al. (2007) criteria, where it is 24 h or the duration of the activity, whichever longer. Popper et al. (2014) recommend a standard period of time should be applied, where this is either defined as a justified fixed period or the duration of the activity, however also include caveats about how long the fish will be exposed because they can move (or remain in location) and so can the source. In the discussion of the criteria, Popper et al. (2014) discuss the complications in determining a relevant period of mobile seismic surveys, as the received levels at the fish change between impulses due to the mobile source, and that in reality a revised guideline based on the closest PK or the per-pulse SEL might be more useful than one based on accumulated SEL. This is because exposures at the closest point of approach are the primary exposures contributing to a receiver's accumulated level (Gedamke et al. 2011). Additionally, several important factors determine the likelihood and duration a receiver is expected to be in close proximity to a sound source (i.e., overlap in space and time between the source and receiver). For example, accumulation time for fast moving (relative to the receiver) mobile sources is driven primarily by the characteristics of source (i.e., speed, duty cycle) (NMFS 2016).

Popper et al. (2014) summaries that in all TTS studies considered, fish that showed TTS recovered to normal hearing levels within 18–24 hours. However in this study the full period of operations has been considered as the accumulation period for SEL.

Table 3. Criteria for seismic noise exposure for fish and turtles, adapted from Popper et al. (2014).

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	> 219 dB SEL_{24h} or > 213 dB PK	> 216 dB SEL_{24h} or > 213 dB PK	>> 186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	210 dB SEL_{24h} or > 207 dB PK	203 dB SEL_{24h} or > 207 dB PK	>> 186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24h} or > 207 dB PK	203 dB SEL_{24h} or > 207 dB PK	186 dB SEL_{24h}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Turtles	210 dB SEL_{24h} or > 207 dB PK	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish eggs and fish larvae	> 210 dB SEL_{24h} or > 207 dB PK	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Notes: Peak sound pressure level dB re 1 µPa; SEL_{24h} dB re 1µPa^2·s. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

2.3.1. Turtle Behavioural Response

There is a paucity of data regarding responses of turtles to acoustic exposure, and no studies of hearing loss due to exposure to loud sounds. McCauley et al. (2000) observed the behavioural response of caged turtles—green (*Chelonia mydas*) and loggerhead (*Caretta caretta*)—to an approaching seismic airgun. For received levels above 166 dB re 1 µPa (SPL), the turtles increased their swimming activity and above 175 dB re 1 µPa they began to behave erratically, which was interpreted as an agitated state. The 166 dB re 1 µPa level has been used as the threshold level for a behavioural disturbance response by NMFS and applied in the Arctic Programmatic Environment Impact Statement (PEIS) (NSF 2011). At that time, and in the absence of any data from which to determine the sound levels that could injure an animal, TTS or PTS onset were considered possible at an SPL of 180 dB re 1 µPa (NSF 2011). Some additional data suggest that behavioural responses occur closer to an SPL of 175 dB re 1 µPa, and TTS or PTS at even higher levels (Moein et al. 1995), but the received levels were unknown and the NSF (2011) PEIS maintained the earlier NMFS criteria levels of 166 and 180 dB re 1 µPa (SPL) for behavioural response and injury, respectively. Popper et al. (2014) suggested injury to turtles could occur for sound exposures above 207 dB re 1 µPa (PK) or above 210 dB re 1 µPa^2·s (SEL_{24h}) (Table 3). Sound levels defined by Popper et al. (2014) show that animals are very likely to exhibit a behavioural response when they are near an airgun (tens of metres), a moderate response if they encounter the source at intermediate ranges (hundreds of metres), and a low response if they are far (thousands of meters) from the airgun. Both the NMFS criteria for behavioural disturbance (SPL of 166 dB re 1 µPa) and the Popper et al. (2014) injury criteria were included in this analysis, although the analysis did not consider the ranges at which an animal could suffer impairment, as defined by Popper et al. (2014).

3. Methods

This section details the methodology for predicting source levels, modelling sound propagation, and assessing distances to the selected impact criteria.

The environmental parameters used in the propagation models are described in detail in Appendix D. A single sound speed profile that provided the greatest propagation across the year was applied, which occurs during the month of September.

3.1. Acoustic Sources

3.1.1. Boomer: AP3000 Dual-Plate Boomer

The representative boomer system for geophysical survey operations is the AP3000 triple-plate boomer (manufactured by Subsea Systems, Inc.). To estimate the sound field for the boomer source, the specifications of the Applied Acoustics AA202 boomer plate (Applied Acoustics Engineering 2013), a suitable approximation, were taken to represent a single plate, three of which comprise the full system. The boomer plate is 38 cm wide by 38 cm long with a circular baffle. Because the boomer source is a circular piston surrounded by a rigid baffle, it cannot be considered a point-like source (Verbeek and McGee 1995). The beam pattern of a boomer plate shows some directivity for frequencies above 1 kHz. Above this frequency, the acoustic wave's emitted length becomes comparable (of the same order of magnitude) with the baffle size (< 150 cm vs. 35 cm).

The input energy for the AP3000 system is up to 600 J per pulse per plate, or up to 1800 J per pulse from all three plates. The width of the pulse calculated based on the 90% SPL (T_{90}) is 8.1 ms.

JASCO performed a source verification study on an AP3000 system (Martin et al. 2012) with a double-plate configuration operating at maximum input energy of 1000 J. During the study, the acoustic data were collected as close as 8 m to the source and directly below it (Figure 2). By assuming a reduction in pressure in line with spherical spreading laws the data showed that the broadband source level for the system was 197.9 dB 1 µPa @ 1 m SPL and 177.4 dB re 1 µPa^2·s @ 1 m SEL.

The increase in the source level of an AP3000 boomer when in triple-plate configuration, instead of double-plate configuration, was estimated at 2.6 dB because a triple-plate configuration could be used with a higher energy input per pulse (up to 1800 J vs. up to 1000 J for double plate configuration). For modelling, the source level of the AP3000 triple-plated boomer operating at 1800 J per pulse energy was calculated to be 200.5 dB 1 µPa @ 1 m SPL and 180.0 dB re 1 µPa^2·s @ 1 m SEL (Table 4). The power spectrum of the boomer signal was determined directly from the measurement of the boomer signal having compensated the signal for geometric spreading and the change in energy (Figure 3). The 1/3-octave frequency boomer source spectra are shown in Figure 4.

The beamwidth of a boomer plate at each 1/3-octave frequency was calculated based on the standard formula for the beam pattern of a circular transducer (Equation 1). Figure 5 shows a vertical slice for the calculated beam pattern at (a) 1.25 and (b) 16.0 kHz. In order to simplify the acoustic propagation calculations, the beam pattern from the triple-plate system was considered to be equal to the beam pattern from a single plate.

Table 4. Specifications of the AP3000 triple-plate boomer system towed at a depth of 2 m used for the modelling

Specification	Specification	Source
Operating frequency (broad band):	200 Hz–16 kHz;	Estimated from field measurements; Martin et al. (2012)
Beam width	omnidirectional –8°	
Beams	1	

Specification	Specification	Source
Tilt angle (below horizontal plane)	90°	System specification document
Maximum energy input (per pulse):	1800 J	
Peak pressure source level	210.8 dB re 1 µPa @ 1 m	Estimated from field measurements; Martin et al. (2012).
Peak-Peak pressure source level	222.7 dB re 1 µPa @ 1 m	
SPL source level	200.5 dB re 1 µPa @ 1 m	
Pulse length (T_{90})	8.1 ms	
Per-pulse SEL source level	180.0 dB re 1 µPa²•s @ 1 m	

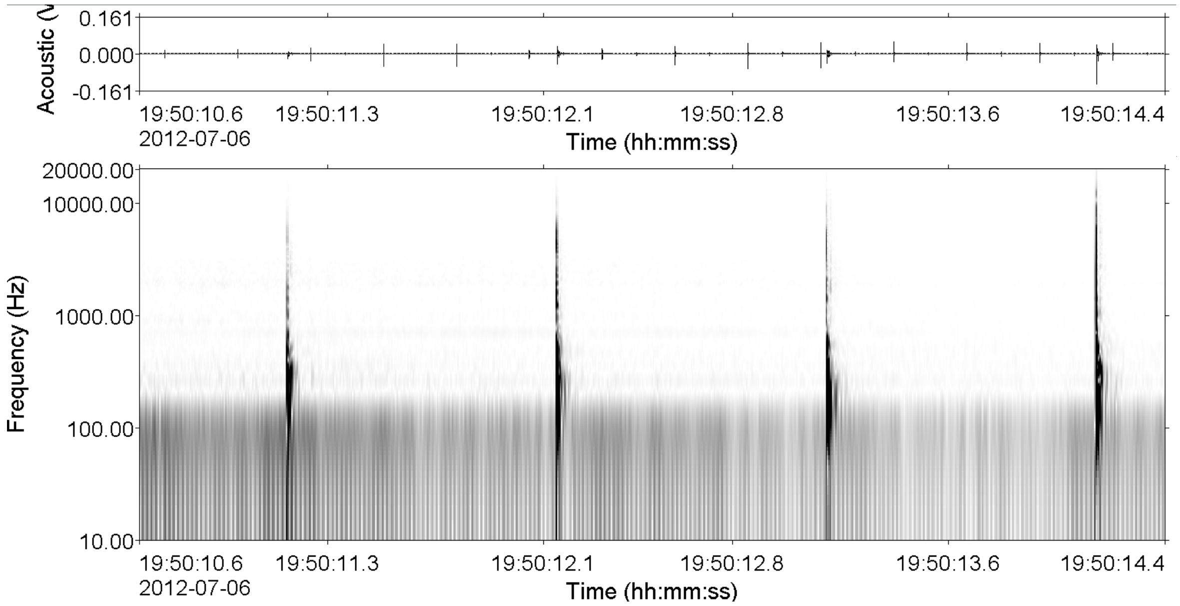


Figure 2. Spectrogram of dual-plate boomer (1000 J) pulses at the closest point of approach. Majority of energy is between 100 and 1000 Hz, with some energy at up to 10 kHz. (131,072 point FFT, 7000 data points, 3500 point overlap, Figure 15 in Martin et al. (2012)).

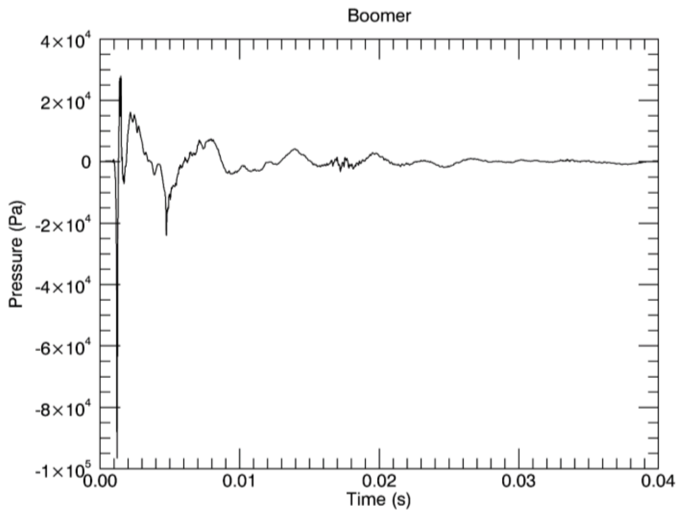


Figure 3. Back-propagated and scaled boomer source signature calculated from measurements (Martin et al. 2012).

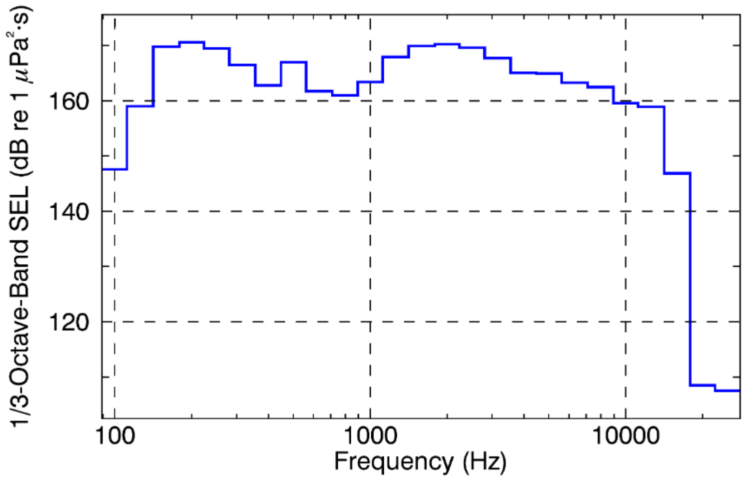


Figure 4. Boomer source spectra calculated from measurements (Martin et al. 2012).

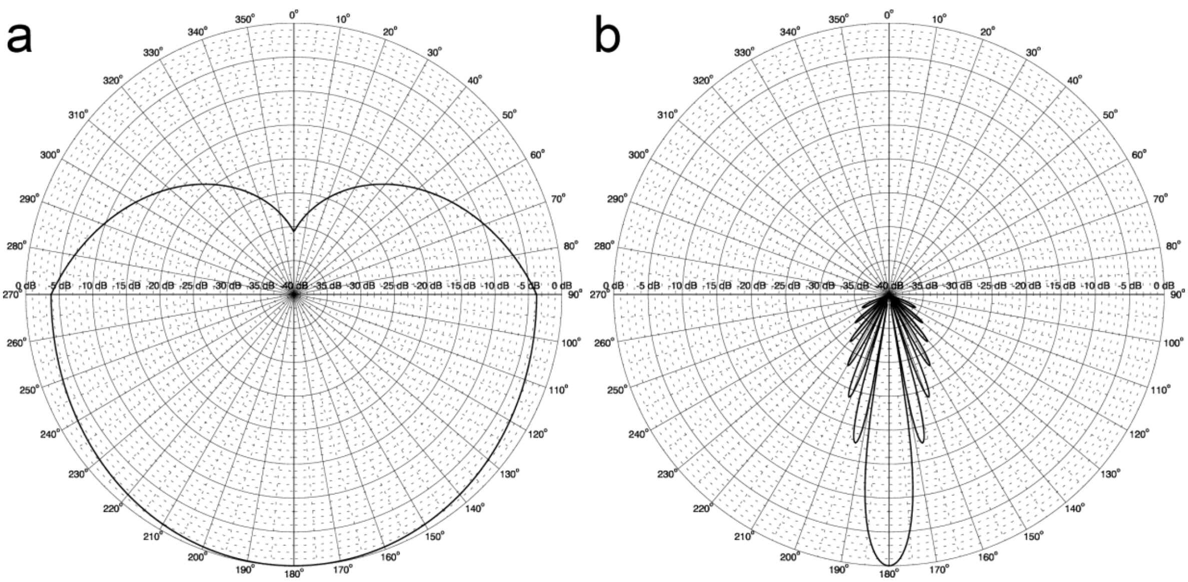


Figure 5. Calculated beam pattern vertical slice for the AA202 boomer plate at (a) 1.25 and (b) 16.0 kHz; across-track direction.

3.1.2. Sub-bottom Profiler: EdgeTech X-Star

The representative sub-bottom profiler system for geophysical survey operations is the EdgeTech X-Star (manufactured by EdgeTech). The system is equipped with a SBP-216 tow-fish. The transducer installed on the SBP-216 tow-fish transmits a chirp pulse that spans an operator-selectable frequency band. The lower and upper limits of the sonar's frequency band are 2 and 16 kHz, respectively. The system projects a single beam directed vertically down. The projected beamwidth depends on the operating frequency, and it can vary in range from 10° to 20°.

The source function was determined by using data obtained from the same measurement campaign as the boomer (Martin et al. (2012).To determine a source function usable for modelling the signal underwent a degree of post-processing. A clip from the recording measured at the closest point of approach was selected for processing (Figure 6). By assuming a point-like source and with no significant reflections or pulse dilation, the source level was determined by back-propagation methods assuming spherical spreading (Figure 7). The SEL band levels were determined from the back-propagated signal and are shown in Figure 8. The calculated source specifications are provided in Table 5. The width of the pulse encompassing 90% of the energy (T_{90}) was 8.1 ms, providing a SPL of 191.7 dB re 1 µPa @ 1 m.

For the purposes of modelling a source depth of 3 m was used, based on the assumed tow depth of a tow-fish. Since the echosounder's transducer projects a circular beam that is aimed vertically down, the source is effectively omnidirectional in the horizontal plane.

Table 5. Specifications of the Edgetech X-Star sub-bottom profiling system towed at a depth of 3 m used for the modelling

Specification	Specification	Source
Operating frequency:	2-16 kHz	System specification document
Beam width	10-20°	
Tilt angle (below horizontal plane)	90°	
Peak pressure source level	197.6 dB re 1 µPa @ 1 m	Estimated from field measurements; Martin et al. (2012).
Peak-Peak pressure source level	204.7 dB re 1 µPa @ 1 m	
SPL source level	191.7 dB re 1 µPa @ 1 m	
Pulse length (T_{90})	8.1 ms	
Per-pulse SEL source level	171.4 dB re 1 µPa^2·s @ 1 m	

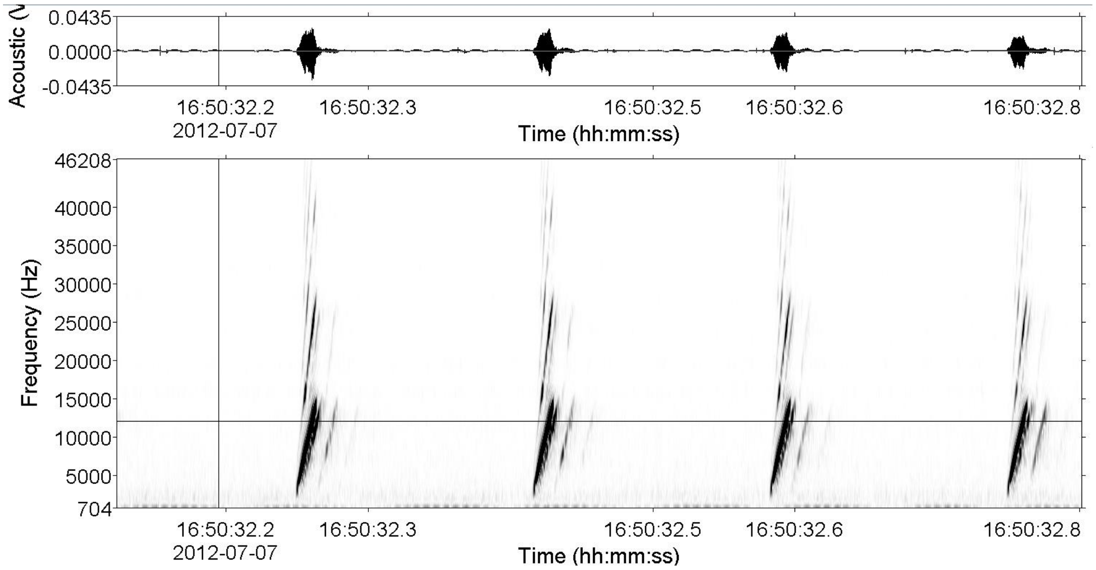


Figure 6. Spectrogram of X-Star SB-216S Sub-Bottom Profiler at closest-point of approach. The centroid frequency of the pulses was approximately 10 kHz, with 90% of the energy between 6 and 13 kHz. Aliased energy is visible above the main pulse. The bottom reflection is visible about 15 ms after the main pulse. (131,072 point FFT, 690 real data points, 345 point overlap.)

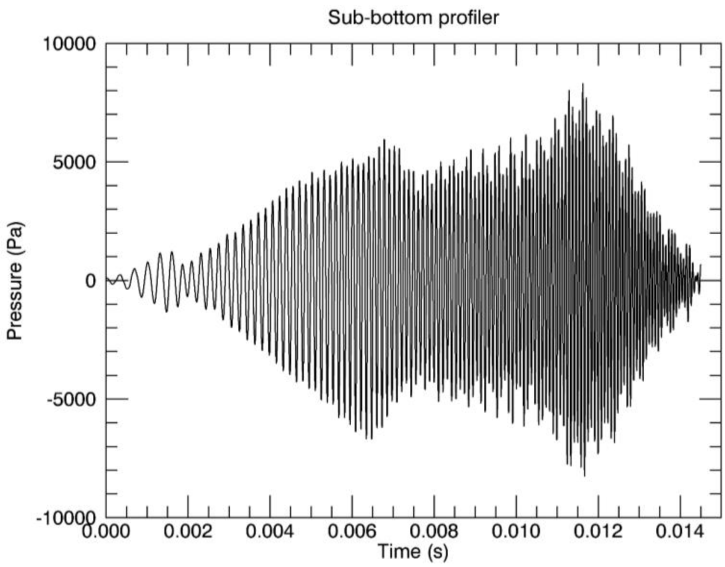


Figure 7. Back-propagated and scaled sub-bottom profiler source signature calculated from measurements (Martin et al. 2012).

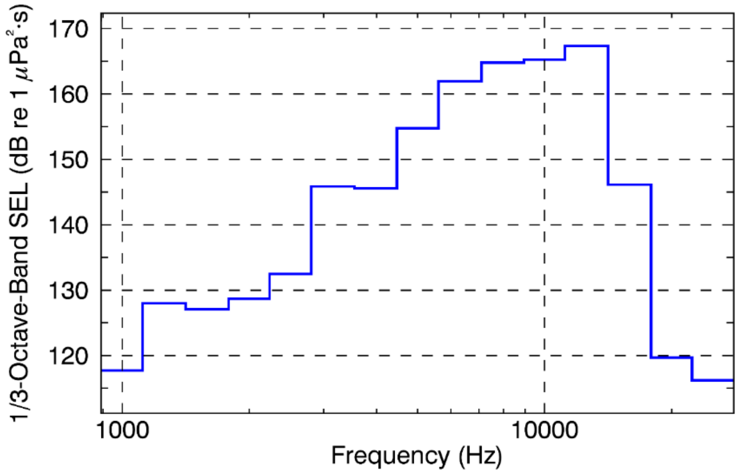


Figure 8. Sub-bottom profiler source spectra calculated from measurements (Martin et al. 2012).

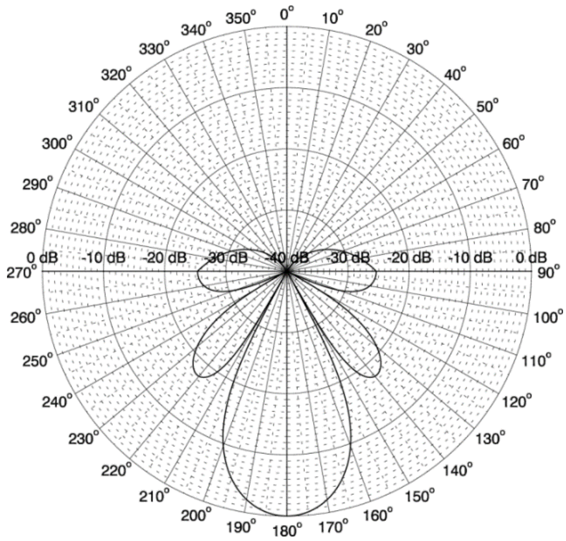


Figure 9. Calculated beam pattern vertical slice for the EdgeTech X-Star sub-bottom profiler at central frequency of 9 kHz.

3.1.3. VSP

The VSP airgun array under consideration is a 450 in^3 array consisting of 3 150 in^3 airguns operated at a centroid depth of 6 m, Figure 10 and Table 6.

The source levels and directivity of the airgun array were predicted with JASCO's Airgun Array Source Model (AASM), which accounts for:

- Array layout
- Volume, tow depth, and firing pressure of each airgun
- Interactions between different airguns in the array

The array was modelled over AASM's full frequency range, up to 25 kHz. Details of the model are described in Appendix B.

The model considered the following specifications:

- A 450 in^3 firing volume seismic airgun array for VSP.
- Airguns operated at a firing pressure of 2000 psi. The type was not specified, however Bolt 1900 LLX were used for the modelling.

- An array layout consisting of three 150 in³ airguns with a centroid depth of 6.0 m.

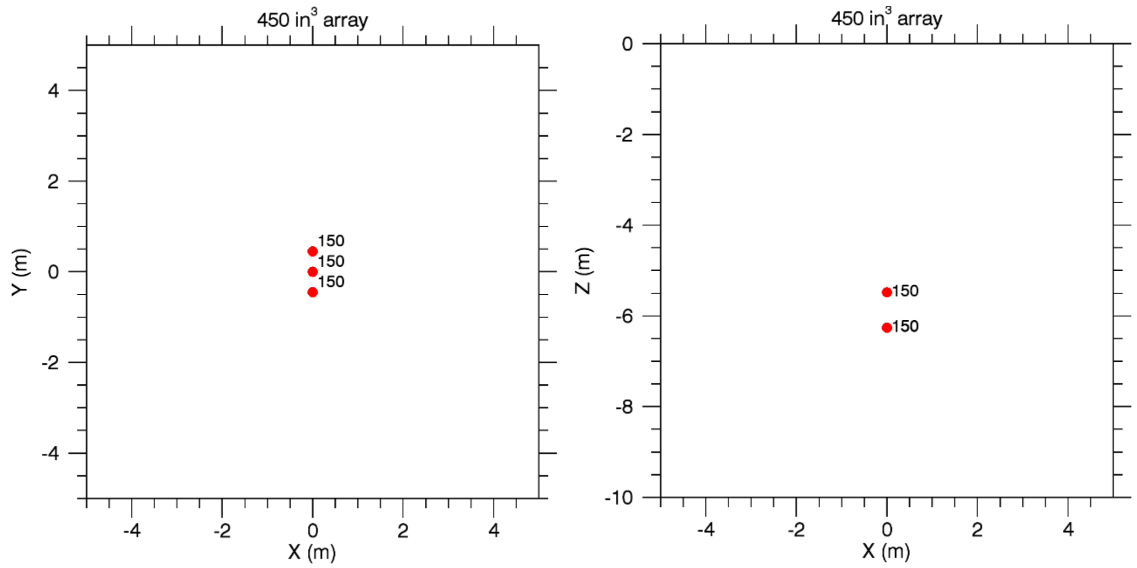


Figure 10. Layout of the modelled 450 in³ VSP array, plan view (left) and side view (right). Centroid operating depth is 6 m. The labels indicate the firing volume (in cubic inches) for each airgun. The convention is that the array is towed in the positive x direction. Also see Table 6.

Table 6. Layout of the modelled 450 in³ VSP array.Centroid operating depth is 6 m. Firing pressure for all guns is 2000 psi. The tow direction is assumed to be in the positive *x* direction.

Gun	*x* (m)	*y* (m)	*z* (m)	Volume (in³)
1	0.0	0	5.48	150
2	0.0	0.45	6.26	150
3	0.0	- 0.45	6.26	150

3.2. Sound Propagation Models

3.2.1. Boomer

The boomer source can be treated as an omnidirectional source for the frequencies of 1000 Hz and lower. For frequencies higher than 1000 Hz, the directionality of the boomer was taken into account. Due The acoustic field projected by the boomer source in 1/3-octave-bands was modelled using two propagation models: for frequencies of 1000 Hz and below MONM-RAM was used, while frequencies above 1000 Hz were modelled using MONM-BELLHOP. These were combined in post processing to determine the acoustic field across the entire frequency range. To determine the maximum range to PK, and PK-PK thresholds, spherical spreading laws were applied to the source level in the downward direction; these are usable due to the short ranges associated with the identified threshold levels within which no appreciable pulse dilation will occur nor reflections.

The acoustic propagation modelling was conducted in terms of PK, PK-PK and SEL units. The conversion to the SPL units was done based on Equation A-5 considering the T_{90} equal to 0.2 ms for the distances from the source less than 20 m, and 10 ms for the distances greater than 20 m from the source.

3.2.2. Sub-bottom Profiler

As the sub-bottom profiler was found only to have significant energy above 1 kHz it was assumed to be directional throughout its operational range. Consequently, MONM-BELLHOP was employed to model the entire frequency range of the SEL acoustic field in terms of 1/3-octave-bands. The ranges to PK and PK-PK levels were determined using spherical spreading laws.

The conversion to the SPL units was done based on Equation A-5 considering the T_{90} equal to 8 ms as determined by the measurement study.

3.2.3. VSP

Four sound propagation models (Appendix C) were used to predict the acoustic field around the VSP array for frequencies from 5 Hz to 25 kHz:

- Range-dependent parabolic equation model (Marine Operations Noise Model, MONM)
- Range-dependent ray tracing model (BELLHOP)
- Full Waveform Range-dependent Acoustic Model (FWRAM)
- Wavenumber integration model (VSTACK).

The models were used in combination to characterise the acoustic fields at short and long ranges in terms of SEL, SPL, PK, and PK-PK.

3.3. Accumulated SEL

3.3.1. Method overview

During a geophysical survey, a new portion of sound energy is introduced into the environment with each pulse from the survey equipment. An accurate assessment of the cumulative acoustic field depends not only on the parameters of each impulse, but also on the number of impulses delivered over a period and the relative position of the impulses. Consideration of the total acoustic energy marine fauna is subjected to over the survey operations is required for comparison to the relevant effect criteria (Section 2).

When there are many pulses, it becomes computationally prohibitive to perform sound propagation modelling for every single event. The offset between the consecutive pulses is small enough, however, that the environmental parameters that influence sound propagation are virtually the same for many impulse points. The acoustic fields can, therefore, be modelled for a subset of pulses and estimated at several adjacent ones. After sound fields from representative impulse locations are calculated, they are adjusted to account for the source position for nearby impulses.

Although estimating the cumulative sound field with the described approach is not as precise as modelling sound propagation at every impulse location, small-scale, site-specific sound propagation features tend to blur and become less relevant when sound fields from adjacent impulses are summed. Larger scale sound propagation features, primarily dependent on water depth, dominate the cumulative field. The accuracy of the present method acceptably reflects those large-scale features, thus providing a meaningful estimate of a wide area SEL field in a computationally feasible framework.

3.3.2. Scenario definition

Four regions were identified for the cumulative study, each requiring many thousands of individual impulses. In each region a representative single pulse noise field for the relevant source is shifted in space and noise fields summed to provide a composite field. For the Thylacine location, two possible surveys were combined into a single scenario, referred to as Thylacine Combined. This scenario included a total of 38 lines each being 7.025 km in length (total estimated time of 51 h including turns). The other three scenarios, Geographe 3 (G3), Artisan (ARTISAN) and VICP69 Meeki (MEEKI), each featured 41 lines, of 4.0 km length (total estimated time of 40.2 h. Along each line the operating sequence was to alternate between the sub-bottom profiler and the boomer with the vessel travelling at 4.5 knots and a turn time of 30 minutes during which no source would be operated. The proposed areas are shown in Figure 11.

To produce maps of cumulative received sound level distribution and calculate distances to specified sound level thresholds at the seafloor, the sound level was calculated at a subset of points within the modelled region. The radial grids of sound levels of the modelled sites at each point were then resampled (by linear triangulation) to produce a regular Cartesian grid. These grids were transposed geographically to each impulse location along the survey lines. The sound field grids from all impulses were summed, using Equation A-4, to produce the cumulative sound field grid. The produced grids had a cell size of 5 m. The contours and threshold ranges were calculated from these flat Cartesian projections of the modelled acoustic fields.

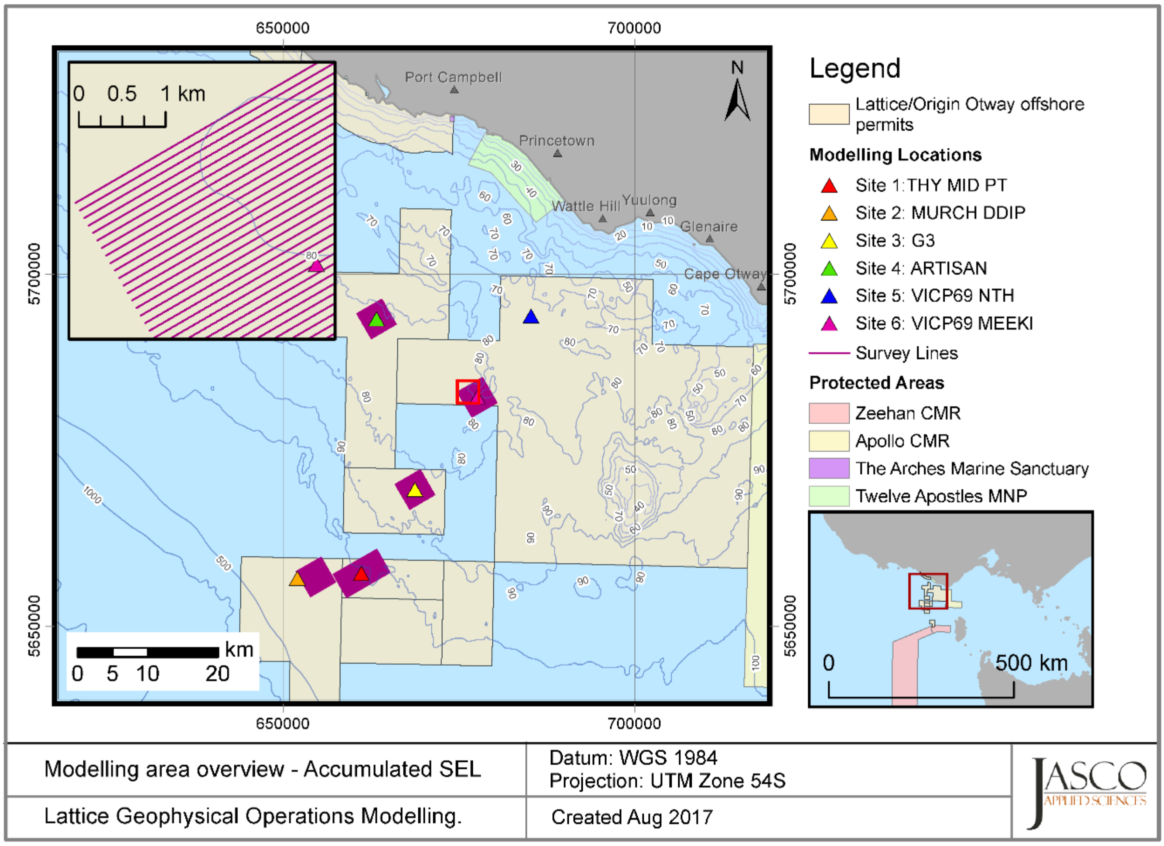


Figure 11. Overview of site surveys (and survey lines) under consideration. The site surveys are referred to by the name of the modelling location located at the same site.

3.4. Geometry and Modelled Regions

The modelled regions were defined based on the anticipated noise footprint of each of the sources. The VSP is significantly louder than either the boomer or the sub-bottom profiler, as well as having greater energy at lower frequencies that would typically propagate further than higher frequencies. The VSP, therefore was modelled in MONM in a series of radial slices with a maximum length of 56 km; the radial slices were 2.5° apart providing a total of 144 individual two-dimensional sound fields that were interpolated onto a regular three-dimensional grid to determine the output metrics. The range step in MONM was 10 m, used across the entire frequency range of 10 to 2000 Hz.

To determine the conversion factor from SEL to SPL, FWRAM was used with four transects modelled (cardinal directions). The Full Waveform Range-dependent Acoustic Model (FWRAM) employs a frequency dependent range step varying from 50 m at 10 Hz to 10 m at 1000 Hz. To calculate the near-field results the VSP was modelled in VSTACK, a wavenumber integration model; results were generated up to a frequency of 1 kHz up to 500 m away. Only a single range-independent transect was modelled using VSTACK.

The boomer and the sub-bottom profiler sources are more strongly directional than the VSP and operate at higher frequencies; consequently, the modelling was principally performed using BELLHOP, the beam-tracing model. The field was modelled in radial slices each 10° apart to provide 36 modelled transects, up to a maximum range of 3.5 km, with a range step of 1 m to provide high-resolution outputs. Where the boomer was omnidirectional (at 1 kHz), MONM was used to generate the contribution; otherwise, BELLHOP was used throughout. These modelling runs were performed separately for each of the six identified single pulse sites.

4. Results

This section presents the model results as distances to sound level thresholds and as sound field contour maps.

4.1. Acoustic Source Levels and Directivity

4.1.1. VSP Array

The pressure signatures of the individual airguns and the composite 1/3-octave-band point-source equivalent directional levels of the arrays were modelled with AASM (Section 3.1). Although AASM accounts for the effects of surface-reflected signals on bubble oscillations and inter-bubble interactions in the notional pressure signatures of each airgun, the signal reflected off the water surface (known as surface ghost) is not included in the far-field source signatures; however, the acoustic propagation models account for those surface reflections because they are a property of the propagating medium rather than the source.

The horizontal and vertical overpressure signatures, corresponding power spectrum levels, and the horizontal directivity plots for array is provided in Appendix B.4.

To help compare these results to the outputs of other airgun array source models, Table 7 presents the vertical source level that accounts for the surface ghost, and lists the broadband PK, and per-pulse SEL source levels of the array in the endfire, broadside, and vertical directions.

Table 7. Source level specifications in the horizontal plane for the 450 in^3 VSP array, for a 6 m centroid depth.

Direction	PK (dB re 1 µPa @ 1 m)	SEL (dB re 1 µPa^2·s @ 1 m)	
		10–2000 Hz	2000–25000 Hz
Broadside	237.6	213.6	167.7
Endfire	237.8	213.7	173.4
Vertical (no ghost)	237.6	213.6	171.1
Vertical (with ghost)	237.6	215.7	174.1

4.2. Single Pulse Sound Fields

4.2.1. Tabulated Results

4.2.1.1. Boomer

The single pulse sound fields for the representative boomer (an AP3000 triple plate boomer) are presented in terms of maximum-over depth SPL for marine mammal and turtle behavioural thresholds (Table 8), maximum-over-depth and seafloor per-pulse SEL (Tables 9 and 10), and water column PK-PK and PK (Tables 11 and 12). Water column PK-PK and PK are included as the levels referenced for benthic invertebrates in Section 2.1 are not reached at the seafloor.

Table 8. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the boomer to modelled maximum-over-depth marine mammal and turtle behavioural response thresholds.

	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
Marine mammal behaviour SPL: 160 dB re 1 µPa	142	139	75	72	140	136	138	134	136	132	145	134
Turtle behaviour, SPL: 166 dB re 1 µPa	36	35	36	35	36	35	36	35	36	35	36	35

Table 9. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the boomer to modelled maximum-over-depth per-pulse SEL isopleths.

Per-pulse SEL (dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}
160	7	7	7	7	6	6	7	6	7	7	6	6
155	13	12	12	12	13	12	12	12	12	12	12	12
150	21	21	21	21	21	21	22	21	21	21	22	21
145	38	37	38	37	38	37	39	38	38	37	38	37
140	84	77	70	67	136	134	131	127	134	129	135	129
135	233	226	244	229	226	208	288	208	303	215	253	216
130	768	609	604	504	738	559	868	725	908	671	762	628
125	2070	1500	1810	1220	1900	1380	1740	1490	1810	1520	1880	1310
120	3260	2660	3250	2480	3210	2480	3000	2460	3070	2460	3100	2440

Table 10. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the boomer to modelled seafloor per-pulse SEL isopleths. A dash indicates the level is not reached.

Per-pulse SEL (dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}
160	—	—	—	—	—	—	—	—	—	—	—	—
155	1	1	—	—	—	—	—	—	—	—	—	—

Per-pulse SEL (dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}	R_{max}
150	3	3	2	2	1	1	1	1	1	1	1	1
145	6	5	5	5	4	4	3	3	4	4	4	4
140	62	60	13	12	136	135	131	127	134	130	135	130
135	232	226	243	229	226	208	288	208	303	213	253	209
130	668	607	602	504	634	547	868	636	908	661	762	651
125	1960	1500	1810	1170	1690	1310	1740	1510	1810	1540	1880	1280
120	3240	2580	3230	2410	3060	2380	3000	2330	3070	2390	2920	2370

Table 11. Maximum (R_{max}) vertical distances down (in m) from the boomer to modelled PK-PK isopleths in the water column. The source is operated at 2 m depth, the results are site independent.

PK-PK (dB re 1 µPa)	Vertical Distance from source (m)
215	2.4
212	3.4
210	4.3
209	4.8
205	7.6
202	10.8

Table 12. Maximum (R_{max}) vertical distances down (in m) from the boomer to modelled PK isopleths in the water column. The source is operated at 2 m depth, the results are site independent.

PK (dB re 1 µPa)	Vertical Distance from source (m)
213	0.6
210	0.8
207	1.6

4.2.1.2. Sub-bottom Profiler

The single pulse sound fields for the representative sub-bottom profiler (an EdgeTech X-Star SBP-216) are presented in terms of maximum-over depth SPL for marine mammal and turtle behavioural thresholds (Table 13), maximum-over-depth and seafloor per-pulse SEL (Tables 14 and 15), and water column PK-PK and PK (Tables 16 and 17). Water column PK-PK and PK are included as the levels referenced for benthic invertebrates in Section 2.1 are not reached at the seafloor.

Table 13. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the sub-bottom profiler to modelled maximum-over-depth applied marine mammal and turtle behavioural response thresholds. A dash indicates the threshold is not reached.

Per-pulse SEL (dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
Marine mammal behaviour SPL: 160 dB re 1 µPa	2	2	2	2	2	2	2	2	2	2	2	2
Turtle behaviour, SPL: 166 dB re 1 µPa	—	—	—	—	—	—	—	—	—	—	—	—

Table 14. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the sub-bottom profiler to modelled maximum-over-depth per-pulse SEL isopleths. A dash indicates the level is not reached.

Per-pulse SEL (dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
145	—	—	—	—	—	—	—	—	—	—	—	—
140	1	1	1	1	1	1	1	1	1	1	1	1
135	4	4	4	4	4	4	4	4	4	4	4	4
130	8	8	8	7	7	7	7	7	7	7	7	7
125	13	12	13	13	11	11	10	10	10	10	11	10
120	16	16	19	18	14	13	13	12	13	13	13	13

Table 15. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in m) from the sub-bottom profiler to modelled seafloor per-pulse SEL isopleths. A dash indicates the level is not reached.

Per-pulse SEL (dB re 1 µPa²·s)	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
135	—	—	—	—	—	—	—	—	—	—	—	—
130	—	—	—	—	—	—	5	5	6	6	6	6
125	10	10	13	13	9	9	8	8	8	8	10	9
120	15	14	19	18	13	12	12	12	13	12	13	13

Table 16. Maximum (R_{max}) vertical distances down (in m) from the boomer to modelled PK-PK isopleths in the water column. The source is operated at 3 m depth, the results are site independent.

PK-PK (dB re 1 µPa)	Vertical Distance from source (m)
215	0.3
212	0.4
210	0.5
209	0.6
205	1.0

PK-PK (dB re 1 µPa)	Vertical Distance from source (m)
202	1.4

Table 17. Maximum (R_{max}) vertical distances down (in m) from the boomer to modelled PK isopleths in the water column. The source is operated at 3 m depth, the results are site independent.

PK (dB re 1 µPa)	Vertical Distance from source (m)
213	0.1
210	0.2
207	0.3

4.2.1.3. VSP

The single pulse results for the 450 in^3 VSP array operating in 72 m of water at Site 5 are presented in terms of maximum-over-depth per-pulse SEL and SPL (Tables 18 and 19), and seafloor per-pulse SEL, PK-PK and PK (Tables 20–22).

Table 18. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 450 in^3 VSP array to modelled maximum-over-depth per-pulse SEL isopleths at Site 5. The 160 dB re 1 µPa^2·s isopleth (bold values) is associated with the DEWHA (2008) criterion.

Per-pulse SEL (dB re 1 µPa²·s)	Distance (km)	
	R_{max}	$R_{95\%}$
190	<0.02	<0.02
180	0.04	0.04
170	0.23	0.22
160	**1.06**	**1.03**
150	3.55	3.10
140	8.76	7.80
130	>23.0	>19.0

Table 19. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 450 in^3 VSP array to modelled maximum-over-depth SPL isopleths at Site 5 The 166 and 160 dB re 1 µPa isopleths (bold values) are associated with the turtle and marine mammal behavioural response thresholds.

SPL (dB re 1 µPa)	Distance (km)	
	R_{max}	$R_{95\%}$
190	<0.04	<0.04
180	0.22	0.21
170	0.89	0.86
166	**1.55**	**1.45**
160	**2.56**	**2.44**
150	6.96	6.24

SPL (dB re 1 µPa)	Distance (km)	
	R_{max}	$R_{95\%}$
140	19.9	16.8
130	>48.0	>42.0

Table 20. Maximum (R_{max}) horizontal distances (in m) from the 450 in^3 VSP array to modelled seafloor per-pulse SEL isopleths at Site 5 using VSTACK. A dash indicates the level is not reached.

Per-pulse SEL (dB re 1 µPa^2·s)	Distance (m)
185	-
180	35
178	65
176	105
174	145
172	180
170	210

Table 21. Maximum (R_{max}) horizontal distances (in m) from the VSP array at Site 5 to modelled seafloor PK-PK isopleths. A dash indicates the level is not reached.

PK-PK (dB re 1 µPa)	Distance (m)
212	–
210	–
209	–
208	30
207	55
206	75
205	100
202	185

Table 22. Maximum (R_{max}) horizontal distances (in m) from the VSP array at Site 5 to modelled seafloor PK isopleths. A dash indicates the level is not reached.

PK (dB re 1 µPa)	Distance (m)
213	–
207	–
204	20
202	60
200	110

PK (dB re 1 µPa)	Distance (m)
198	165

4.2.2. Maps and Graphs

4.2.2.1. Boomer

Maps of the per-pulse SEL at the seafloor along with vertical slices for the representative boomer are shown for two representative sites, Site 1 (Thylacine Midpoint: Figures 12 and 13) and Site 4 (Artisan: Figures 14 and 15). The shape of the footprint at all six modelled sites (Table 1) is almost identical.

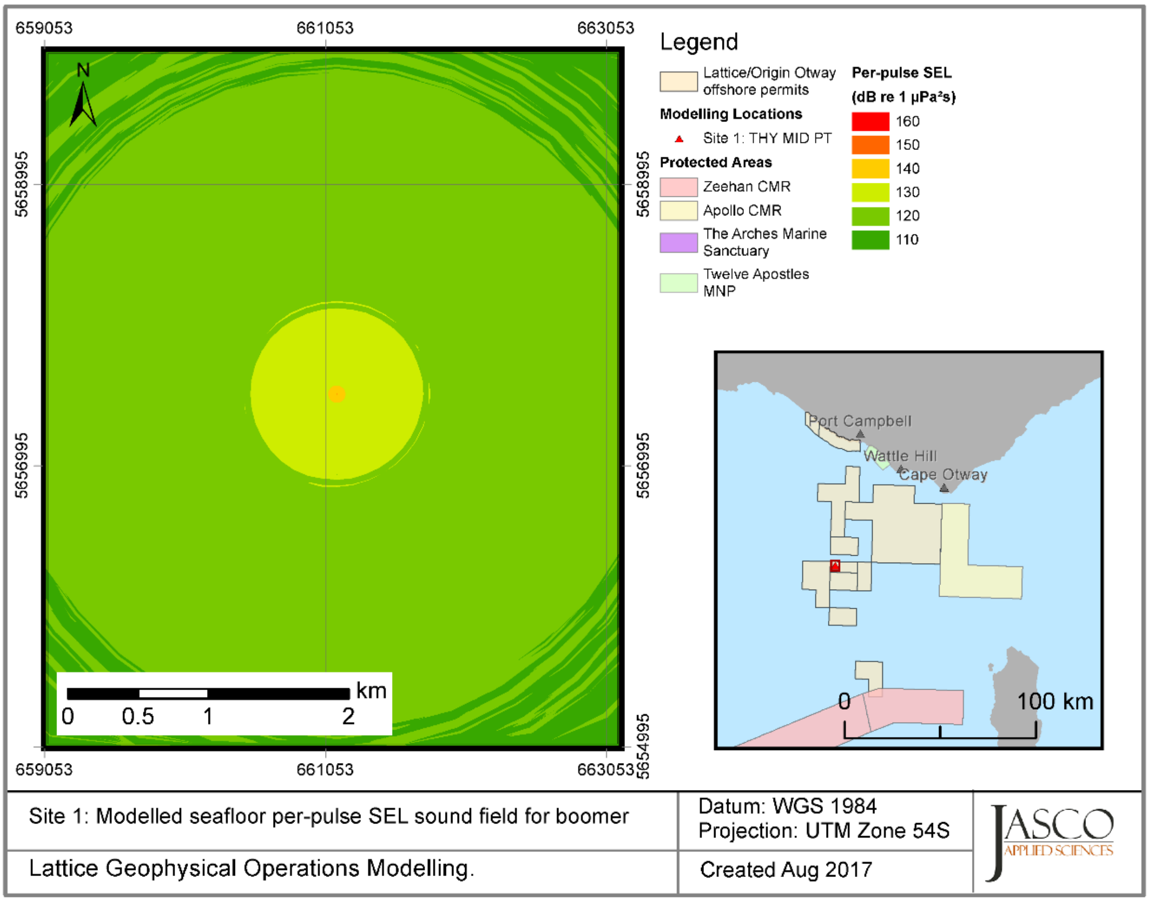


Figure 12. Boomer, Site 1: Sound level contour map showing unweighted seafloor per-pulse SEL results for the boomer towed at 2 m depth.

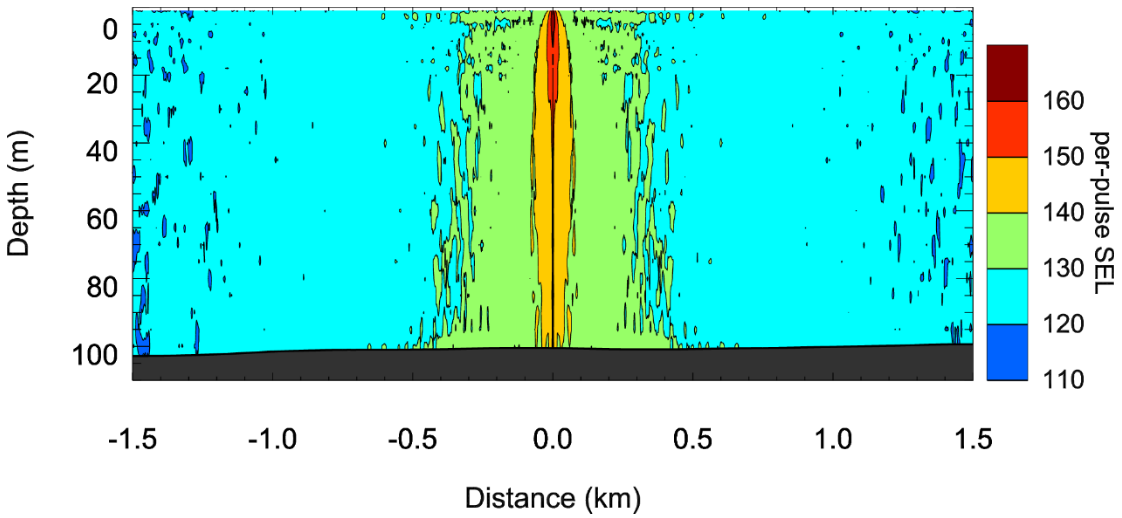


Figure 13. Boomer, Site 1: Predicted unweighted per-pulse SEL for the boomer towed at 2 m depth as vertical slices. Levels are shown from south to north.

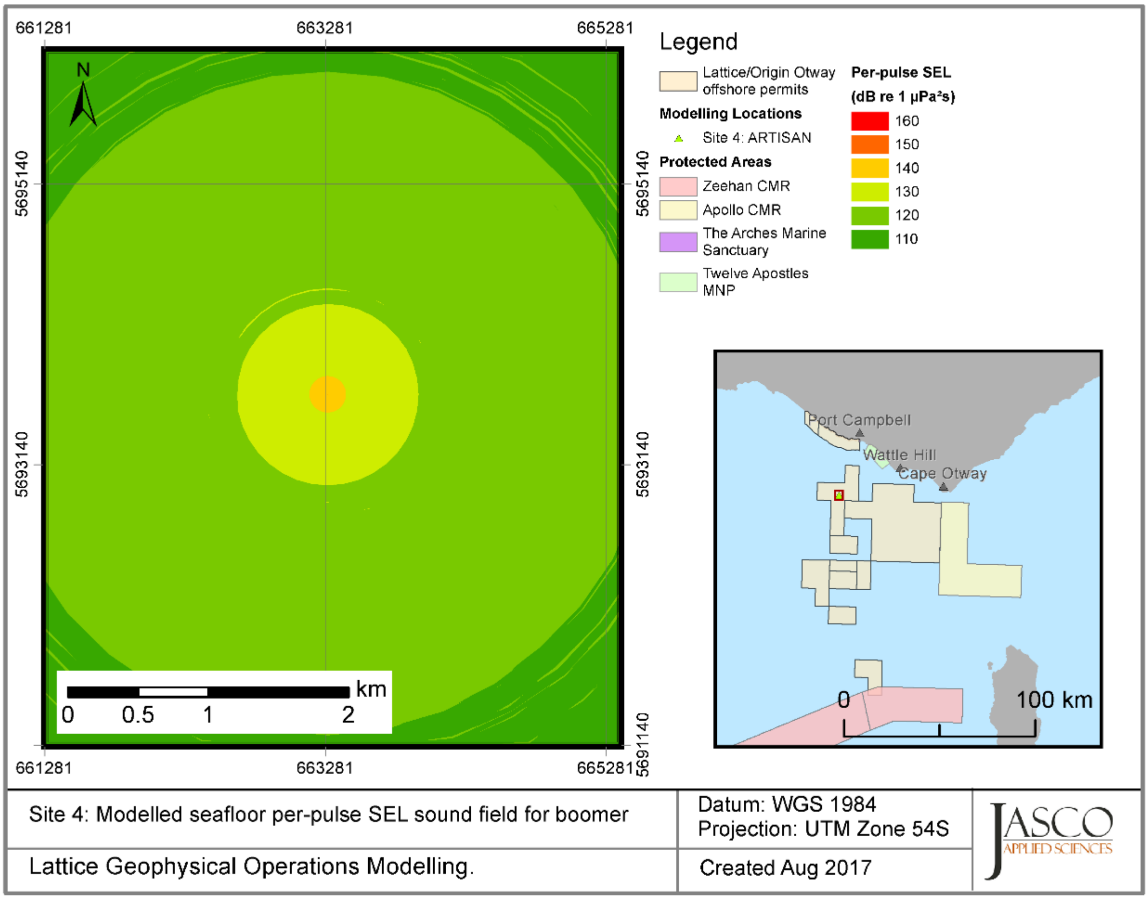


Figure 14. Boomer, Site 4: Sound level contour map showing unweighted seafloor per-pulse SEL results for the boomer towed at 2 m depth.

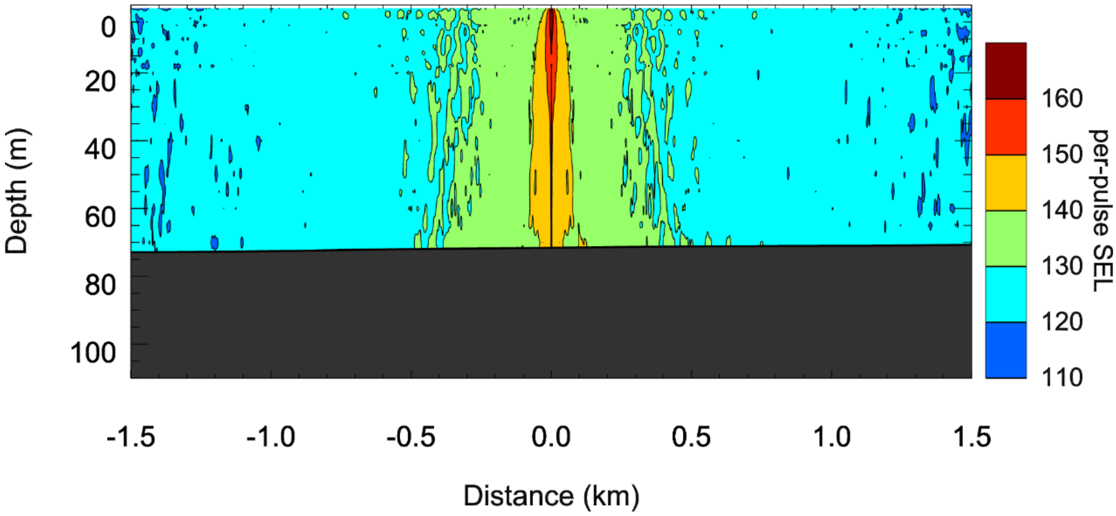


Figure 15. Boomer, Site 4: Predicted unweighted per-pulse SEL for the boomer towed at 2 m depth as vertical slices. Levels are shown from south to north.

4.2.2.2. Sub-bottom Profiler

Maps of the per-pulse SEL at the seafloor along with vertical slices for the representative SBP is shown for two representative sites, Site 1 (Thylacine Midpoint: Figures 16 and 17) and Site 4 (Artisan: Figures 18 and 19). The shape of the footprint at all six modelled sites (Table 1) is almost identical.

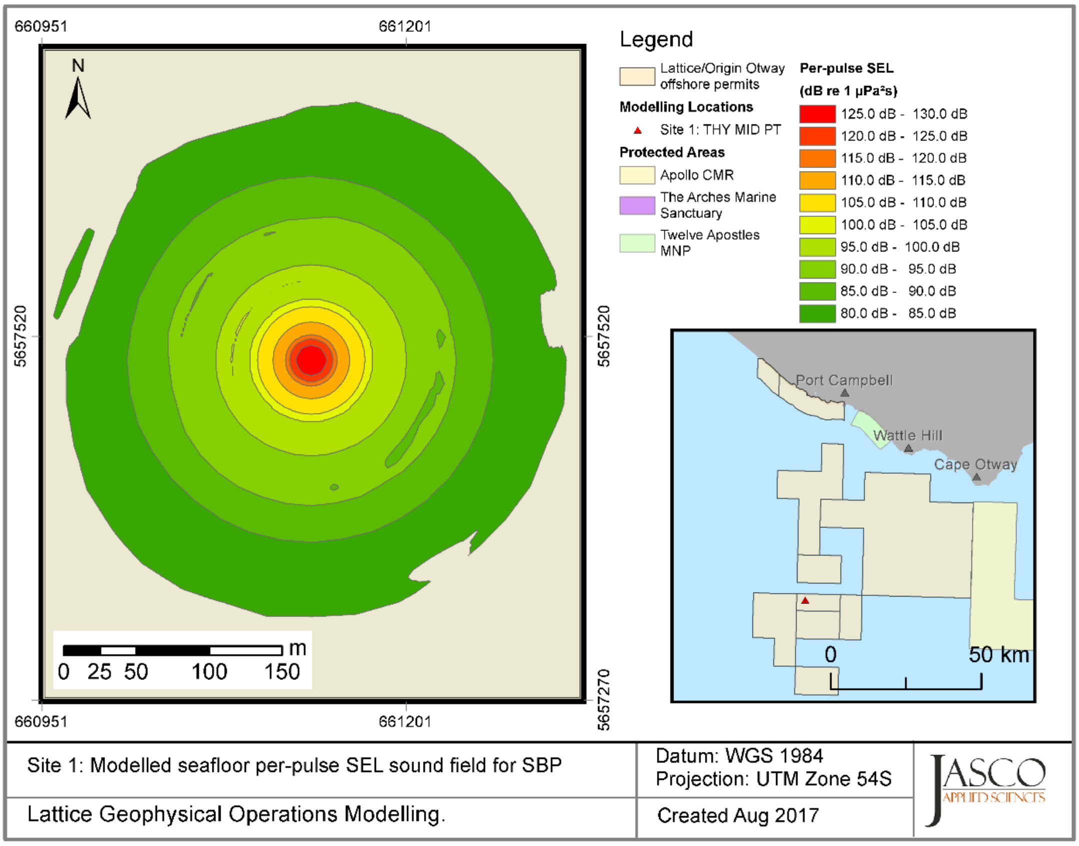


Figure 16. SBP, Site 1: Sound level contour map showing unweighted seafloor per-pulse SEL results for the SBP towed at 3 m depth.

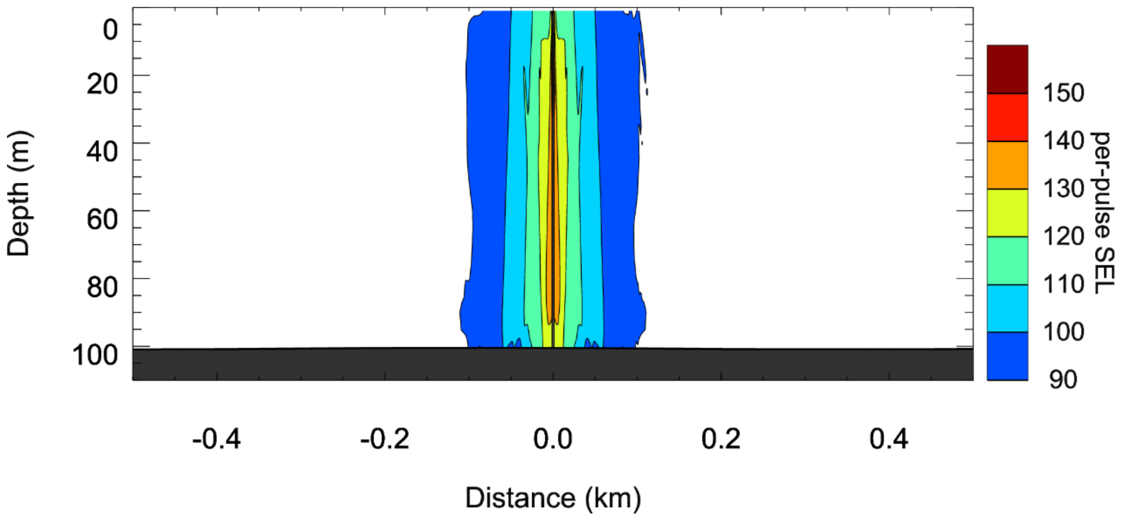


Figure 17. SBP, Site 1: Predicted unweighted per-pulse SEL for the SBP towed at 3 m depth as a vertical slice. Levels are shown from south to north.

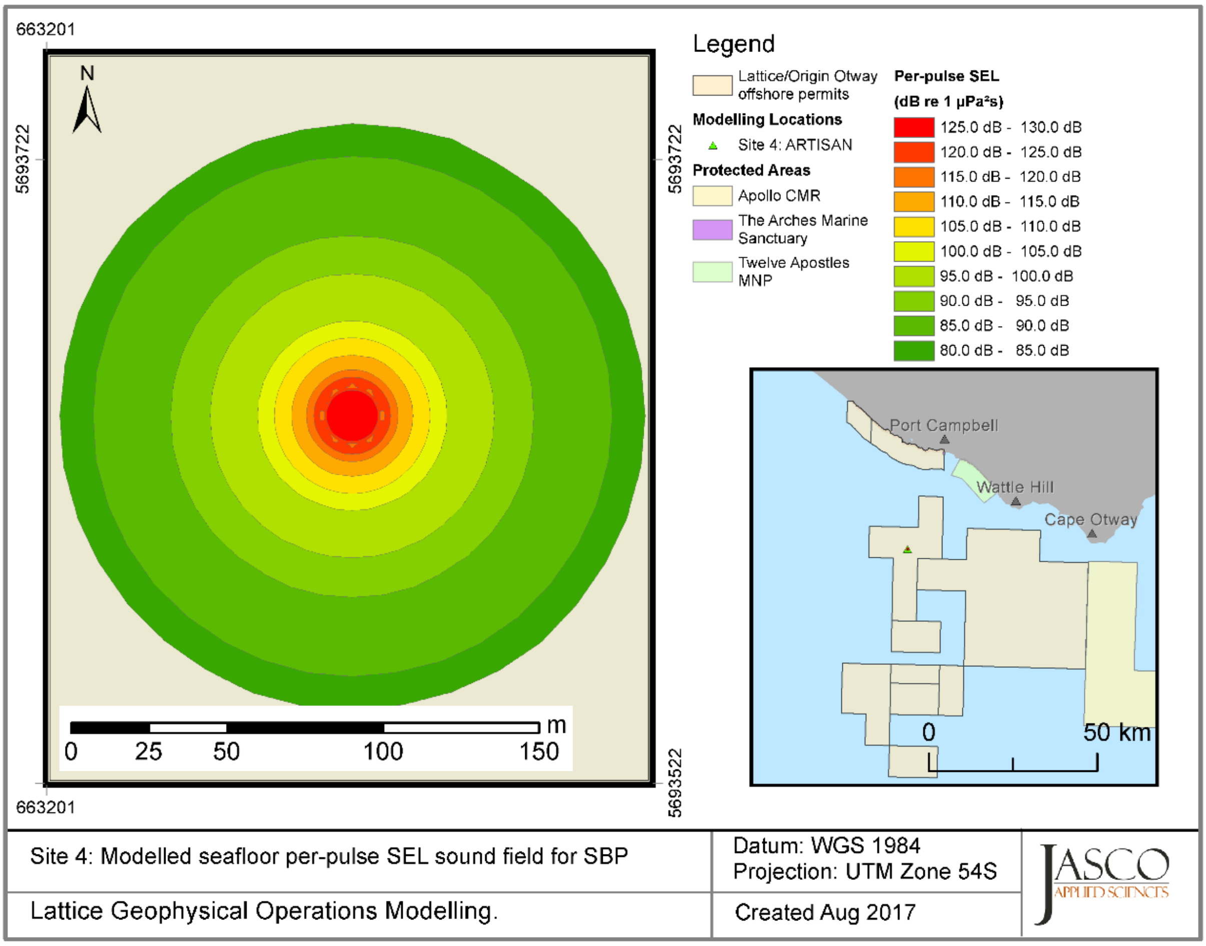


Figure 18. SBP, Site 4: Sound level contour map showing unweighted seafloor per-pulse SEL results for the SBP towed at 3 m depth.

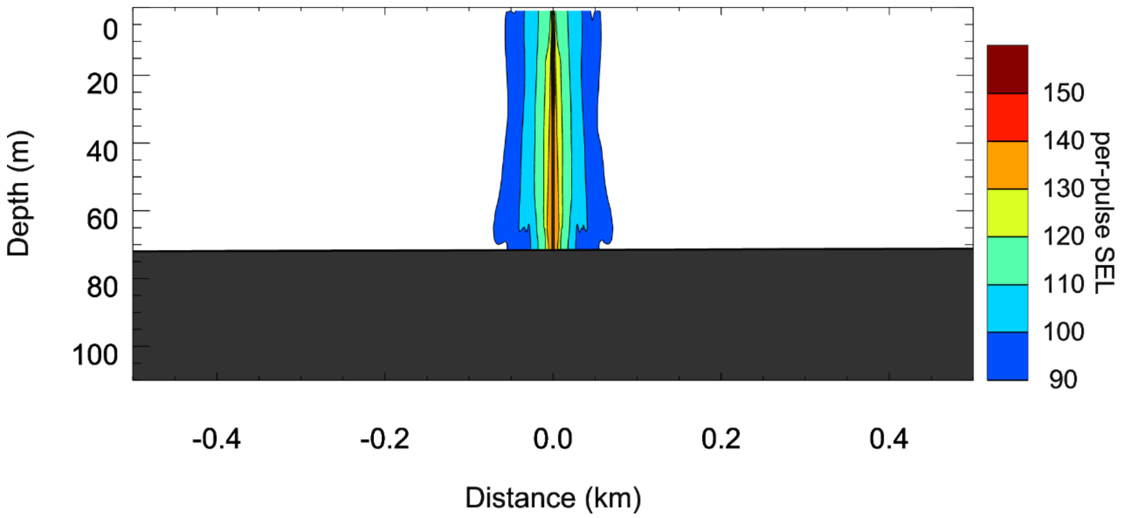


Figure 19. SBP, Site 4: Predicted unweighted per-pulse SEL for the SBP towed at 3 m depth as a vertical slice. Levels are shown from south to north.

4.2.2.3. VSP

Maps of the per-pulse SEL as maximum-over-depth along with vertical slices for the VSP is shown at Site 5, Block VICP69, North (Figures 20 and 21). Additionally, the PK and PK-PK at the seafloor out to 300 m is shown in Figure 22.

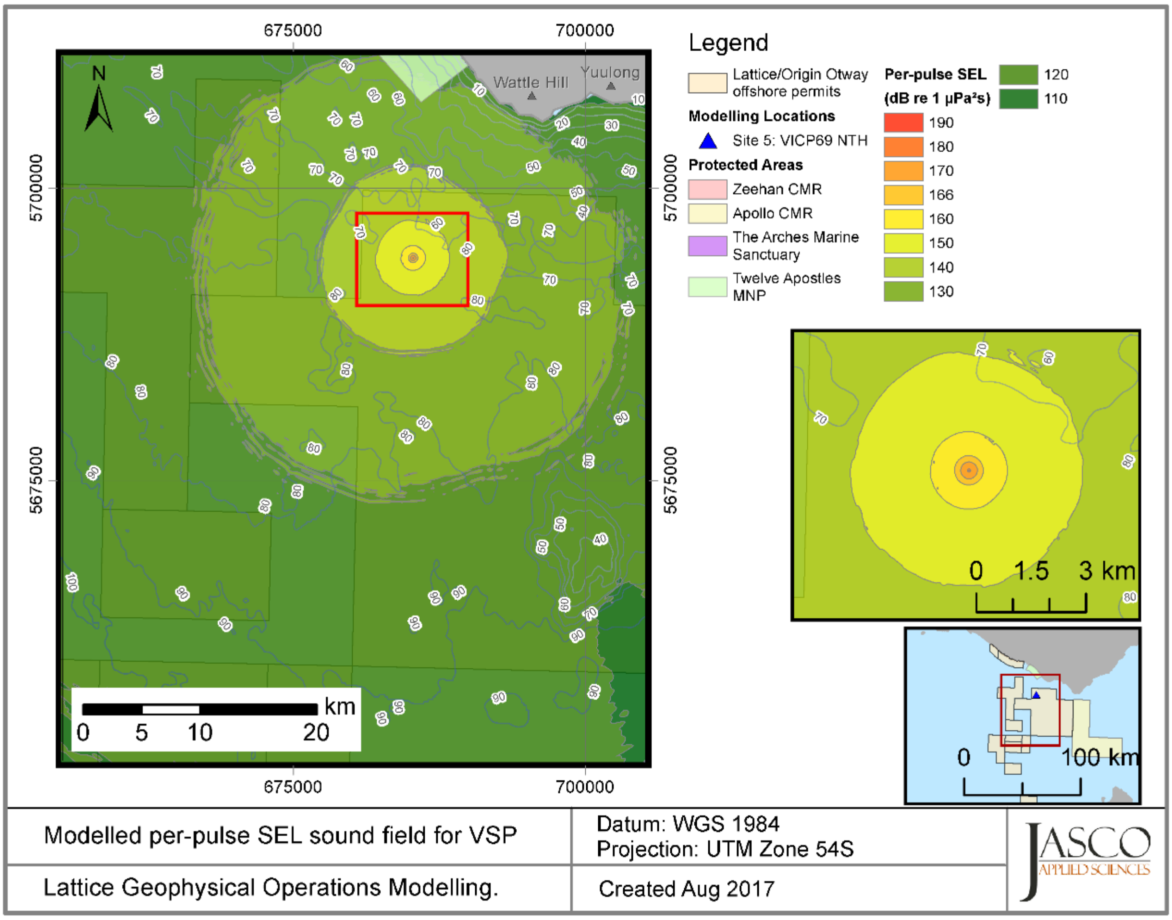


Figure 20. Sound level contour map showing unweighted maximum-over-depth per-pulse SEL results for the 450 in³ VSP array operated at 6 m depth at Site 5.

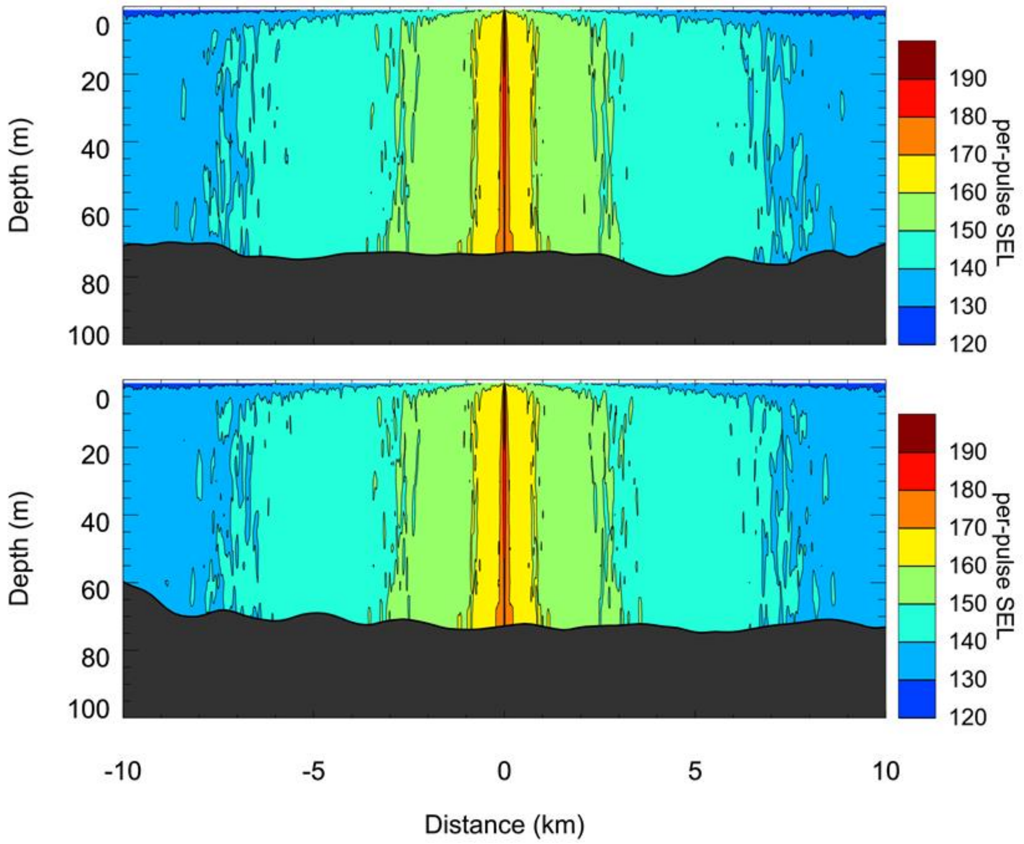


Figure 21. Predicted unweighted per-pulse SEL as vertical slices. Levels are shown in the broadside (top) and endfire directions (bottom). The source depth is 6 m.

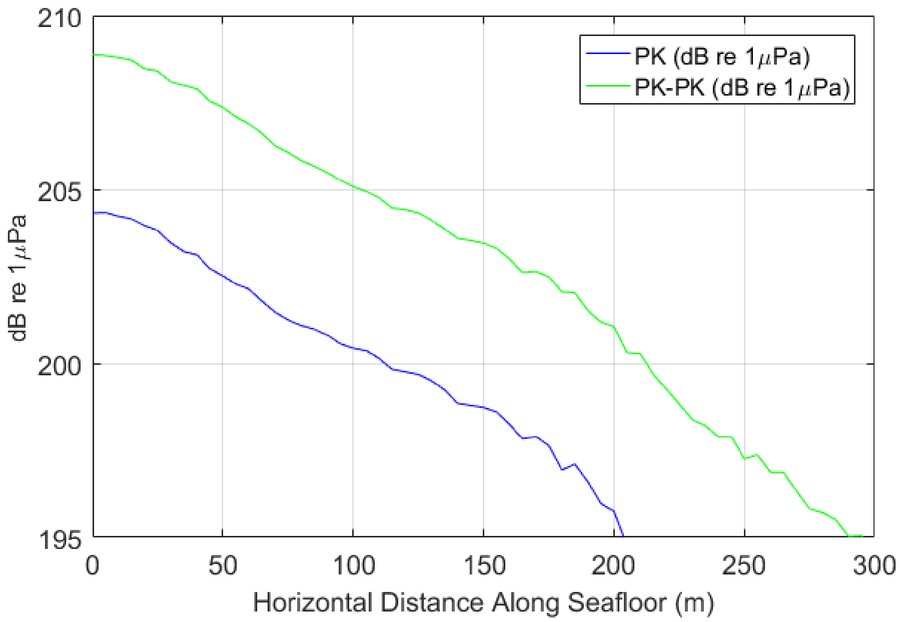


Figure 22. Predicted maximum PK and PK-PK in the endfire direction at the seafloor at Site 5, 72.8 m depth. The source depth is 6 m.

4.3. Accumulated Sound Exposure Levels

4.3.1. Tabulated Results

A cumulative noise study was performed for the four regions, Thylacine Combined, Geographe 3, Artisan, and Block VICP69 Meeki, as indicated in Figure 11. The study involved multiple survey lines with alternating pulses of the boomer and the sub-bottom profiler. Table 23 shows the distances to cumulative SEL thresholds at the seafloor where the accumulation period covers the entire survey.

Table 23. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the survey areas to modelled seafloor cumulative SEL isopleths, and the ensonified area to the specified threshold (in km²). A dash indicates that the level was not exceeded at the seafloor.

SEL (dB re 1 µPa²·s)	Thylacine Combined			Geographe 3			Artisan			Block VICP69, Meeki		
	R_{max} (km)	$R_{95\%}$ (km)	*Area* (km²)	R_{max} (km)	R_{max} (km)	*Area* (km²)	R_{max} (km)	R_{max} (km)	*Area* (km²)	R_{max} (km)	R_{max} (km)	*Area* (km²)
170	—	—	—	—	—	—	—	—	—	—	—	—
165	0.11	0.05	12.52	0.05	0.05	8.86	0.09	0.05	9.46	0.05	0.05	9.08
160	1.7	1.2	38.9	1.1	0.8	22.7	1.2	0.8	22.7	1.1	0.8	22.7
155	6.9	5.3	189	4.8	4.1	107	4.8	3.9	106	5.5	4.2	114
150	9.6	6.9	287	8.2	6.4	221	8.1	6.4	220	8.3	6.4	221
145	>10	>10	NA	>10	>10	NA	>10	>10	NA	>10	>10	NA

4.3.2. Sound Level Contour Maps

Maps of the accumulated SEL at the seafloor for the combined operations of the boomer and the SBP over the duration of the surveys (described in Section 3.3.2) are shown for the four considered surveys. These are at the Thylacine Combined (Figure 23), Geographe 3 (Figure 24), Artisan (Figure 25) and Block VICP69, Meeki (Figure 26) locations.

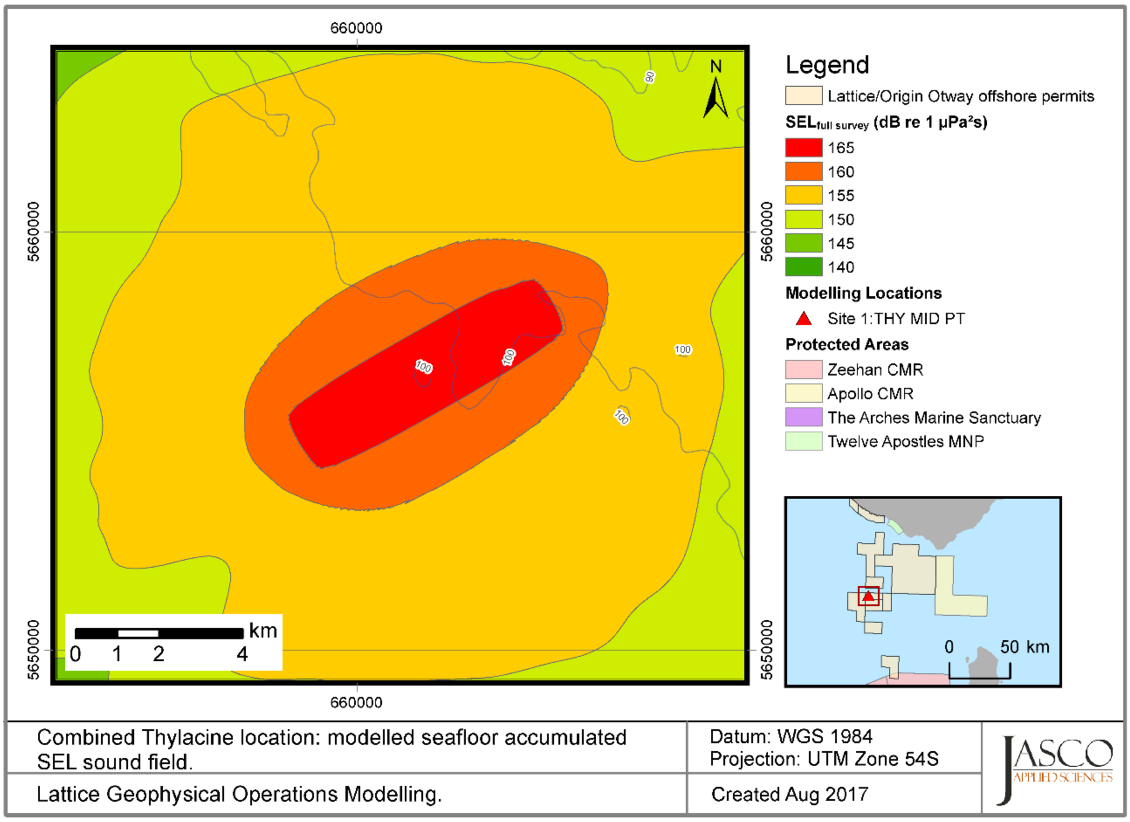


Figure 23. Thylacine Combined location: Sound level contour map of seafloor accumulated SEL over the full survey for the boomer and SBP operations.

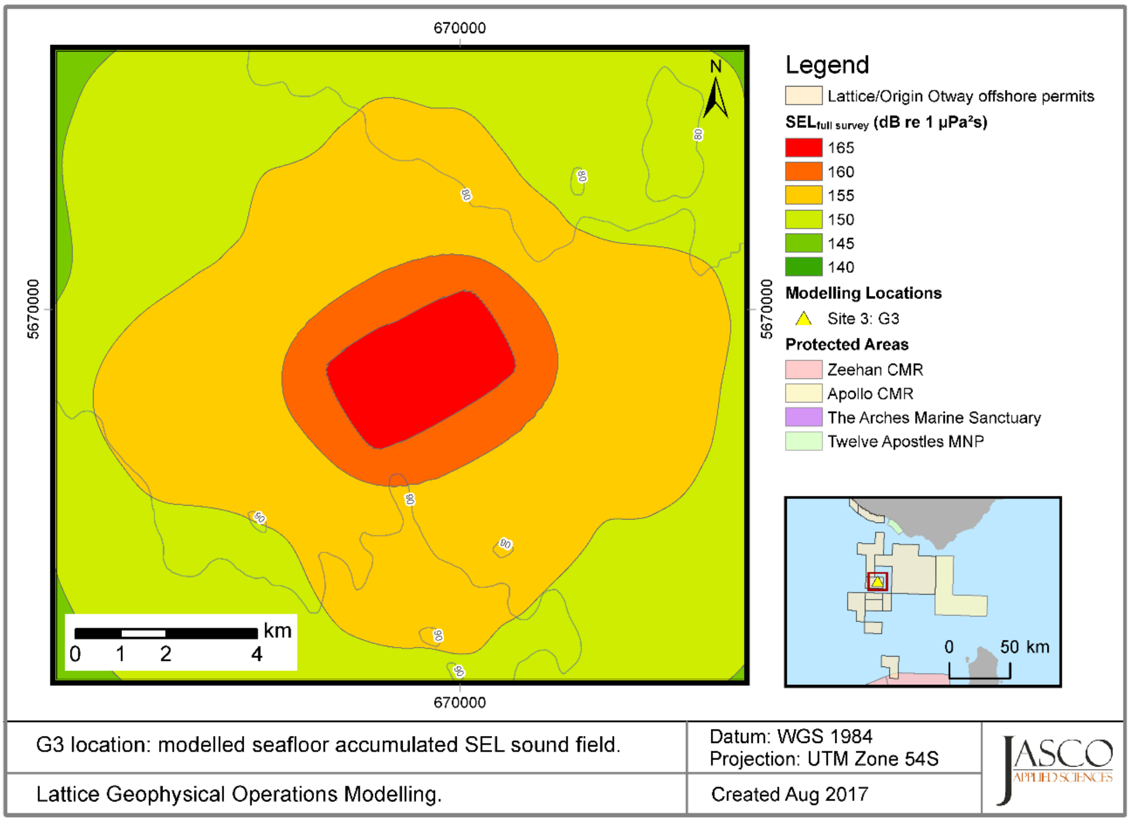


Figure 24. G3 location: Sound level contour map of seafloor accumulated SEL over the full survey for the boomer and SBP operations.

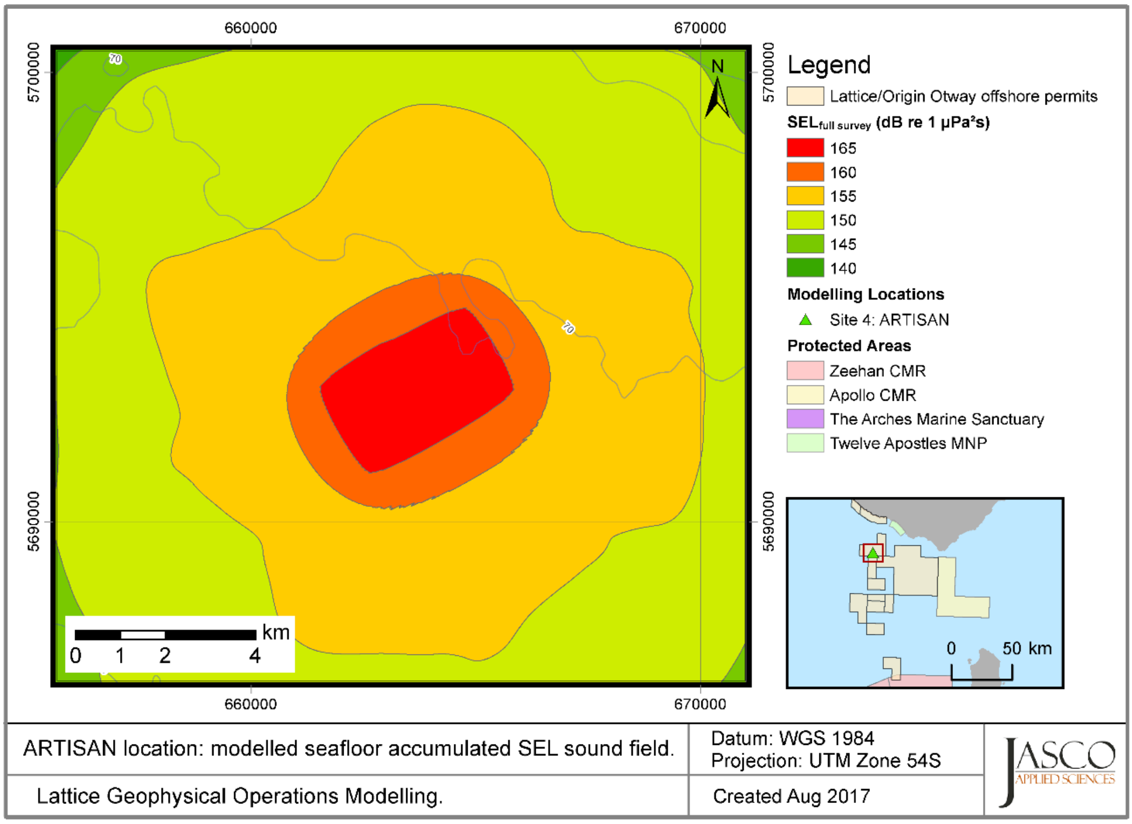


Figure 25. ARTISAN location: Sound level contour map of seafloor accumulated SEL over the full survey for the boomer and SBP operations.

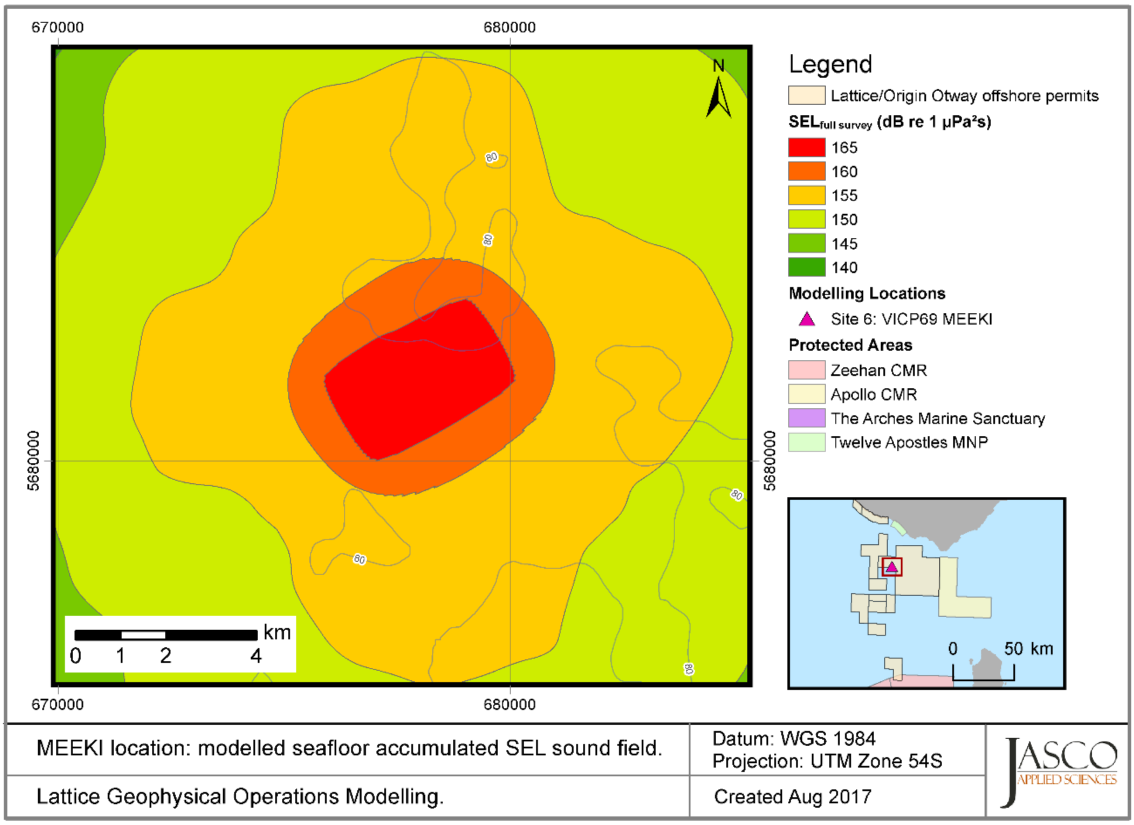


Figure 26. MEEKI location: Sound level contour map of seafloor accumulated SEL over the full survey for the boomer and SBP operations.

5. Discussion and Conclusion

5.1. Overview and source levels

This modelling study predicted underwater sound levels associated with the specified geophysical operations of the VSP, and surveys including boomer and sub-bottom profiler sources. Due to a lack of available literature on source functions for the high-frequency sources, the boomer and the sub-bottom profiler source inputs were determined from a previous JASCO measurement campaign (Sections 3.1.1 and 3.1.2). It was determined that the per-pulse SEL source level of the boomer was 180.0 dB re 1 µPa²·s @ 1 m, and for the sub-bottom profiler it was 171.4 dB re 1 µPa²·s @ 1 m; further metrics for the back propagated source levels are shown in Tables 4 and 5 respectively. The boomer was found to be a relatively broadband source with appreciable energy across the range of 160 Hz to 12.5 kHz (Figure 4). The sub-bottom profiler had the majority of energy at higher frequencies, between 5 kHz and 12.5 kHz.

The 450 in³ VSP was modelled using AASM at a centroid depth of 6 m (Section 3.1.3). The SEL source level of the VSP was 213.7 dB re 1 µPa²·s @ 1 m in the endfire direction, and 213.6 dB re 1 µPa²·s @ 1 m in the broadside direction; further source metrics are shown in Table 7. Most of the acoustic energy is output at lower frequencies, in the tens to hundreds of hertz. Due to the geometry of the array, the VSP is practically an omnidirectional source.

The modelling was performed using a typical September sound speed profile, as the setting most likely to achieve the greatest transmission, such that a precautionary estimation of distances can be made for the surveys (Section D.3.2). The lithography of the regions place Sites 1 & 2 in a region typified by a hard caprock, Sites 3, 4, and 6 in a region with a shallow sand layer over increasingly consolidated calcarenite, and Site 5 with a deeper sand layer over the calcarenite; this is detailed in Section D.3.3. The modelling also accounted for variations in site-specific bathymetry (Section D.3.1)

5.2. Single pulse sound fields

The results for the single pulse sound fields are presented in Section 4.2.

Across all sites, the maximum range for the boomer to exceed the marine mammal behavioural threshold (SPL of 160 dB re 1 µPa) is 145 m (Site 6), and to exceed the turtle behavioural threshold (SPL of 166 dB re 1 µPa) is 36 m, which is consistent across all sites (Table 8). The consistency for the turtle behavioural threshold is due to the levels being reached before influences from the site-dependent environment factors (bathymetry and geoacoustics). The range to the marine mammal behavioural threshold level at Site 2 is significantly shorter than at the other sites; this is due to the greater water depth and consequent lack of constructive noise fields within 150 m horizontally from the source.

The PK-PK ranges for the boomer are shown in Table 11. Due to the high threshold levels, the ranges were calculated assuming an acoustic field that is initially spherically spreading. This is valid where the source can be considered a point source, and there is no influence from reflecting surfaces. Due also to the directionality of the source, the ranges to the thresholds on-axis are going to be significantly greater than those off-axis and thus the vertical ranges from the sources are presented. It is shown that for the triple-plate boomer, the level drops below all relevant isopleths within 11 m of the source. Similar principles apply for PK levels in Table 12; the greatest range to a specified threshold is 1.6 m.

The SBP is a higher-frequency, more directional, and lower energy source than the boomer; consequently, the ranges are consistently lower. Using the generated source levels, the threshold for turtle behaviour is not reached at any horizontal distance from the source, and the marine mammal behavioural threshold is exceeded up to 2 m horizontally from the source (Table 13). Additionally, the ranges to thresholds at the seafloor are accordingly small (Table 15); here it is of note that the 115 and 120 dB re 1 µPa²·s SEL levels are at their greatest ranges at Site 2 due to the greater distance the conical beam may propagate, and thus widen, before reaching the interface.

For the SBP, the PK-PK and PK results were treated in the same way as for the boomer; results are shown for a spherically spreading noise field with the on-axis sound pressure analysed to determine ranges to thresholds. For the identified thresholds of interest for the SBP, the vertical distance does not exceed 1.4 m. In summary, sound fields from the boomer and the SBP do not reach any of the assessed thresholds for benthic crustaceans or fish (Section 2) at the seafloor.

The single pulse results for the VSP operated at Site 5 are shown in Section 4.2.1.3. The source has a significantly higher source level than either the boomer or the sub-bottom profiler. The maximum range to the DEWHA (2008) criterion of 160 dB re 1 µPa²·s SEL is 1.06 km, while the $R_{95\%}$ range is predicted to be 1.03 km. The maximum ranges to the marine mammal and turtle behavioural thresholds of 160 and 166 dB re 1 µPa SPL are 2.56 and 1.55 km respectively. The per-pulse SEL levels at the seafloor were modelled using VSTACK to allow for levels to be determined at high propagation angles. The maximum per-pulse SEL on the seafloor below the array is 181 dB re 1 µPa²·s, therefore the levels from Day et al. (2016b) of 190, 188 and 186 dB re 1 µPa²·s, are not reached at the seafloor.

In the case of the VSP source, PK thresholds of interest are reached at the seafloor and so it was modelled fully with all environmental parameters considered, rather than the spherical spreading approach used for the other two sources. The results show that the lowest isopleth of interest derived from Day et al. (2016b), 209 dB re 1 µPa, is not reached at the seafloor, and the horizontal range along the seafloor to the 202 dB re 1 µPa PK-PK level from Payne et al. (2007) is 185 m. PK metrics relevant to the Popper et al. (2014) criteria for fish are also not reached at the seafloor.

In this modelling study, both the boomer and sub-bottom profiler sources were directed straight down. Consequently, the sound channels constructed as a result of the sound speed profile are unlikely to influence the propagation of sound greatly. It is of note, that if either high-frequency source is directed toward the sea surface then the sound channels are likely to enhance the propagation of these sources. As the VSP is typically a low-frequency source, the fine details in the sound speed profile near the surface are unlikely to influence the propagation.

5.3. Multiple pulse sound fields

The study included modelling to assess the cumulative effect of noise generated for four separate survey areas. The surveys themselves comprise multiple lines along which the boomer and sub-bottom profiler sources are fired alternately. In total, more than 27000 pulses were included for the Thylacine Combined survey over the estimated 51 h of survey, and more than 21000 pulses for each of the other three surveys over the estimated 40.2 h. Sound levels were assessed only at the seafloor with results shown in Table 14. The modelling results show that the SEL at the seafloor did not exceed 170 dB re 1 µPa²·s for any single survey. This is below any of the relevant isopleths for benthic invertebrates, including the 183 dB re 1 µPa²·s ‘no effect’ accumulated SEL (McCauley and Duncan 2016). Due to the identical sources, and sound speed profiles, and similar depths and geoacoustics, the ranges between the surveys are similar. The greatest ranges are realised for the Thylacine Combined survey; here, the survey is in deeper water than the others as well as featuring the caprock layer that is likely to produce stronger reflections off the sediment layer.

Glossary

3-D
Three-dimensional

1/3-octave-band
Non-overlapping passbands that are one-third of an octave wide (where an octave is a doubling of frequency). Three adjacent 1/3-octave-bands comprise a one octave-band. One-third-octave-bands become wider with increasing frequency. Also see octave.

90% time window
The time interval over which the cumulative energy rises from 5% to 95% of the total pulse energy. This interval contains 90% of the total pulse energy. Symbol: T_{90}.

90% sound pressure level (SPL(T_{90}))
The root-mean-square sound pressure levels calculated over the 90%-energy time window of a pulse. Used only for pulsed sounds.

attenuation
The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium.

audiogram
A graph of hearing threshold level (sound pressure levels) as a function of frequency, which describes the hearing sensitivity of an animal over its hearing range.

azimuth
A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also called bearing.

bandwidth
The range of frequencies over which a sound occurs. Broadband refers to a source that produces sound over a broad range of frequencies (e.g., seismic airguns, vessels) whereas narrowband sources produce sounds over a narrow frequency range (e.g., sonar) (ANSI/ASA S1.13-2005 R2010).

BIA
Biologically Important Area (http://www.environment.gov.au/marine/marine-species/bias)

broadside direction
Perpendicular to the travel direction of a source. Compare to endfire direction.

cetacean
Any animal in the order Cetacea. These are aquatic, mostly marine mammals and include whales, dolphins, and porpoises.

decibel (dB)
One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power (ANSI S1.1-1994 R2004).

endfire direction
Parallel to the travel direction of a source. Also see broadside direction.

ensonified area
The total area ensonified in conjunction with a specified isopleth.

frequency
The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

functional hearing group
Grouping of marine mammal species with similar estimated hearing ranges. Southall et al. (2007) proposed the following functional hearing groups: low-, mid-, and high-frequency cetaceans, pinnipeds in water, and pinnipeds in air.

geoacoustic
Relating to the acoustic properties of the seafloor.

hearing threshold
The sound pressure level that is barely audible for a given individual in the absence of significant background noise during a specific percentage of experimental trials.

hertz (Hz)
A unit of frequency defined as one cycle per second.

high-frequency cetacean
The functional hearing group that represents odontocetes specialised for using high frequencies.

impulsive sound
Sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA 2013, ANSI S12.7-1986 R2006). For example, seismic airguns and impact pile driving.

low-frequency cetacean
The functional hearing group that represents mysticetes (baleen whales).

maximum-over-depth (MOD)
The maximum value over all modelled depths above the sea floor.

mid-frequency cetacean
The functional hearing group that represents some odontocetes (dolphins, toothed whales, beaked whales, and bottlenose whales).

mysticete
Mysticeti, a suborder of cetaceans, use their baleen plates, rather than teeth, to filter food from water. They are not known to echolocate, but use sound for communication. Members of this group include rorquals (Balaenopteridae), right whales (Balaenidae), and the grey whale (*Eschrichtius robustus*).

non-impulsive sound
Sound that is broadband, narrowband or tonal, brief or prolonged, continuous or intermittent, and typically does not have a high peak pressure with rapid rise time (typically only small fluctuations in decibel level) that impulsive signals have (ANSI/ASA S3.20-1995 R2008). Marine vessels, aircraft, machinery, construction, and vibratory pile driving are examples.

octave
The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

odontocete
The presence of teeth, rather than baleen, characterises these whales. Members of the Odontoceti are a suborder of cetaceans, a group comprised of whales, dolphins, and porpoises. The toothed whales' skulls are mostly asymmetric, an adaptation for their echolocation. This group includes sperm whales, killer whales, belugas, narwhals, dolphins, and porpoises.

parabolic equation method
A computationally-efficient solution to the acoustic wave equation that is used to model transmission loss. The parabolic equation approximation omits effects of back-scattered sound, simplifying the computation of transmission loss. The effect of back-scattered sound is negligible for most ocean-acoustic propagation problems.

peak sound pressure level (PK)
The maximum instantaneous sound pressure level, in a stated frequency band, within a stated period. Also called zero-to-peak sound pressure level. Unit: dB re 1 µPa

permanent threshold shift (PTS)
A permanent loss of hearing sensitivity caused by excessive noise exposure. PTS is considered auditory injury.

pinniped
A common term used to describe all three groups that form the superfamily Pinnipedia: phocids (true seals or earless seals), otariids (eared seals or fur seals and sea lions), and walrus.

point source
A source that radiates sound as if from a single point (ANSI S1.1-1994 R2004).

power spectrum density
The acoustic signal power per unit frequency as measured at a single frequency. Unit: µPa^2/Hz, or µPa^2·s.

power spectrum density level
The decibel level ($10\log_{10}$) of the power spectrum density, usually presented in 1 Hz bins. Unit: dB re 1 µPa^2/Hz.

pressure, acoustic
The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: *p*.

pulsed sound
Discrete sounds with durations less than a few seconds. Sounds with longer durations are called continuous sounds.

received level
The sound level measured at a receiver.

signature
Pressure signal generated by a source.

sound
A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound exposure
Time integral of squared, instantaneous frequency-weighted sound pressure over a stated time interval or event. Unit: pascal-squared second (Pa^2·s) (ANSI S1.1-1994 R2004).

sound exposure level (SEL)
A measure related to the sound energy in one or more pulses. Unit: dB re 1 µPa^2·s.

sound field
Region containing sound waves (ANSI S1.1-1994 R2004).

sound pressure level (SPL)
The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 R2004).

For sound in water, the reference sound pressure is one micropascal (p_0 = 1 µPa) and the unit for SPL is dB re 1 µPa:

$$\mathrm{SPL} = 10\log_{10}\left(p^2/p_0^2\right) = 20\log_{10}\left(p/p_0\right)$$

Unless otherwise stated, SPL refers to the root-mean-square sound pressure level Unit: dB re 1 µPa.

sound speed profile
The speed of sound in the water column as a function of depth below the water surface.

source level (SL)
The sound pressure level or sound exposure level measured 1 metre from a theoretical point source that radiates the same total sound power as the actual source. Unit: dB re 1 µPa @ 1 m or dB re 1 µPa^2·s.

spectrum
An acoustic signal represented in terms of its power (or energy) distribution versus frequency.

SBP
Sub-bottom profiler.

temporary threshold shift (TTS)
Temporary loss of hearing sensitivity caused by excessive noise exposure.

transmission loss (TL)
Also called propagation loss, this refers to the decibel reduction in sound level between two stated points that results from sound spreading away from an acoustic source subject to the influence of the surrounding environment.

VSP
Vertical Seismic Profiler.

wavelength
Distance over which a wave completes one oscillation cycle. Unit: meter (m). Symbol: λ.

Literature Cited

[DEWHA] Department of the Environment, W., Heritage and the Arts. 2008. *EPBC Act Policy Statement 2.1 - Interaction Between Offshore Seismic Exploration and Whales*. *In*: Department of the Environment, W., Heritage and the Arts. 14 pp.

[ISO] International Organization for Standardization. 2016. *ISO/DIS 18405.2:2017. Underwater acoustics—Terminology*. Geneva. https://www.iso.org/standard/62406.html.

[ITC] International Transducer Corporation. 1993. *Application Equations for Underwater Sound Transducers* (pamphlet). International Transducer Corporation, Santa Barbara, CA.

[NMFS] National Marine Fisheries Service. 2013. *Marine Mammals: Interim Sound Threshold Guidance* (webpage). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html.

[NMFS] National Marine Fisheries Service. 2016. *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. 178 pp. http://www.nmfs.noaa.gov/pr/acoustics/Acoustic%20Guidance%20Files/opr-55_acoustic_guidance_tech_memo.pdf.

[NOAA] National Oceanic and Atmospheric Administration. 2013. *Draft guidance for assessing the effects of anthropogenic sound on marine mammals: Acoustic threshold levels for onset of permanent and temporary threshold shifts*, December 2013, 76 pp. Silver Spring, Maryland: NMFS Office of Protected Resources. http://www.nmfs.noaa.gov/pr/acoustics/draft_acoustic_guidance_2013.pdf.

[NSF] National Science Foundation (U.S.), U.S. Geological Survey, and [NOAA] National Oceanic and Atmospheric Administration (U.S.). 2011. *Final Programmatic Environmental Impact Statement/Overseas. Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey*. National Science Foundation, Arlington, VA.

Aerts, L., M. Blees, S. Blackwell, C. Greene, K. Kim, D. Hannay, and M. Austin. 2008. *Marine mammal monitoring and mitigation during BP Liberty OBC seismic survey in Foggy Island Bay, Beaufort Sea, July-August 2008: 90-day report*. Document Number LGL Report P1011-1. Report by LGL Alaska Research Associates Inc., LGL Ltd., Greeneridge Sciences Inc. and JASCO Applied Sciences for BP Exploration Alaska. 199 pp. http://www.nmfs.noaa.gov/pr/pdfs/permits/bp_liberty_monitoring.pdf.

ANSI S12.7-1986. R2006. *American National Standard Methods for Measurements of Impulsive Noise*. American National Standards Institute, New York.

ANSI S1.1-1994. R2004. *American National Standard Acoustical Terminology*. American National Standards Institute, New York.

ANSI S1.1-2013. R2013. *American National Standard Acoustical Terminology*. American National Standards Institute, New York.

ANSI/ASA S1.13-2005. R2010. *American National Standard Measurement of Sound Pressure Levels in Air*. American National Standards Institute and Acoustical Society of America, New York.

ANSI/ASA S3.20-1995. R2008. *American National Standard Bioacoustical Terminology*. American National Standards Institute and Acoustical Society of America, New York.

Applied Acoustics Engineering. 2013. *AA2xx Series Seismic Source Operation Manual*. https://www.seatronics-group.com/files/3714/1753/6053/Applied_Acoustic_A200_Boomer_Plate_-_Manual.pdf

Carnes, M.R. 2009. *Description and Evaluation of GDEM-V 3.0*. Document Number NRL Memorandum Report 7330-09-9165. US Naval Research Laboratory, Stennis Space Center, MS. 21 pp.

Collins, M.D. 1993. A split-step Padé solution for the parabolic equation method. *Journal of the Acoustical Society of America* 93(4): 1736-1742.

Collins, M.D., R.J. Cederberg, D.B. King, and S. Chin-Bing. 1996. Comparison of algorithms for solving parabolic wave equations. *Journal of the Acoustical Society of America* 100(1): 178-182.

Coppens, A.B. 1981. Simple equations for the speed of sound in Neptunian waters. *Journal of the Acoustical Society of America* 69(3): 862-863. http://link.aip.org/link/?JAS/69/862/1.

Day, R., D., R.D. McCauley, Q.P. Fitzgibbon, K. Hartmann, J.M. Semmens, and Institute for Marine and Antarctic Studies. 2016a. *Assessing the Impact of Marine Seismic Surveys on Southeast Australian Scallop and Lobster Fisheries. FRDC Project No 2012/008*. Impacts of Marine Seismic Surveys on Scallop and Lobster Fisheries. Fisheries Ressearch & Development Corporation, University of Tasmania, Hobart. 159 pp.

Day, R.D., R.D. McCauley, Q.P. Fitzgibbon, and J.M. Semmens. 2016b. Seismic air gun exposure during early-stage embryonic development does not negatively affect spiny lobster *Jasus edwardsii larvae* (Decapoda:Palinuridae). *Scientific Reports* 6: 1-9. http://dx.doi.org/10.1038/srep22723.

Dragoset, W.H. 1984. A comprehensive method for evaluating the design of airguns and airgun arrays. *16th Annual Proc. Offshore Tech. Conf.* Volume 3. 75–84 pp.

Duncan, A. 2017. *In-field validation of modelled underwater sound levels from the Crowes Foot 3D seismic survey*. Report Number 2016-35. Report by CMST for Origin Energy. 23 pp.

Fisher, F.H. and V.P. Simmons. 1977. Sound absorption in sea water. *Journal of the Acoustical Society of America* 62(3): 558-564. http://link.aip.org/link/?JAS/62/558/1.

Funk, D., D. Hannay, D. Ireland, R. Rodrigues, and W. Koski (eds.). 2008. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–November 2007: 90-day report*. LGL Report P969-1. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 218 pp.

Gedamke, J., N. Gales, and S. Frydman. 2011. Assessing risk of baleen whale hearing loss from seismic surveys: The effect of uncertainty and individual variation. *Journal of the Acoustical Society of America* 129(1): 496-506. http://www.ncbi.nlm.nih.gov/pubmed/21303030.

Hamilton, E.L. 1980. Geoacoustic modeling of the sea floor. *Journal of the Acoustical Society of America* 68(5): 1313-1340.

Hannay, D. and R. Racca. 2005. *Acoustic Model Validation*. Document Number 0000-S-90-04-T-7006-00-E, Revision 02. Technical report for Sakhalin Energy Investment Company Ltd. by JASCO Research Ltd. 34 pp.

Ireland, D.S., R. Rodrigues, D. Funk, W. Koski, and D. Hannay. 2009. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–October 2008: 90-Day Report*. Document Number LGL Report P1049-1. 277 pp.

Kinsler, L.E., A.R. Frey, A.B. Coppens, and J.V. Sanders. 1950. *Fundamentals of acoustics*. John Wiley & Sons Inc., New York.

Landro, M. 1992. Modeling of GI gun signatures. *Geophysical Prospecting* 40: 721–747.

Laws, M., L. Hatton, and M. Haartsen. 1990. Computer modeling of clustered airguns. *First Break* 8: 331–338.

Lurton, X. 2002. *An Introduction to Underwater Acoustics: Principles and Applications.* Springer, Chichester, U.K.

MacGillivray, A.O. and N.R. Chapman. 2012. Modeling underwater sound propagation from an airgun array using the parabolic equation method. *Canadian Acoustics* 40(1): 19-25. http://jcaa.caa-aca.ca/index.php/jcaa/article/view/2502.

Martin, B., J. MacDonnell, N.E. Chorney, and D. Zeddies. 2012. Appendix A: Sound Source Verification of Fugro Geotechnical Sources. *In ESS Group, Inc. Renewal Application for Incidental Harassment Authorization for the Non-Lethal Taking of Marine Mammals Resulting from Pre-Construction High Resolution Geophysical Survey*. For Cape Wind Associates, LLC. http://www.nmfs.noaa.gov/pr/pdfs/permits/capewind_iha_application_renewal.pdf.

Martin, B., K. Broker, M.-N.R. Matthews, J. MacDonnell, and L. Bailey. 2015. *Comparison of measured and modeled air-gun array sound levels in Baffin Bay, West Greenland. OceanNoise 2015*, 11-15 May, Barcelona, Spain.

Massa, D.P. 2003. Acoustic transducers. *In Wiley Encyclopedia of Telecommunications*. John Wiley & Sons, Inc.

Mattsson, A. and M. Jenkerson. 2008. *Single Airgun and Cluster Measurement Project*. *Joint Industry Programme (JIP) on Exploration and Production Sound and Marine Life Proramme Review*, October 28-30. International Association of Oil and Gas Producers, Houston, TX.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adihyta, J. Murdoch, et al. 2000. Marine seismic surveys: A study of environmental implications. *Australian Petroleum Production Exploration Association (APPEA) Journal* 40: 692-708.

McCauley, R.D. and A. Duncan. 2016. *Estimation of sound exposure levels at "Big Reef" from proposed Crowes Foot seismic survey, Victoria 2016*. Report 2016-26 by CMST for ERM / Origin Energy Ltd.

Moein, S.E., J.A. Musick, J.A. Keinath, D.E. Barnard, M.L. Lenhardt, and R. George. 1995. *Evaluation of Seismic Sources for Repelling Sea Turtles from Hopper Dredges, in Sea Turtle Research Program: Summary Report*. *In*: Hales, L.Z. (ed.). Report from U.S. Army Engineer Division, South Atlantic, Atlanta GA, and U.S. Naval Submarine Base, Kings Bay GA. Technical Report CERC-95. 90 pp.

O'Neill, C., D. Leary, and A. McCrodan. 2010. Sound Source Verification. (Chapter 3) *In* Blees, M.K., K.G. Hartin, D.S. Ireland, and D. Hannay (eds.). *Marine mammal monitoring and mitigation during open water seismic exploration by Statoil USA E&P Inc. in the Chukchi Sea, August-October 2010: 90-day report*. LGL Report P1119. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. for Statoil USA E&P Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 1-34.

Payne, J.F., C. Andrews, L. Fancey, A.L. Cook, and J.R. Christian. 2007. *Pilot study on the effects of seismic air gun noise on lobster (Homarus americanus)*. Report Number 2712.

Payne, J.F., C. Andrews, L. Fancey, D. White, and J. Christian. 2008. *Potential Effects of Seismic Energy on Fish and Shellfish: An Update since 2003*. Report Number 2008/060. Canadian Science Advisory Secretariat. 22 pp.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, et al. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. SpringerBriefs in Oceanography, Volume ASA S3/SC1.4 TR-2014. ASA Press.

Popper, A.N., T.J. Carlson, J.A. Gross, A.D. Hawkins, D. Zeddies, L. Powell, and J. Young. 2016. Effects of Seismic Air Guns on Pallid Sturgeon and Paddlefish. *Adv Exp Med Biol* 875: 871-8. NLM.

Porter, M.B. and Y.-C. Liu. 1994. Finite-element ray tracing. *In*: Lee, D. and M.H. Schultz (eds.). *Proceedings of the International Conference on Theoretical and Computational Acoustics*. Volume 2. World Scientific Publishing Co. 947-956 pp.

Racca, R., A. Rutenko, K. Bröker, and M. Austin. 2012a. A line in the water - design and enactment of a closed loop, model based sound level boundary estimation strategy for mitigation of behavioural impacts from a seismic survey. *11th European Conference on Underwater Acoustics 2012*. Volume 34(3), Edinburgh, United Kingdom.

Racca, R., A. Rutenko, K. Bröker, and G. Gailey. 2012b. *Model based sound level estimation and in-field adjustment for real-time mitigation of behavioural impacts from a seismic survey and post-event evaluation of sound exposure for individual whales*. *Acoustics 2012 Fremantle: Acoustics, Development and the Environment*, Fremantle, Australia. http://www.acoustics.asn.au/conference_proceedings/AAS2012/papers/p92.pdf.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, et al. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. *Aquatic Mammals* 33(4): 411-521.

Teague, W.J., M.J. Carron, and P.J. Hogan. 1990. A comparison between the Generalized Digital Environmental Model and Levitus climatologies. *Journal of Geophysical Research* 95(C5): 7167-7183.

Verbeek, N.H. and T.M. McGee. 1995. Characteristics of high-resolution marine reflection profiling sources. *Journal of Applied Geophysics* 33(4): 251-269.

Warner, G., C. Erbe, and D. Hannay. 2010. Underwater Sound Measurements. (Chapter 3) *In* Reiser, C.M., D.W. Funk, R. Rodrigues, and D. Hannay (eds.). *Marine Mammal Monitoring and Mitigation during Open Water Shallow Hazards and Site Clearance Surveys by Shell Offshore Inc. in the Alaskan Chukchi Sea, July-October 2009: 90-Day Report*. LGL Report P1112-1. Report by LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 1-54.

Zhang, Y. and C. Tindle. 1995. Improved equivalent fluid approximations for a low shear speed ocean bottom. *Journal of the Acoustical Society of America* 98(6): 3391-3396. http://scitation.aip.org/content/asa/journal/jasa/98/6/10.1121/1.413789.

Ziolkowski, A. 1970. A method for calculating the output pressure waveform from an air gun. *Geophysical Journal of the Royal Astronomical Society* 21(2): 137-161.

Zykov, M. 2013. *Underwater Sound Modeling of Low Energy Geophysical Equipment Operations*. Document Number 00600 Version 1.0. Technical report for CSA Ocean Sciences by JASCO Applied Sciences Ltd. http://www.slc.ca.gov/Programs/OGPP/AppG.pdf.

Appendix A. Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 µPa. Because the perceived loudness of sound, especially impulsive noise such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate noise and its effects on marine life. We provide specific definitions of relevant metrics used in the accompanying report. Where possible we follow the ANSI and ISO standard definitions and symbols for sound metrics, but these standards are not always consistent.

The zero-to-peak sound pressure level, or peak sound pressure level (PK; dB re 1 µPa), is the maximum instantaneous sound pressure level in a stated frequency band attained by an acoustic pressure signal, $p(t)$:

$$L_{p,pk} = 20 \log_{10}\left[\frac{\max(|p(t)|)}{p_0}\right] \tag{A-1}$$

$L_{p,pk}$ is often included as a criterion for assessing whether a sound is potentially injurious; however, because it does not account for the duration of a noise event, it is generally a poor indicator of perceived loudness.

The root-mean-square (rms) sound pressure level (SPL; dB re 1 µPa) is the rms pressure level in a stated frequency band over a specified time window (T, s) containing the acoustic event of interest. It is important to note that SPL always refers to an rms pressure level and, therefore, not instantaneous pressure:

$$L_p = 10 \log_{10}\left(\frac{1}{T}\int_T p^2(t)dt \Big/ p_0^2\right) \tag{A-2}$$

The SPL represents a nominal effective continuous sound over the duration of an acoustic event, such as the emission of one acoustic pulse, a marine mammal vocalisation, the passage of a vessel, or over a fixed duration. Because the window length, T, is the divisor, events with similar sound exposure level (SEL) but more spread out in time have a lower SPL. Throughout this study, a fixed time window of 125 ms is used as the integration period.

The sound exposure level (SEL, dB re 1 µPa^2·s) is a measure related to the acoustic energy contained in one or more acoustic events (N). The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T):

$$L_E = 10 \log_{10}\left(\int_T p^2(t)dt \Big/ T_0 p_0^2\right) \tag{A-3}$$

where T_0 is a reference time interval of 1 s. The SEL continues to increase with time when non-zero pressure signals are present. It therefore can be construed as a dose-type measurement so the integration time used must be carefully considered in terms of relevance for impact to the exposed recipients.

SEL can be calculated over periods with multiple acoustic events or over a fixed duration. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10 \log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}}\right) \tag{A-4}$$

If applied, the frequency weighting of an acoustic event should be specified, as in the case of M-weighted SEL (e.g., $\mathrm{SEL}_{\mathrm{LFC,24h}}$). The use of fast, slow, or impulse exponential-time-averaging, or other time-related characteristics should else be specified.

Because the SPL and SEL are both computed from the integral of square pressure, these metrics are related by a simple expression, which depends only on the duration of the 90% energy time window T_{90}:

$$L_E = L_{p90} + 10\log_{10}(T_{90}) + 0.458 \qquad \text{(A-5)}$$

where the 0.458 dB factor accounts for the SPL containing 90% of the total energy from the per-pulse SEL.

Appendix B. Acoustic Source Modelling

B.1. Transducer Beam Theory

Mid- and high-frequency underwater acoustic sources for geophysical measurements create an oscillatory overpressure through rapid vibration of a surface, using either electromagnetic forces or the piezoelectric effect of materials. A vibratory source based on the piezoelectric effect is commonly referred to as a transducer, and may be capable of receiving as well as emitting signals. Transducers are usually designed to produce an acoustic wave of a specific frequency, often in a highly directive beam. The directional capability increases with increasing operating frequency. The main parameter characterizing directivity is the beamwidth, defined as the angle subtended by diametrically opposite “half power” (-3 dB) points of the main lobe (Massa 2003). For different transducers, the beamwidth varies from 180° (almost omnidirectional) to a few degrees.

Transducers are usually built with either circular or rectangular active surfaces. For circular transducers, the beam pattern in the horizontal plane (assuming a downward pointing main beam) is equal in all directions. The beam pattern of a rectangular transducer is variable with the azimuth in the horizontal plane.

The acoustic radiation pattern, or beam pattern, of a transducer is the relative measure of acoustic transmitting or receiving power as a function of spatial angle. Directionality is generally measured in decibels relative to the maximum radiation level along the central axis perpendicular to the transducer surface. The pattern is defined largely by the operating frequency of the device and the size and shape of the transducer. Beam patterns generally consist of a main lobe, extending along the central axis of the transducer, and multiple secondary lobes separated by nulls. The width of the main lobe depends on the size of the active surface relative to the sound wavelength in the medium. Larger transducers produce narrower beams. Figure B-1 shows a 3-dimensional (3-D) visualisation of a typical beam pattern for a circular transducer.

The true beam pattern of a transducer can be obtained only by in situ measurement of the emitted energy around the device. Such data, however, are not always available, and for propagation modelling it is often sufficient to estimate the beam pattern of the source based on transducer beam theory. An example of a measured beam pattern is shown in Figure B-2.

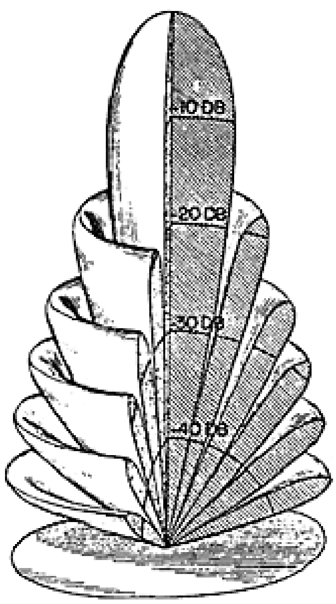


Figure B-1. Typical 3-D beam pattern for a circular transducer (Massa 2003).

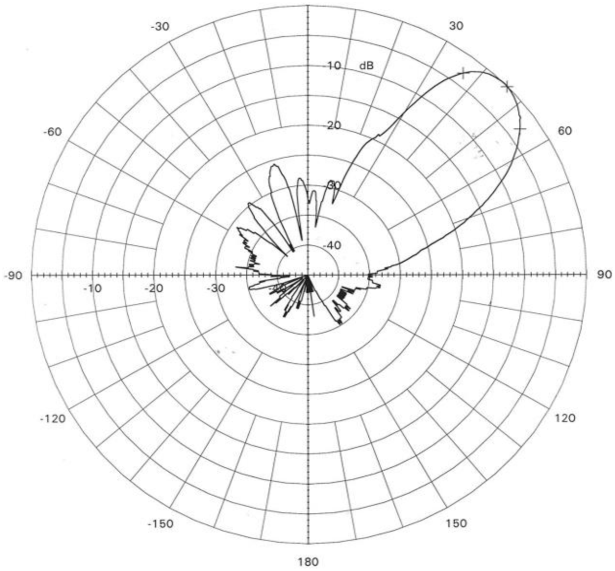


Figure B-2. Vertical cross section of a beam pattern measured in situ from a transducer used by Kongsberg (source: Zykov (2013)).

B.2. Circular Transducers

The beam of an ideal circular transducer is symmetrical about the main axis; the radiated level depends only on the depression angle. In this study, beam directivities were calculated from the standard formula for the beam pattern of a circular transducer (Kinsler et al. 1950, [ITC] International Transducer Corporation 1993). The directivity function of a conical beam relative to the on-axis pressure amplitude is:

$$R(\phi) = \frac{2 \cdot J_1\left(\pi\, D_\lambda \sin(\phi)\right)}{\pi\, D_\lambda \sin(\phi)} \text{ and } D_\lambda = \frac{60}{\theta_{bw}}, \tag{1}$$

where J_1 is the first-order Bessel function, D_λ is the transducer dimension in wavelengths of sound in the medium, θ_{bw} is the beamwidth in degrees, and ϕ is the beam angle from the transducer axis. The beam pattern of a circular transducer can be calculated from the transducer's specified beamwidth or from the diameter of the active surface and the operating frequency. The calculated beam pattern for a circular transducer with a beamwidth of 20° is shown in Figure B-3. The grayscale represents the source level (dB re 1 µPa @ 1 m) and the declination angle is relative to a central vector (0°, 0°) pointing down.

Although some acoustic energy is emitted at the back of the transducer, the theory accounts for the beam power in only the front half-space ($\phi < 90°$) and assumes no energy directed into the back half-space. The relative power at these rearward angles is significantly lower, generally by more than 30 dB, and consequently the emission in the back half-space can be estimated by applying a simple decay rate, in decibels per angular degree, which gives a beam power at $\phi = 90°$ of 30 dB less than that at $\phi = 0°$. This is a conservative estimate of the beam power in the back half-space.

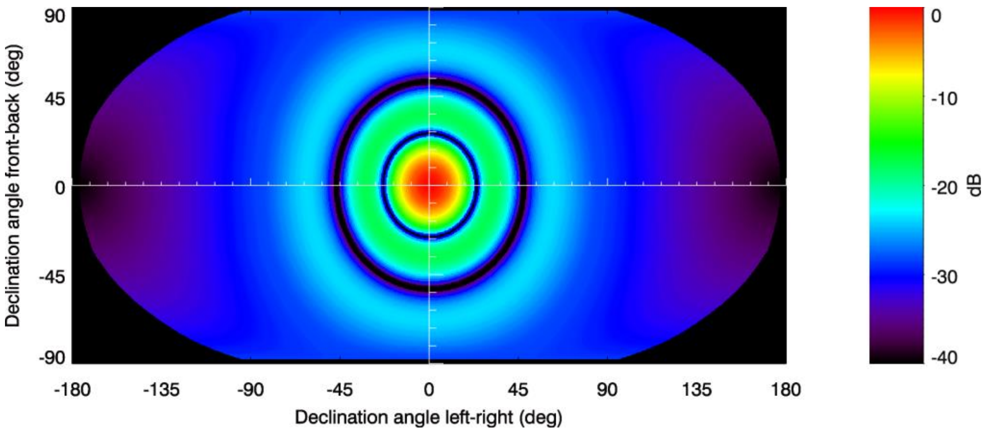


Figure B-3. Calculated beam pattern for a circular transducer with a beamwidth of 20°. The beam power function is shown relative to the on-axis level using the Robinson projection.

B.3. VSP Modelling

The source levels and directivity of the airgun array were predicted with JASCO's Airgun Array Source Model (AASM). AASM includes low- and high-frequency modules for predicting different components of the airgun array spectrum. The low-frequency module is based on the physics of oscillation and radiation of airgun bubbles, as originally described by Ziolkowski (1970), that solves the set of parallel differential equations that govern bubble oscillations. Physical effects accounted for in the simulation include pressure interactions between airguns, port throttling, bubble damping, and generator-injector (GI) gun behaviour discussed by Dragoset (1984), Laws et al. (1990), and Landro (1992). A global optimisation algorithm tunes free parameters in the model to a large library of airgun source signatures.

Whilst airgun signatures are highly repeatable at the low frequencies, which are used for seismic imaging, their sound emissions have a large random component at higher frequencies that cannot be predicted deterministically. Therefore, the high-frequency module of AASM uses a stochastic simulation to predict the sound emissions of individual airguns above 800 Hz, using a multivariate statistical model. The current version of AASM has been tuned to fit a large library of high quality seismic source signature data obtained from the Joint Industry Program (JIP) on Sound and Marine Life (Mattsson and Jenkerson 2008). The stochastic model uses a Monte-Carlo simulation of the random component of the high-frequency spectrum of each airgun in an array. The mean high-frequency spectra from the stochastic model augment the low-frequency signatures from the physical model, allowing AASM to predict airgun source levels at frequencies up to 25,000 Hz.

AASM produces a set of "notional" signatures for each array element based on:

- Array layout
- Volume, tow depth, and firing pressure of each airgun
- Interactions between different airguns in the array

These notional signatures are the pressure waveforms of the individual airguns at a standard reference distance of 1 m; they account for the interactions with the other airguns in the array. The signatures are summed with the appropriate phase delays to obtain the far-field source signature of the entire array in all directions. This far-field array signature is filtered into 1/3-octave-bands to compute the source levels of the array as a function of frequency band and azimuthal angle in the horizontal plane (at the source depth), after which it is considered to be a directional point source in the far field.

A seismic array consists of many sources and the point-source assumption is invalid in the near field where the array elements add incoherently. The maximum extent of the near field of an array (R_{nf}) is:

$$R_{\mathrm{nf}} < \frac{l^2}{4\lambda} \tag{B-2}$$

where λ is the sound wavelength and *l* is the longest dimension of the array (Lurton 2002, §5.2.4). For example, an airgun array length of *l* = 21 m yields a near-field range of 147 m at 2 kHz and 7 m at 100 Hz. Beyond this R_{nf} range, the array is assumed to radiate like a directional point source and is treated as such for propagation modelling.

The interactions between individual elements of the array create directionality in the overall acoustic emission. Generally, this directionality is prominent mainly at frequencies in the mid-range between tens of hertz to several hundred hertz. At lower frequencies, with acoustic wavelengths much larger than the inter-airgun separation distances, the directionality is small. At higher frequencies, the pattern of lobes is too finely spaced to be resolved and the effective directivity is less.

B.4. VSP Acoustic Source Levels and Directivity Results

Figure B-4 shows the broadside (perpendicular to the tow direction), endfire (parallel to the tow direction), and vertical overpressure signatures and corresponding power spectrum levels for the 3090 in³ array. The signatures consist of a strong primary peak, related to the initial release of high-pressure air, followed by a series of pulses associated with bubble oscillations. Most energy is produced at frequencies below 200 Hz. Frequency-dependent peaks and nulls in the spectrum result from interference among airguns in the array, and correspond with the volumes and relative locations of the airguns to each other.

Horizontal 1/3-octave-band source levels are shown as a function of band centre frequency and azimuth (Figure B-5); directivity in the sound field is most noticeable at mid-frequencies as described in the model detail in Appendix B.3.

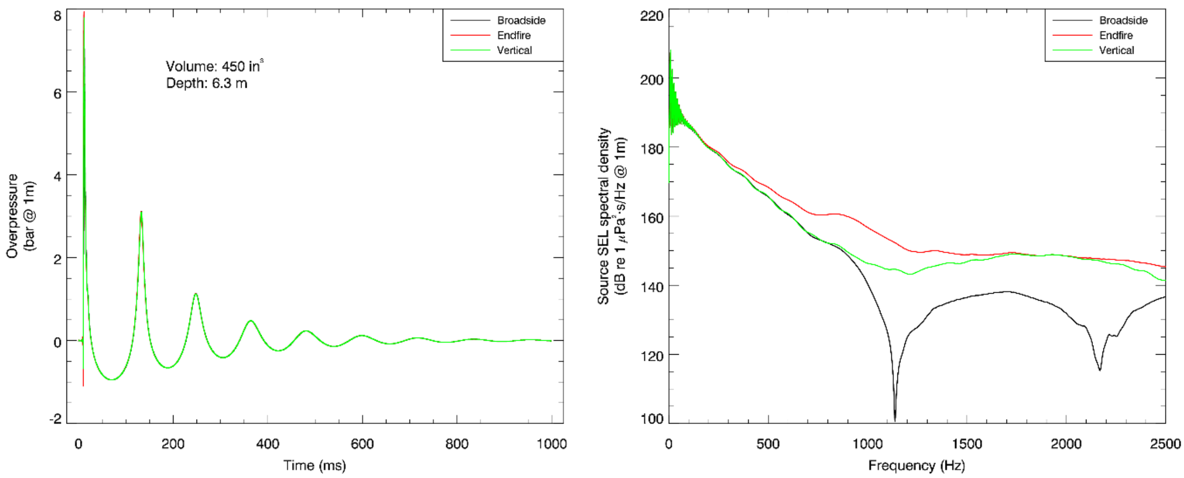


Figure B-4. Predicted source level details for the 450 in³ VSP array operated at a centroid depth of 6 m. (Left) the overpressure signature and (right) the power spectrum for broadside (perpendicular to tow direction) and endfire (directly aft of the array) directions, and for vertically down.

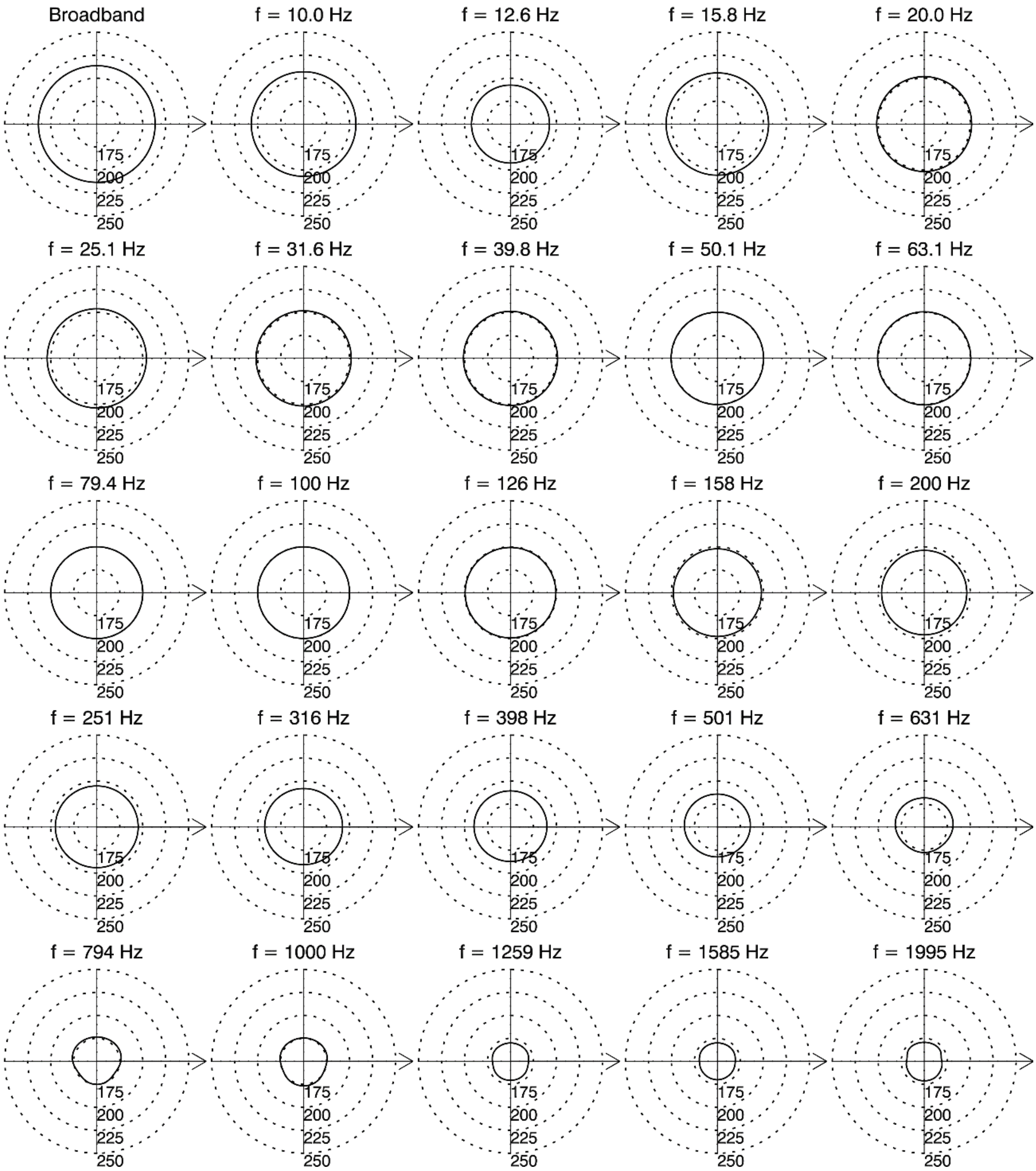


Figure B-5. Directionality of the predicted horizontal source levels for the 450 in^3 array, 5–2000 Hz. Source levels (in dB re 1 µPa^2·s) are shown as a function of azimuth for the centre frequencies of the 1/3-octave-bands modelled; frequencies are shown above the plots. Tow direction is to the right. Operating depth is 6 m (see Section 3.1.3).

Appendix C. Sound Propagation Models

C.1. MONM-BELLHOP

Underwater sound propagation (i.e., transmission loss) was predicted with JASCO's Marine Operations Noise Model (MONM). This model computes sound propagation at frequencies of 5 Hz to 1.25 kHz via a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). MONM computes sound propagation at frequencies > 1.25 kHz via the BELLHOP Gaussian beam acoustic ray-trace model (Porter and Liu 1994).

The parabolic equation method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins et al. 1996). MONM accounts for the additional reflection loss at the seabed, which results from partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces, and it includes wave attenuations in all layers. MONM incorporates the following site-specific environmental properties: a bathymetric grid of the modelled area, underwater sound speed as a function of depth, and a geoacoustic profile based on the overall stratified composition of the seafloor.

This version of MONM accounts for sound attenuation due to energy absorption through ion relaxation and viscosity of water in addition to acoustic attenuation due to reflection at the medium boundaries and internal layers (Fisher and Simmons 1977). The former type of sound attenuation is significant for frequencies higher than 5 kHz and cannot be neglected without noticeably affecting the model results.

MONM computes acoustic fields in three dimensions by modelling transmission loss within two-dimensional (2-D) vertical planes aligned along radials covering a 360° swath from the source, an approach commonly referred to as N×2-D. These vertical radial planes are separated by an angular step size of $\Delta\theta$, yielding N = 360°/$\Delta\theta$ number of planes (Figure C-1).

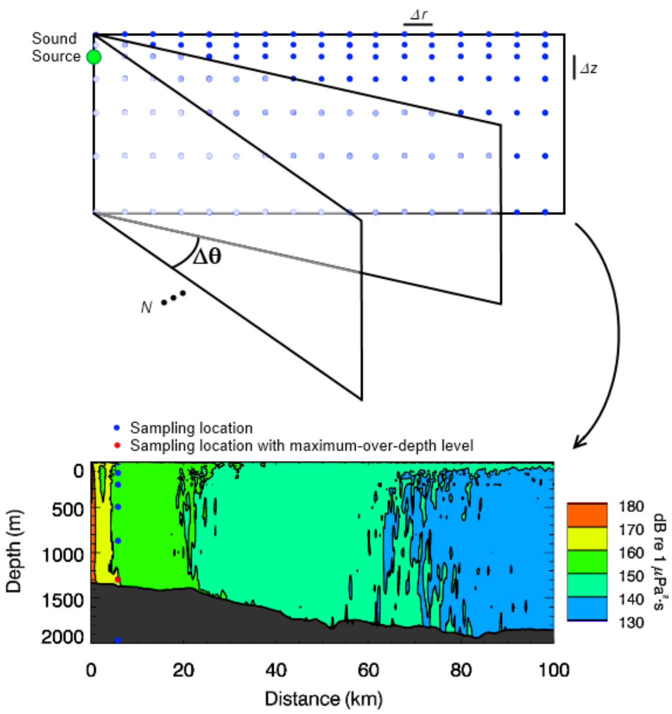


Figure C-1. The N×2-D and maximum-over-depth modelling approach used by MONM.

MONM treats frequency dependence by computing acoustic transmission loss at the centre frequencies of 1/3-octave-bands. Sufficiently many 1/3-octave-bands, starting at 10 Hz, are modelled to include most acoustic energy emitted by the source. At each centre frequency, the transmission loss is modelled within each of the N vertical planes as a function of depth and range from the source.

The 1/3-octave-band received per-pulse SELs are computed by subtracting the band transmission loss values from the directional source level in that frequency band. Composite broadband received SELs are then computed by summing the received 1/3-octave-band levels.

The received per-pulse SEL sound field within each vertical radial plane is sampled at various ranges from the source, generally with a fixed radial step size. At each sampling range along the surface, the sound field is sampled at various depths, with the step size between samples increasing with depth below the surface. The step sizes are chosen to provide increased coverage near the depth of the source and at depths of interest in terms of the sound speed profile. For areas with deep water, sampling is not performed at depths beyond those reachable by marine mammals. The received per-pulse SEL at a surface sampling receiver location is taken as the maximum value that occurs over all samples within the water column, i.e., the maximum-over-depth received per-pulse SEL. These maximum-over-depth per-pulse SELs are presented as colour contours around the source.

MONM's predictions have been validated against experimental data from several underwater acoustic measurement programs conducted by JASCO (Hannay and Racca 2005, Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Racca et al. 2012a, Racca et al. 2012b, Martin et al. 2015).

C.2. FWRAM

For impulsive sounds from the seismic array, time-domain representations of the pressure waves generated in the water are required to calculate SPL and peak pressure level. Furthermore, the airgun array must be represented as a distributed source to accurately characterise vertical directivity effects in the near-field zone. For this study, synthetic pressure waveforms were computed using FWRAM, which is a time-domain acoustic model based on the same wide-angle parabolic equation (PE) algorithm as MONM. FWRAM computes synthetic pressure waveforms versus range and depth for range-varying marine acoustic environments, and it takes the same environmental inputs as MONM (bathymetry, water sound speed profile, and seafloor geoacoustic profile). Unlike MONM, FWRAM computes pressure waveforms via Fourier synthesis of the modelled acoustic transfer function in closely spaced frequency bands. FWRAM employs the array starter method to accurately model sound propagation from a spatially distributed source (MacGillivray and Chapman 2012).

Besides providing direct calculations of the peak pressure level and SPL, the synthetic waveforms from FWRAM can also be used to convert the SEL values from MONM to SPL.

C.3. Wavenumber Integration Model

Sound pressure levels near the airgun array were modelled using JASCO's VSTACK wavenumber integration model. VSTACK computes synthetic pressure waveforms versus depth and range for arbitrarily layered, range-independent acoustic environments using the wavenumber integration approach to solving the exact (range-independent) acoustic wave equation. This model is valid over the full angular range of the wave equation and can fully account for the elasto-acoustic properties of the sub-bottom. Wavenumber integration methods are extensively used in the field of underwater acoustics and seismology where they are often referred to as reflectivity methods or discrete wavenumber methods. VSTACK computes sound propagation in arbitrarily stratified water and seabed layers by decomposing the outgoing field into a continuum of outward-propagating plane cylindrical waves. Seabed reflectivity in the model is dependent on the seabed layer properties: compressional and shear wave speeds, attenuation coefficients, and layer densities. The output of the model can be post-processed to yield estimates of the SEL, SPL, and PK.

VSTACK accurately predicts steep-angle propagation in the proximity of the source, but is computationally slow at predicting sound pressures at large distances due to the need for smaller wavenumber steps with increasing distance. Additionally, VSTACK assumes range-invariant bathymetry with a horizontally stratified medium (i.e., a range-independent environment) which is azimuthally symmetric about the source. VSTACK is thus best suited to modelling the sound field near the source.

Appendix D. Methods and Parameters

This section describes the specifications of the airgun array source that was used at all sites and the environmental parameters used in the propagation models.

D.1. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure D-1).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure D-1(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure D-1(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.

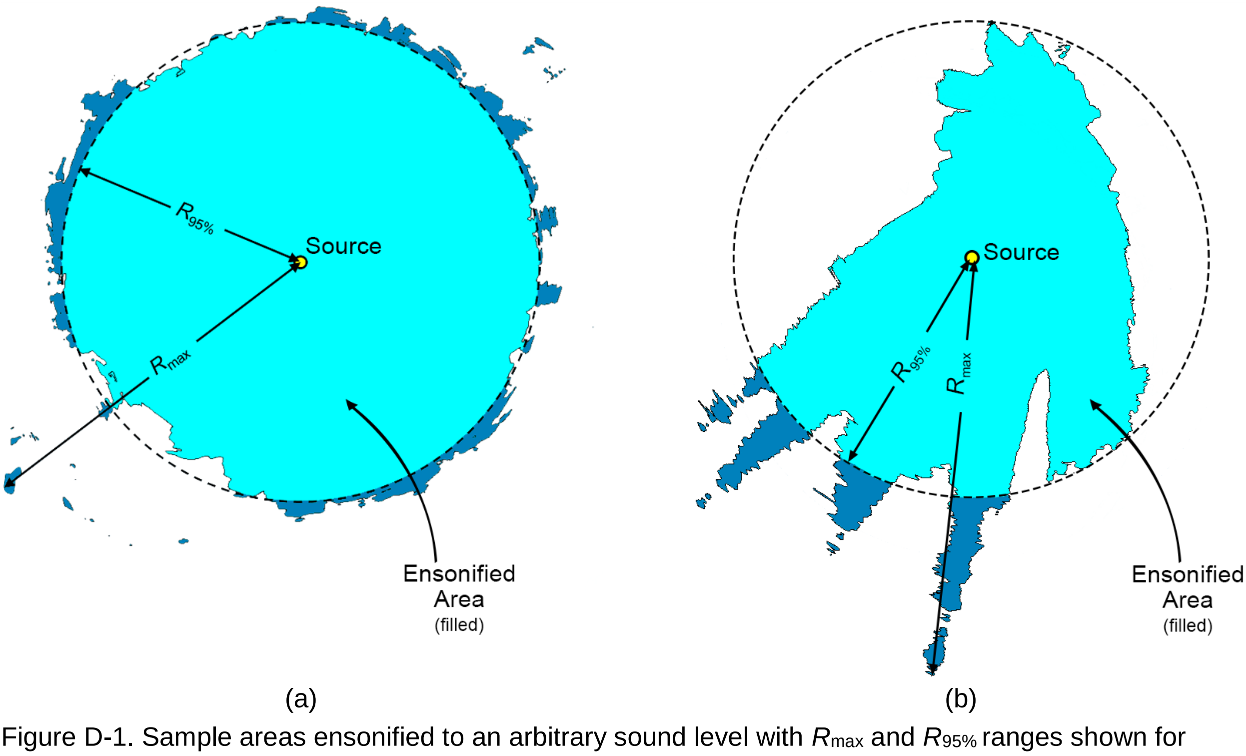


Figure D-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

D.2. Estimating SPL from Modelled SEL Results

The SEL of individual sound pulses is an energy-like metric related to the dose of sound received over the pulse's duration. The SPL on the other hand is related to the pulses intensity over a specified time interval (Appendix A). The time interval applied in this report is fixed at 125 ms.

Seismic pulses typically lengthen in duration as they propagate away from their source due to seafloor and surface reflections and other waveguide dispersion effects. The changes in pulse length affect the numeric relationship between SPL and SEL because the amount of pulse energy within the specified time interval changes. Full-waveform modelling is necessary to estimate SPL, but this type of modelling is computationally intensive and can be prohibitively time consuming when run at high spatial resolution over large areas.

The current study, modelled synthetic seismic pulses from 5–1024 Hz with FWRAM (Appendix C.2).

FWRAM uses Fourier synthesis to recreate the signal in the time domain so that both the SEL and SPL can be calculated from the propagated signal. SPL was calculated using a 125 ms fixed time window positioned to maximise the SPL over the pulse duration. The difference between the SEL and SPL was extracted for all ranges and depths corresponded to those generated in the high spatial-resolution MONM results. The resulting SEL-to-SPL offsets were then averaged in 0.5 km range bins. The final range-dependent conversion function for each site correspond to the 90th percentile curve derived from the SEL-to-SPL offsets along all radials at that site. These range-dependent conversion functions were applied to predicted per-pulse SEL results from MONM and BELLHOP to model SPLs. The range-dependent conversion function for the VSP at Site 5 is shown in Figure D-2.

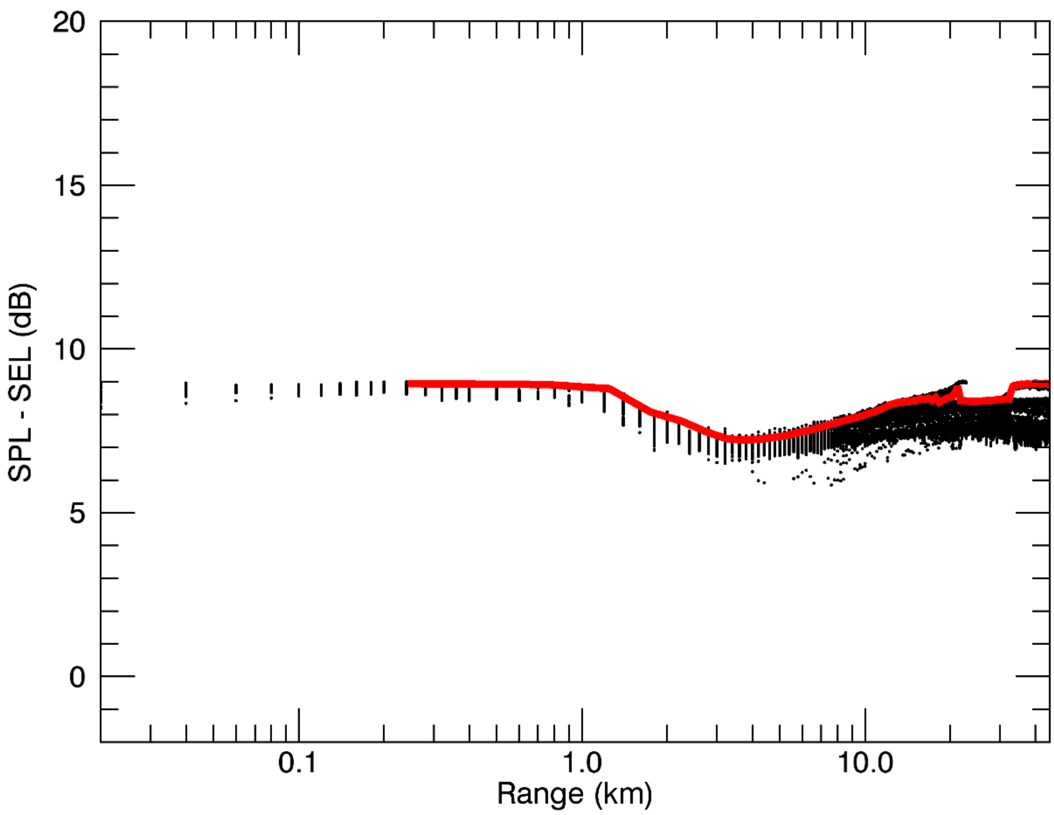


Figure D-2. Conversion Factor applied: Range-dependent conversion function for converting single-pulse SEL to SPL for the 450 in^3 VSP array.

D.3. Environmental Parameters

D.3.1. Bathymetry

Water depths throughout the modelled area were supplied by the client. The bathymetric data was re-gridded onto a Cartesian grid with a regular grid spacing of 50 × 50 m; this grid was used for all modelled sites in this study.

D.3.2. Sound speed profile

The sound speed profiles for the modelled sites were derived from temperature and salinity profiles from the U.S. Naval Oceanographic Office's *Generalized Digital Environmental Model V 3.0* (GDEM; Teague et al. 1990, Carnes 2009). GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the U.S. Navy's Master Oceanographic Observational Data Set (MOODS). The temperature and salinity profiles were converted to sound speed profiles according to the equations of Coppens (1981).

The sound speed profiles across the year were calculated across the area encompassing all sites, with the median sound speed at each depth retained for comparison. It was found that the sound speed profile for September provided the greatest propagation and is consequently used for the modelling. Since the profiles did not extend to the maximum water depth in the modelling area, they were supplemented with a deeper nearby offshore profile.

The final profile features a sound channel at 70 m, as well as a surface duct that may allow for enhanced high frequency propagation. Due to the bathymetry of the modelling region, most propagation is within the top two-hundred metres. At greater depths, the profile is downwardly refracting until 1300 m depth. The sound speed profile used throughout the modelling is shown in Figure D-3.

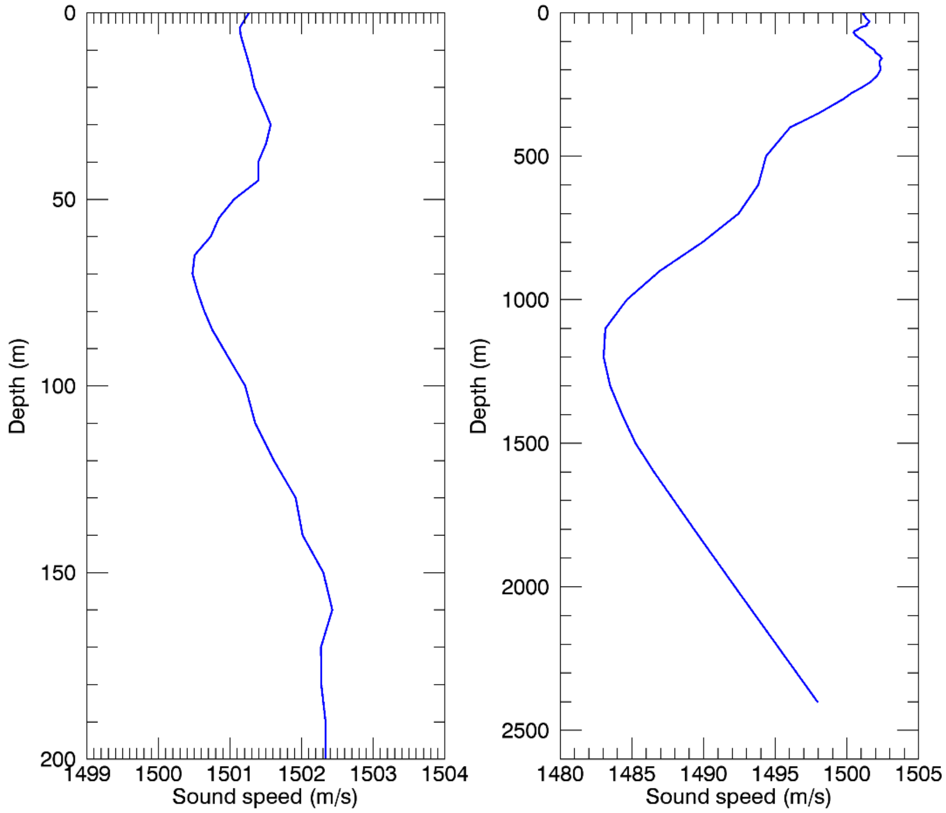


Figure D-3. The sound speed profile for September across the modelling region for the first 200 m (left), and over the entire range of depths (right). The profile was calculated from temperature and salinity profiles from GDEM V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

D.3.3. Geoacoustics

Each of the models used in this study utilise a single geoacoustic profile for each site. The geoacoustics determine how sound is reflected from the seabed, as well as how it is coupled into the sediment layers. The geoacoustic description for Site 5 are taken from a ground truthing report due to its proximity to the location (Duncan 2017). The geoacoustic profiles for the other sites were generated using lithographic descriptions from the geotechnical reports supplied by the client. Sites 1 and 2 located towards the south of the region were found typically to feature a well-cemented calcarenite caprock over a softer calcarenite layer. Sites 3, 4, and 6 typically exhibited a sand layer that sat above increasingly cemented calcarenite. In all cases, the calcarenite layer was found to extend to many hundreds of metres below the seafloor.

Geoacoustic values for Calcarenite have been taken from Duncan et al. 2013; where the calarenite is indicated to be increasingly consolidated with depth, the properties have been linearly interpolated. The geoacoustic parameters for sand are generated using models proposed by Hamilton (Hamilton 1980). The three final geoacoutics profiles used for the modelling are presented in Tables D-1 to D-3.

Table D-1. Geoacoustic profile used as the input to the models at Sites 1 & 2.

Depth below seafloor (m)	Material	Density (g/cm³)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0-1	Well-cemented carbonate caprock	2.7	2600	0.5	1200	0.5
1-20	Increasingly cemented calcarenite	2.2	2000	0.3	900	0.27
20-40		2.3	2120	0.34	960	0.316
40-60		2.4	2240	0.38	1020	0.362
60-80		2.5	2360	0.42	1080	0.408
80-10		2.6	2480	0.46	1140	0.454
>100	Well-cemented calcarenite	2.7	2600	0.5	1200	0.5

Table D-2. Geoacoustic profile used as the input to the models at Sites 3, 4, & 6.

Depth below seafloor (m)	Material	Density (g/cm³)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0-0.5	Coarse carbonate sand	2.03	1803.1	0.85	300	6.2
0.5-20	Increasingly cemented calcarenite	2.2	2000	0.3	900	0.27
20-40		2.3	2120	0.34	960	0.316
40-60		2.4	2240	0.38	1020	0.362
60-80		2.5	2360	0.42	1080	0.408
80-100		2.6	2480	0.46	1140	0.454
>100	Well-cemented calcarenite	2.7	2600	0.5	1200	0.5

Table D-3. Geoacoustic profile used as the input to the models at Site 5.

Depth below seafloor (m)	Material	Density (g/cm³)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0	Coarse carbonate sand	2.03	1802.2	0.85	300	6.2
20		2.07	1836.27	0.84	320	6.5
20-36	Increasingly cemented calcarenite	2.2	2000	0.3	900	0.27
36-52		2.3	2120	0.34	960	0.316
52-68		2.4	2240	0.38	1020	0.362
68-84		2.5	2360	0.42	1080	0.408
84-100		2.6	2480	0.46	1140	0.454
>100	Well-cemented calcarenite	2.7	2600	0.5	1200	0.5

Appendix D JASCO Acoustic Modelling Technical Note

Technical Note

Supplemental modelling results for *Otway Basin Geophysical Operations Acoustic Modelling: Acoustic Modelling for Assessing Marine Fauna Sound Exposures*

From: Michael Wood and Craig McPherson
JASCO Applied Sciences (Australia) Pty Ltd

Date: 02 April 2019

Document: 01777

This technical note provides additional modelling results that supplement the original report: *Otway Basin Geophysical Operations Acoustic Modelling: Acoustic Modelling for Assessing Marine Fauna Sound Exposures* (McPherson and Wood 2017).

Tabulated ranges are provided to impact thresholds defined by NMFS (2018) for cetaceans and pinnipeds from operations involving the boomer and sub-bottom profiler (SBP) sound sources, and from the 450 in^3 vertical seismic profiling (VSP) array.

The sound exposure level (SEL) results for the different auditory classes of marine mammal are frequency-weighted in accordance with NMFS (2018); the weighting functions are described in Appendix A; peak pressure levels (PK) are unweighted.

Results are presented for the Boomer and SBP in Section 1, and for the VSP in Section 2, while Section 3 discusses potential alternative sources for the study.

1. Boomer and SBP

1.1. Impact ranges from PK for high-frequency cetaceans

The ranges to identified impact thresholds for high-frequency cetaceans from the PK levels of the Boomer and SBP are shown in Table 1. The threshold levels for the equivalent effect in low- and mid-frequency cetaceans are appreciably higher, and thus were not reached.

Table 1. Maximum ranges to identified impact thresholds due to PK levels defined by NMFS for high-frequency cetaceans from SBP and Boomer operations.

PK Threshold Level dB re 1 µPa	Effect	SBP Range (m)	Boomer AP3000 Range (m)
202	PTS	0.6	2.8
196	TTS	1.2	5.5

1.2. Maximum ranges to impact thresholds from SEL_{24h} for marine mammals

The ranges to recommended impact thresholds from the Boomer and SBP are presented in Table 2. In all cases, the frequency-weighted levels are not high enough to reach the impact thresholds except for TTS in low-frequency cetaceans; the maximum range in this case is 10 m from the acoustic centre of the source.

Table 2. Maximum ranges to identified impact thresholds due to frequency-weighted SEL_{24h} levels defined by NMFS from SBP and Boomer operations.

Auditory group	Effect	Frequency-weighted Threshold Level dB re 1 µPa²·s	Artisan Range (m)	G3 Range (m)	Meeki Range (m)	Thy Comb Range (m)
Low-frequency Cetaceans	PTS	183	—	—	—	—
	TTS	168	10	<10	<10	<10
Mid-frequency Cetaceans	PTS	185	—	—	—	—
	TTS	170	—	—	—	—
High-frequency Cetaceans	PTS	155	—	—	—	—
	TTS	140	—	—	—	—
Phocid pinnipeds	PTS	185	—	—	—	—
	TTS	170	—	—	—	—
Otariid pinnipeds	PTS	203	—	—	—	—
	TTS	188	—	—	—	—

2. VSP

The ranges to recommended impact thresholds resulting from the VSP are presented in Table 3. Results assume both stationary source and receivers. Results are frequency-weighted in accordance with NMFS (2018). Maximum ranges are shown for 1, 5, 10, 15, 25, 144, and 360 impulses within a 24-hour period. Ranges up to 2.5 km calculated using 1 m resolution modelling on 5 m resolution gridded sound fields; ranges greater 2.5 km calculated using 10 m resolution modelling on 25 m resolution gridded sound fields.

Table 3. Maximum ranges to identified impact thresholds due to frequency-weighted SEL_{24h} defined by NMFS from VSP operations assuming different numbers of impulses during a 24-hour period.

Auditory group	Effect	Frequency-weighted Threshold Level dB re 1 µPa²·s	Number of impulses						
			1 R_{max} (m)	5 R_{max} (m)	10 R_{max} (m)	15 R_{max} (m)	25 R_{max} (m)	144 R_{max} (m)	360 R_{max} (m)
Low-frequency Cetaceans	PTS	183	11	30	45	56	72	323	738
	TTS	168	81	335	625	924	1227	3051	4743
Mid-frequency Cetaceans	PTS	185	—	—	—	—	—	—	—
	TTS	170	—	—	—	—	—	<10	<10
High-frequency Cetaceans	PTS	155	—	—	—	<10	<10	18	32
	TTS	140	<10	21	29	36	51	149	256
Phocid pinnipeds	PTS	185	—	—	—	<10	<10	21	34
	TTS	170	<10	22	32	40	55	222	409
Otariid pinnipeds	PTS	203	—	—	—	—	—	—	—
	TTS	188	—	—	—	—	—	<10	14

3. Comparison of sources

Beach Energy solicited tenders for the geophysical survey, and received three responses which proposed alternative equipment to that considered in McPherson and Wood (2017). These three responses have been evaluated, with the findings summarised below.

The primary sources of concern are the boomer and sub-bottom profiler, with other the potential sources for this project such as multi-beam echo sounders and side-scan-sonars being high frequency devices only, with centre frequencies over 100 Hz. As no mid-frequency multi-beam sonars are being considered, the potential for overlap between marine fauna hearing ranges and multi-beam sonar signals of concern is extremely limited.

The proposed sub-bottom profiler is the Edgetech X-star system, which is the same source as considered in the modelling study. Alternative boomers suggested as potential sources instead of the AP3000 include the AA251, AA300 and AA301. The modelled AP3000 signature was based upon scaling the signature of an AA202 single boomer plate. The frequency spectrum components of these potential sources are very similar to the modelled AP3000, and they will also exhibit a similar beam pattern. The peak source pressure level of the alternative boomers is slightly higher than the AP3000, which has a peak source pressure level of 210.8 dB re 1 $\mu Pa^2 m^2$, with that for the AA251 being of 212 dB re 1 $\mu Pa^2 m^2$ and AA301's 215 dB re 1 $\mu Pa^2 m^2$. This results in slightly greater ranges to PK thresholds for high-frequency cetaceans (Table 4), however criteria for other mammal auditory groups are not reached. There is also an increase in distance to PK-PK sound levels of interest, however the resulting ranges are still small, with no PK-PK sound level applied in the impact assessment exceeded more than 18 m from the source (Table 5). However, as both the Boomer and SBP are both towed at 3 m, the maximum depth at which the sound level of 202 dB re 1 µPa will be reached will be 21 m. As the shallowest modelling site of interest (Artisan, Table 1 in McPherson and Wood (2017)) has a depth of 71 m, no PK-PK sound levels of interest for benthic invertebrates will be reached at the seafloor.

Despite the differences in peak source pressure level between the modelled and potential alternative boomers, there is estimated to be only a very minor change in the per-pulse source sound exposure level (SEL), partly due to the length of the impulse from these alternative sources. Due to minor changes expected in term of per-pulse SEL, the modelling results presented in McPherson and Wood (2017) for SEL_{24h} are considered to be appropriate approximations of the potential sound fields and ranges to SEL_{24h} impact criteria.

Table 4. Maximum ranges to identified impact thresholds due to PK levels defined by NMFS for high-frequency cetaceans for the modelled boomer (AP3000) and two potential alternative boomers.

PK Threshold level dB re 1 µPa	Effect	Boomer AP3000 Range (m)	Boomer AA251 Range (m)	Boomer AA301 Range (m)
202	PTS	2.8	3.2	4.5
196	TTS	5.5	6.3	8.9

Table 5. Maximum ranges to identified PK-PK sound levels for the modelled boomer (AP3000) and two potential alternative boomers.

PK-PK dB re 1 µPa	Boomer AP3000 Range (m)	Boomer AA251 Range (m)	Boomer AA301 Range (m)
215	2.4	2.8	3.9
212	3.4	3.9	5.5
210	4.3	4.9	7.0
209	4.8	5.5	7.8
205	7.6	8.7	12.4
202	10.8	12.4	17.5

References

[NMFS] National Marine Fisheries Service. 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 pp. https://www.fisheries.noaa.gov/webdam/download/75962998.

Finneran, J.J. 2015. *Auditory weighting functions and TTS/PTS exposure functions for cetaceans and marine carnivores*. Technical report by SSC Pacific, San Diego, CA.

Finneran, J.J. 2016. *Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise*. Technical Report for Space and Naval Warfare Systems Center Pacific, San Diego, CA. 49 pp. http://www.dtic.mil/dtic/tr/fulltext/u2/1026445.pdf.

McPherson, C.R. and M.A. Wood. 2017. *Otway Basin Geophysical Operations Acoustic Modelling*. Document Number 01473. Technical report by JASCO Applied Sciences for Lattice Energy.

Appendix A.

NMFS (2018) Frequency weighting functions

In 2015, a U.S. Navy technical report by Finneran (2015) recommended new auditory weighting functions. The auditory weighting functions for marine mammals are applied in a similar way as A-weighting for noise level assessments for humans. The new frequency-weighting functions are expressed as:

$$G(f) = K + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\} \quad \text{(A-1)}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively), phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses noise impacts on marine mammals (NMFS 2018). Table A-1 lists the frequency-weighting parameters for each hearing group. Figure A-1 shows the resulting frequency-weighting curves.

Table A-1. Parameters for the auditory weighting functions recommended by NMFS (2018).

Functional hearing group	*a*	*b*	f_1 (Hz)	f_2 (Hz)	K (dB)
Low-frequency cetaceans	1.0	2	200	19,000	0.13
Mid-frequency cetaceans	1.6	2	8,800	110,000	1.20
High-frequency cetaceans	1.8	2	12,000	140,000	1.36
Phocid pinnipeds in water	1.0	2	1,900	30,000	0.75
Otariid pinnipeds in water	2.0	2	940	25,000	0.64

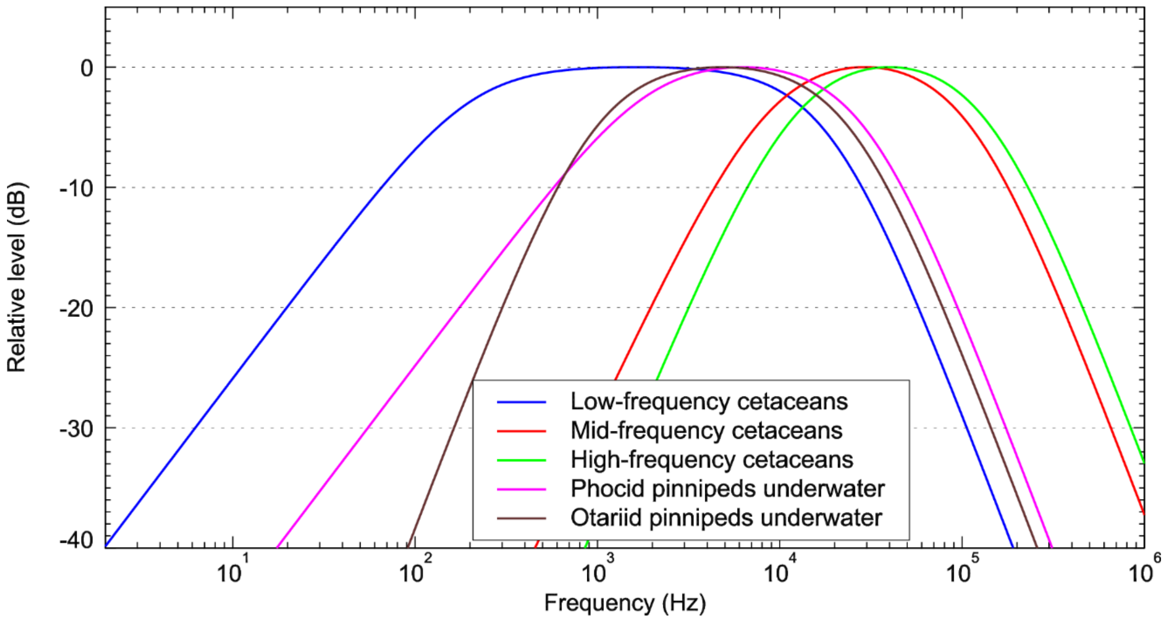


Figure A-1. Auditory weighting functions for the functional marine mammal hearing groups as recommended by NMFS (2018).

Appendix E EP Revision Change Register

Any changes to the EP should be assessed against the OPGGS(E)R revision submission criteria.

Date	EP Revision	Section Revised	Changes	MOC No.	EP Submission Required

Appendix F Stakeholder Information Sheets

Appendix F.1 November 2019 Information Sheet

Bass Offshore Project
Seabed Assessment

beach


Yolla Platform, Bass Basin

Project Update | November 2019

Project overview

Beach Energy is planning further development of the Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses.

Beach extracts natural gas from the Yolla field via wells on the Yolla platform, transporting it to shore via a 147 km subsea pipeline. There, it joins the 32 km gas pipeline to the Lang Lang Gas Plant in Victoria. Once processed natural gas is supplied to the east coast domestic gas market.

About Beach

Beach Energy is an ASX listed oil and gas, exploration and production company headquartered in Adelaide. It has operated and non-operated, onshore and offshore, oil and gas production from five production basins across Australia and New Zealand and is a key supplier of domestic natural gas to Australia. Beach Energy is the operating partner of the BassGas joint venture which also includes AWE Limited and Prize Petroleum International Pte Ltd.

To ensure ongoing supply of domestic gas to the market Beach is proposing to undertake further development in the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields (See map overleaf).

Activities will include:

- Seabed assessments to determine the suitability of the seabed for drilling operations and installation of infrastructure to connect new production wells to the existing Yolla platform
- Drilling of offshore production wells
- Installation of infrastructure to tie-in the new production wells to the existing Yolla platform
- Potential additional exploration activities within the White Ibis field

At this stage planning has only been undertaken for the seabed assessments and is the focus of this information sheet.

Locations

All activities will take place in Commonwealth waters approximately 150 km from the Victorian coast.

The map below shows the location of the existing BassGas infrastructure, fields, and proposed seabed assessment location.

The seabed assessment will cover a 6 km x 6 km area over the Trefoil and Rockhopper permits and a 40 km x 1 km corridor between the Trefoil and Rockhopper permits and the Yolla platform.

Coordinates of the seabed assessment area are provided in the table below.

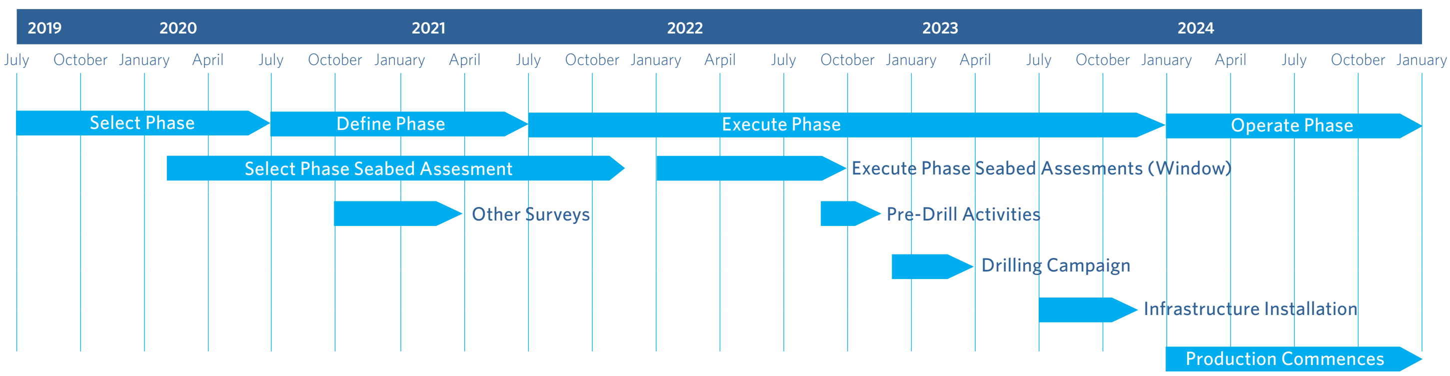
Map Reference	Longitude	Latitude
A	145°21'52.5"E	39°49'01.2"S
B	145°26'04.7"E	39°49'04.7"S
C	145°26'03.0"E	39°50'22.3"S
D	145°48'41.6"E	39°50'02.4"S
E	145°48'42.4"E	39°50'34.7"S
F	145°26'02.2"E	39°50'54.8"S
G	145°26'00.3"E	39°52'19.2"S
H	145°21'47.8"E	39°52'15.7"S

Timing

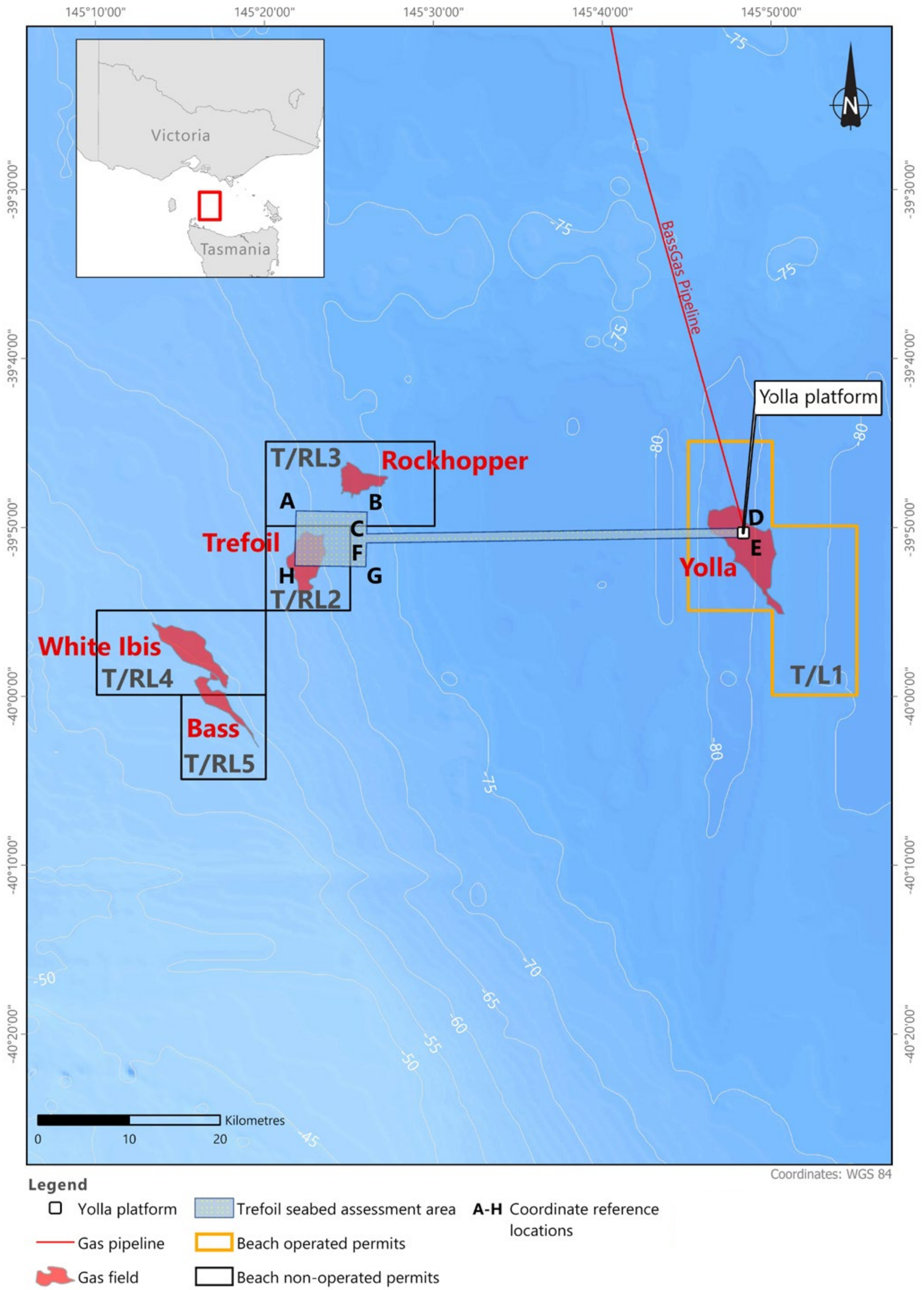
The seabed assessment will take up to 25 days and will be undertaken between February 2020 to December 2021 depending on contract and approval timings. The seabed assessment consists of two elements, a geophysical survey program which will take up to 15 days and a geotechnical component which will take up to 10 days.

Start dates and durations will be provided to relevant stakeholders after completion of planning and regulatory approvals. Exact timings will also depend on fair sea state conditions. Stakeholders will be provided with specific locations and timings prior to the commencement of the activity.

The diagram below outlines the activities starting from February 2020 and running over several phases through to 2024.



Trefoil Seabed Assessment Location



Project Environment Approvals

Beach is required to submit an Offshore Project Proposal (OPP) to the National Offshore Petroleum Safety and Environment Management Authority (NOPSEMA) for the development wells and subsea infrastructure to tie the wells back to the Yolla platform.

The OPP process involves NOPSEMA's assessment of the potential environmental impacts and risks of the activities conducted over the life of the project. The process includes a public comment period prior to approval and requires Beach to ensure environmental impacts and risks will be managed to acceptable levels. Following approval, Beach is then required to develop Environment Plans for specific activities which will be submitted to NOPSEMA for assessment before each activity can commence.

Stakeholders can review and provide comment on the OPP once NOPSEMA has determined the OPP is suitable for publication. Following the public comment period, Beach must prepare a consultation report and the final OPP for assessment by NOPSEMA.

Guidance on the OPP and public comment process is available on the NOPSEMA website www.nopsema.gov.au/environmental-management/offshore-project-proposals/

Beach will undertake further consultation with stakeholders as part of developing the OPP for any future BassGas development.

Environmental, Heritage, Social and Economic Values within the project area

Beach recognises the environmental, heritage, social and economic values in the areas in which we operate.

The environment within the project area is characterised by:

- Water depths ranging from 66 to 82 metres
- Seabed consists of sparsely scattered clumps of solitary sponges, sea cucumbers, sea squirts and snails.

A variety of marine fauna occur in the project area 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 dolphin and shark species throughout the year
- New Zealand and Australian fur seals throughout the year
- Loggerhead, green and leatherback turtles throughout the year.

Economic values within the project area are:

- Commercial fishing activity
- Commercial shipping activity.

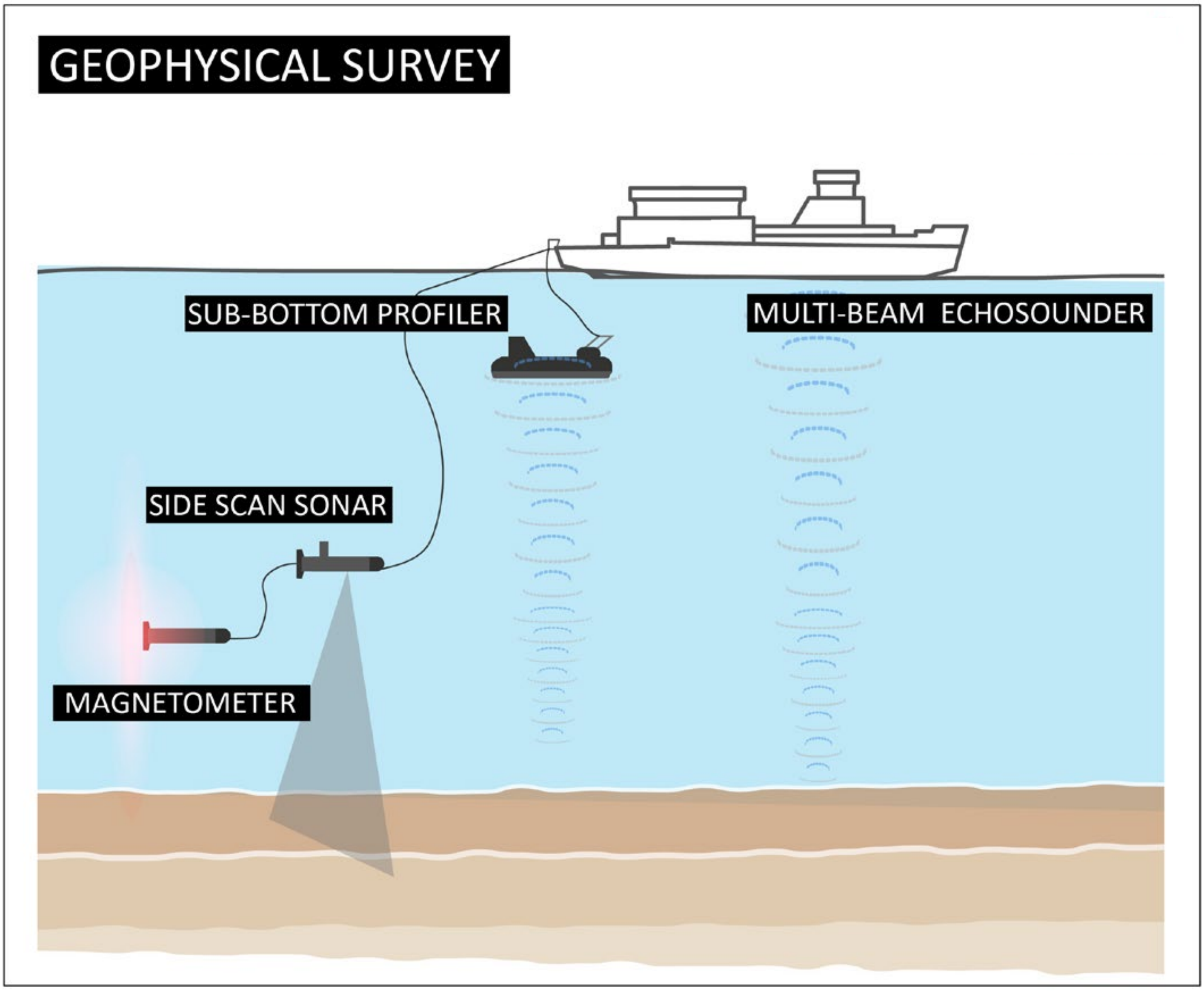
No social or heritage values were identified in the project area including State or Australian Marine Parks.

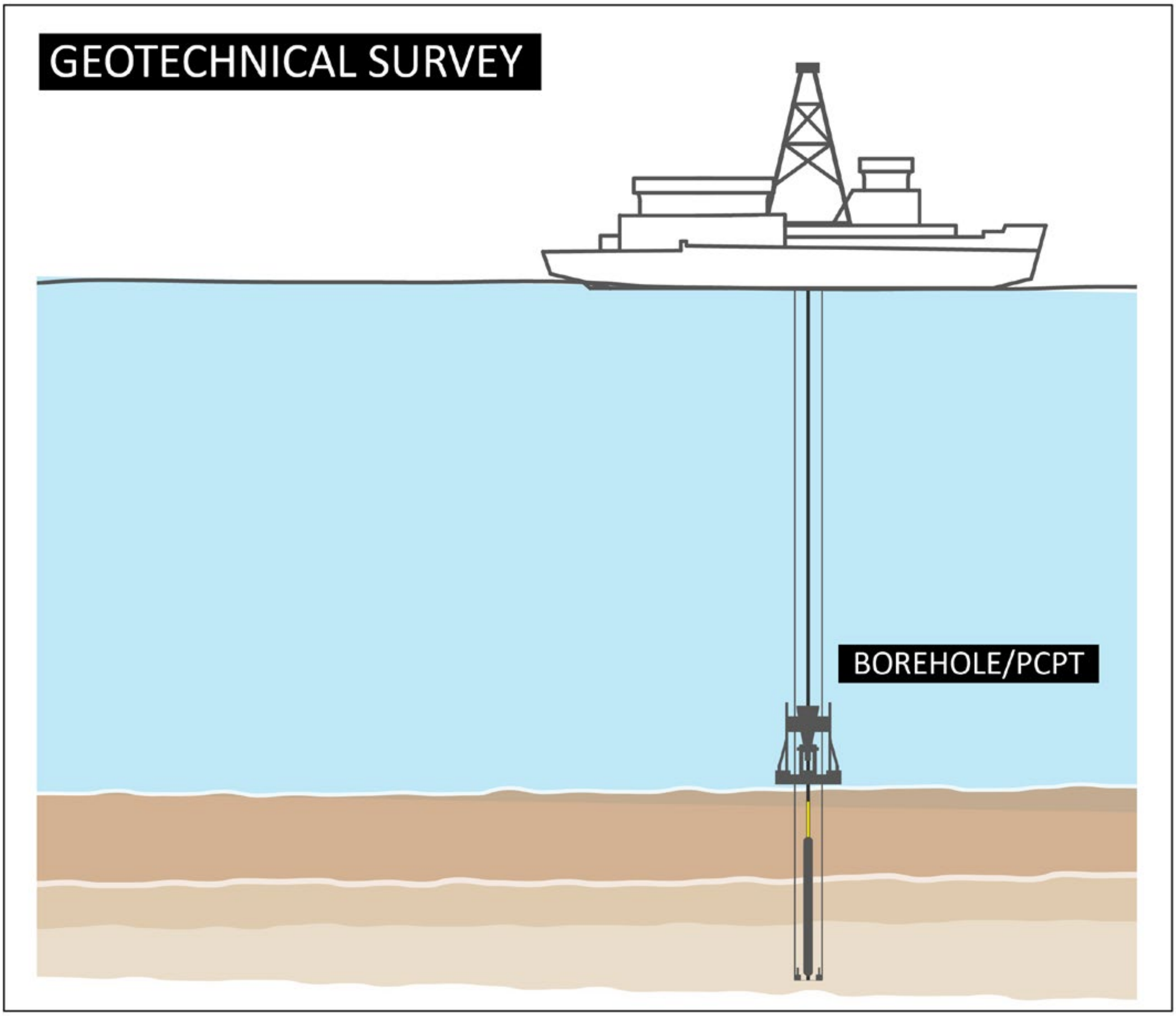
Seabed Assessment Activities

The seabed assessment activities will involve geotechnical and geophysical investigations from a survey vessels consisting of:

- **Geophysical survey program, including:**
  - o Echo sounder for measuring water depths
  - o Multibeam echosounder for bathymetry mapping
  - o Side-scan sonar for identifying seabed features
  - o Magnetometer to detect metallic objects on or below the seabed
  - o Velocity profiler to determine speed of sound in water
  - o Sub-bottom profiler (SBP) to identify shallow formation structures below seafloor.
- **Geotechnical survey program, including:**
  - o Piezocone penetration test (PCPT) to 30 metres to measure the resistance of the seabed to continuous penetration
  - o Sample borehole drilled to a depth of 40 metres using seawater or bentonite.

The geotechnical survey will use a vessel that has drilling capability and therefore the geophysical survey may be undertaken by a different vessel to the geotechnical survey. The diagrams below show the common setup for the geophysical and geotechnical surveys.





Questions and Answers

Why are you undertaking the seabed assessment?

The seabed assessment is being undertaken to determine a suitable location to place a jack-up rig for the drilling of potential development wells. A jack-up rig requires a firm seabed to place its three "legs" which are used to hold the drill rig in place. The borehole, from which a core of the seabed is taken, and the piezocone penetration test (PCPT) will provide information on the strength of the seabed to support the drill rig.

The seabed assessment will also obtain more detailed information on the bathymetry and seabed features at the well locations and between the well locations and the Yolla platform.

What approvals are required before you can commence the seabed assessment?

An Environment Plan is required to be submitted to the National Offshore Petroleum Safety and Environment Authority (NOSPEMA) for approval under the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (the Regulations).

The contents of an Environment Plan are set out in the Regulations and 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.

The Environment Plan is made public on submission to NOPSEMA. If you would like to be notified of when the Environment Plan is published on the NOPSEMA website, you can register your interest on the NOPSEMA website at www.info.nopsema.gov.au/home/open_for_comment

Will the activities affect rock lobsters and scallops?

Sound from the seabed assessment equipment are of low intensity and based on modelling for higher intensity sound sources, sound levels will not reach the impact level referred to in the Day et al Report[1] at the seafloor and therefore impacts to scallops and rock lobsters are not predicted.

What will happen to any discharges from the borehole drilling?

Seawater and/or bentonite will be used to lubricate the drill bit and stabilise the borehole, as well as remove seabed material produced through drilling, called cuttings. As the fluids and cuttings come out of the borehole they will be deposited onto the seabed. Bentonite is an inert material that is classed as posing little or no risk to the environment.

Will the site assessments impact upon commercial fishing?

The seabed assessment area is located within existing designated Commonwealth and State fisheries. Engagement with fisheries has identified a low level of activity in the area. Each fishery covers a vast area, whereas the seabed assessments will only require access to a relatively small area for a period of up to 25 days.

Beach is committed to minimising the impact of its activities and will consult with commercial fishers on arrangements to ensure each other's operational plans are understood, helping to minimise any impacts to fishing activities.

How will you reduce the risk of collision with other vessels?

Survey vessels will operate in accordance with Australian Maritime Standards and ensure safe operations by:

- Having operational and navigation lighting
- Maintaining a 24-hour visual, radio and radar watch for other vessels
- Pre-survey start notifications
- Text messaging of vessel location, where requested.

Will an exclusion zone exist?

Exclusion zones will not be in place during the seabed assessment and normal navigational requirements will be followed.

To avoid entanglement and safety risks, fishing nets, lines or pots should not be placed in the seabed assessment area for the period of the seabed assessment.

Will the activities affect whales and dolphins?

Based on the low intensity of sound generated from the equipment any impact to whales and dolphins will be low and temporary based on the short duration of the seabed assessment. Shutdown and exclusions zones will be used to manage any impacts to whales that may be in the area during the seabed assessment. Avoidance of whales and dolphins will be undertaken in accordance with the EPBC Regulations (2000) including adherence to distance and speed requirements.

When will drilling occur?

Drilling is currently planned for late 2022 and stakeholders will be kept informed about the proposed drilling and development as Beach progresses further planning. Beach is required to prepare a drilling Environment Plan and Well Operations Management Plan for submission and acceptance by NOPSEMA. Stakeholders will be consulted as part of the development of the Environment Plan.

1 Day, R.D., McCauley, R.M. Fitzgibbon, Q.P., Hartmann, K., Semmens, J.M., Institute for Marine and Antarctic Studies, 2016, Assessing the impact of marine seismic surveys on southeast Australian scallop and lobster fisheries, University of Tasmania, Hobart, October. CC BY 3.0.

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 seabed assessments, drilling program and development activities.

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, copies of correspondence, including emails will be considered alongside technical and environmental assessments as the Offshore Project Proposal and Environment Plans are prepared for submission, and will be communicated to NOPSEMA as required by legislation.

Lang Lang Gas Plant, Victoria

Contact us

1800 797 011

community@beachenergy.com.au

beachenergy.com.au

beach

Appendix F.2 January 2020 Information Sheet

Bass Offshore Project
Seabed Assessment

Yolla Platform, Bass Basin

Project Update | January 2020

Project overview

Beach Energy is planning further development of the Bass offshore natural gas reserves within existing Commonwealth offshore exploration permits and production licenses.

Beach extracts natural gas from the Yolla field via wells on the Yolla platform, transporting it to shore via a 147 km subsea pipeline. There, it joins the 32 km gas pipeline to the Lang Lang Gas Plant in Victoria. Once processed natural gas is supplied to the east coast domestic gas market.

About Beach

Beach Energy is an ASX listed oil and gas, exploration and production company headquartered in Adelaide. It has operated and non-operated, onshore and offshore, oil and gas production from five production basins across Australia and New Zealand and is a key supplier of domestic natural gas to Australia. Beach Energy is the operating partner of the BassGas joint venture which also includes AWE Limited and Prize Petroleum International Pte Ltd.

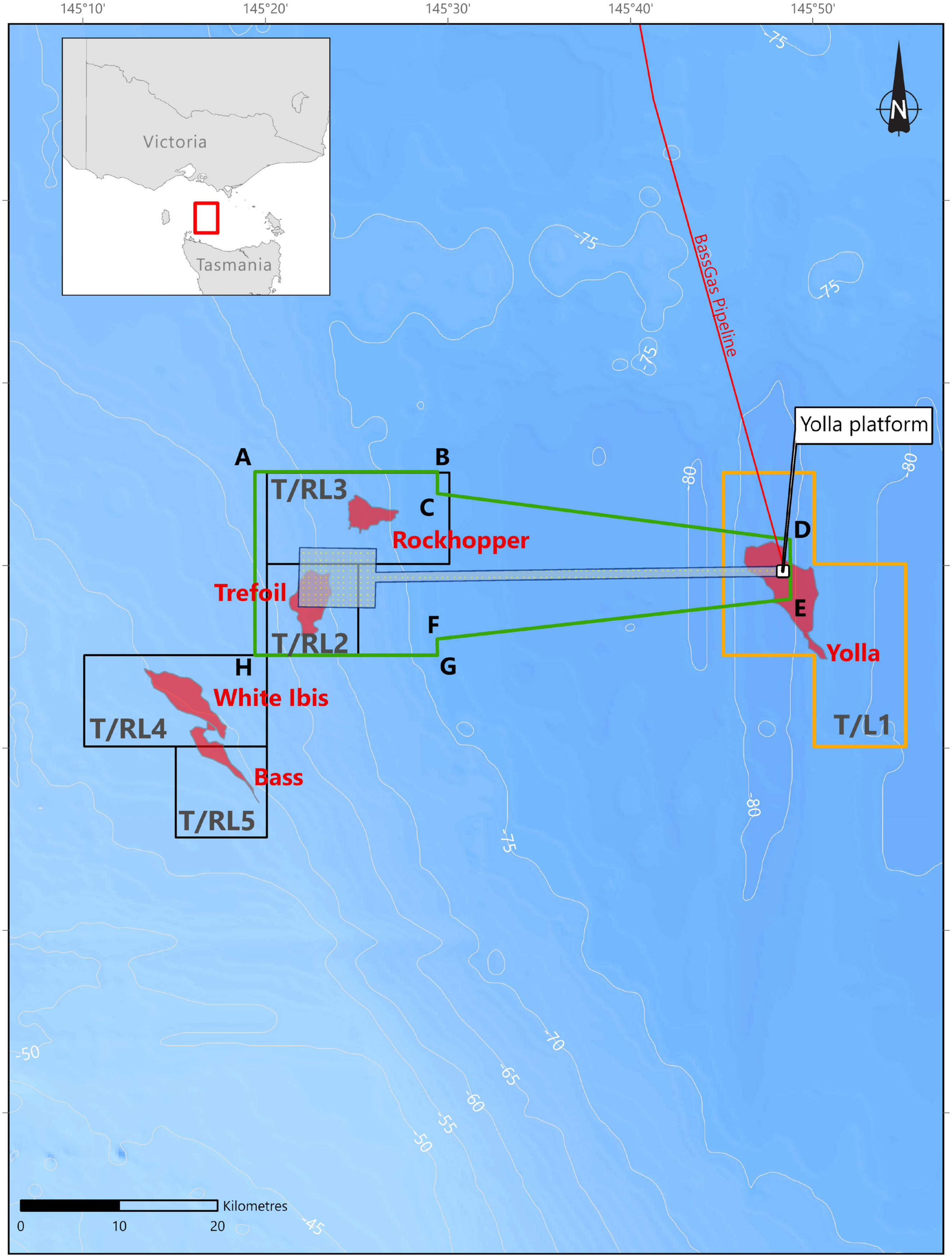
To ensure ongoing supply of domestic gas to the market Beach is proposing to undertake further development in the Trefoil field and exploration and possible development within the Rockhopper and White Ibis fields (See map overleaf).

Activities will include:

- Seabed assessments to determine the suitability of the seabed for drilling operations and installation of infrastructure to connect new production wells to the existing Yolla platform
- Drilling of offshore production wells
- Installation of infrastructure to tie-in the new production wells to the existing Yolla platform
- Potential additional exploration activities within the White Ibis field.

At this stage planning has only been undertaken for the seabed assessments and is the focus of this information sheet.

Trefoil Seabed Assessment Location



There is no warranty that this map is free from errors or omissions. Coordinates: WGS 84

Legend

- Yolla platform
- Gas pipeline
- Gas field
- Preliminary Trefoil seabed assessment area
- Beach operated permits
- Beach non-operated permits
- Trefoil seabed assessment operational area
- **A-H** Coordinate reference locations

Locations

All activities will take place in Commonwealth waters approximately 90 km from the Victorian coast and Tasmanian coast.

The map above shows the location of the existing BassGas infrastructure, fields, and proposed seabed assessment location.

The seabed assessment will cover a 6 km x 6 km area over the Trefoil and Rockhopper permits and a 40 km x 1 km corridor between the Trefoil and Rockhopper permits and the Yolla platform.

The location of the seabed assessment area shown in the map above may change but will be within the operational area shown on the map.

Coordinates of the operational area are provided in the table below.

Map Reference	Longitude	Latitude
A	145° 19.43' E	39° 44.87' S
B	145° 29.42' E	39° 44.86' S
C	145° 29.42' E	39° 46.06' S
D	145° 48.74' E	39° 48.58' S
E	145° 48.76' E	39° 51.83' S
F	145° 29.40' E	39° 54.03' S
G	145° 29.42' E	39° 54.91' S
H	145° 19.43' E	39° 54.91' S

Timing

The seabed assessment consists of two elements, a geophysical survey which will take up 25 days and a geotechnical survey which will take up to 55 days. The surveys will be undertaken between February 2020 and December 2021 depending on vessel availability and approval timings.

Start dates and durations will be provided to relevant stakeholders after completion of planning and regulatory approvals. Exact timings will also depend on fair sea state conditions. Stakeholders will be provided with specific locations and timings a minimum of one month prior to the commencement of the activity.

Project Environment Approvals

Beach is required to submit an Offshore Project Proposal (OPP) to the National Offshore Petroleum Safety and Environment Management Authority (NOPSEMA) for the development wells and subsea infrastructure to tie the wells back to the Yolla platform.

The OPP process involves NOPSEMA's assessment of the potential environmental impacts and risks of the activities conducted over the life of the project.

The process includes a public comment period prior to approval and requires Beach to ensure environmental impacts and risks will be managed to acceptable levels. Following approval, Beach is then required to develop Environment Plans for specific activities which will be submitted to NOPSEMA for assessment before each activity can commence.

Stakeholders can review and provide comment on the OPP once NOPSEMA has determined the OPP is suitable for publication. Following the public comment period, Beach must prepare a consultation report and the final OPP for assessment by NOPSEMA.

Guidance on the OPP and public comment process is available on the NOPSEMA website www.nopsema.gov.au/environmental-management/offshore-project-proposals/

Beach will undertake further consultation with stakeholders as part of developing the OPP for any future BassGas development.

Environmental, Heritage, Social and Economic Values within the project area

Beach recognises the environmental, heritage, social and economic values in the areas in which we operate.

The environment within the project area is characterised by:

- Water depths ranging from 64 - 82 metres
- Seabed consists of sparsely scattered clumps of solitary sponges, sea cucumbers, sea squirts and snails.

A variety of marine fauna occur in the project area 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 dolphin and shark species throughout the year
- New Zealand and Australian fur seals throughout the year
- Loggerhead, green and leatherback turtles throughout the year.

Economic values within the project area are:

- Commercial fishing activity
- Commercial shipping activity.

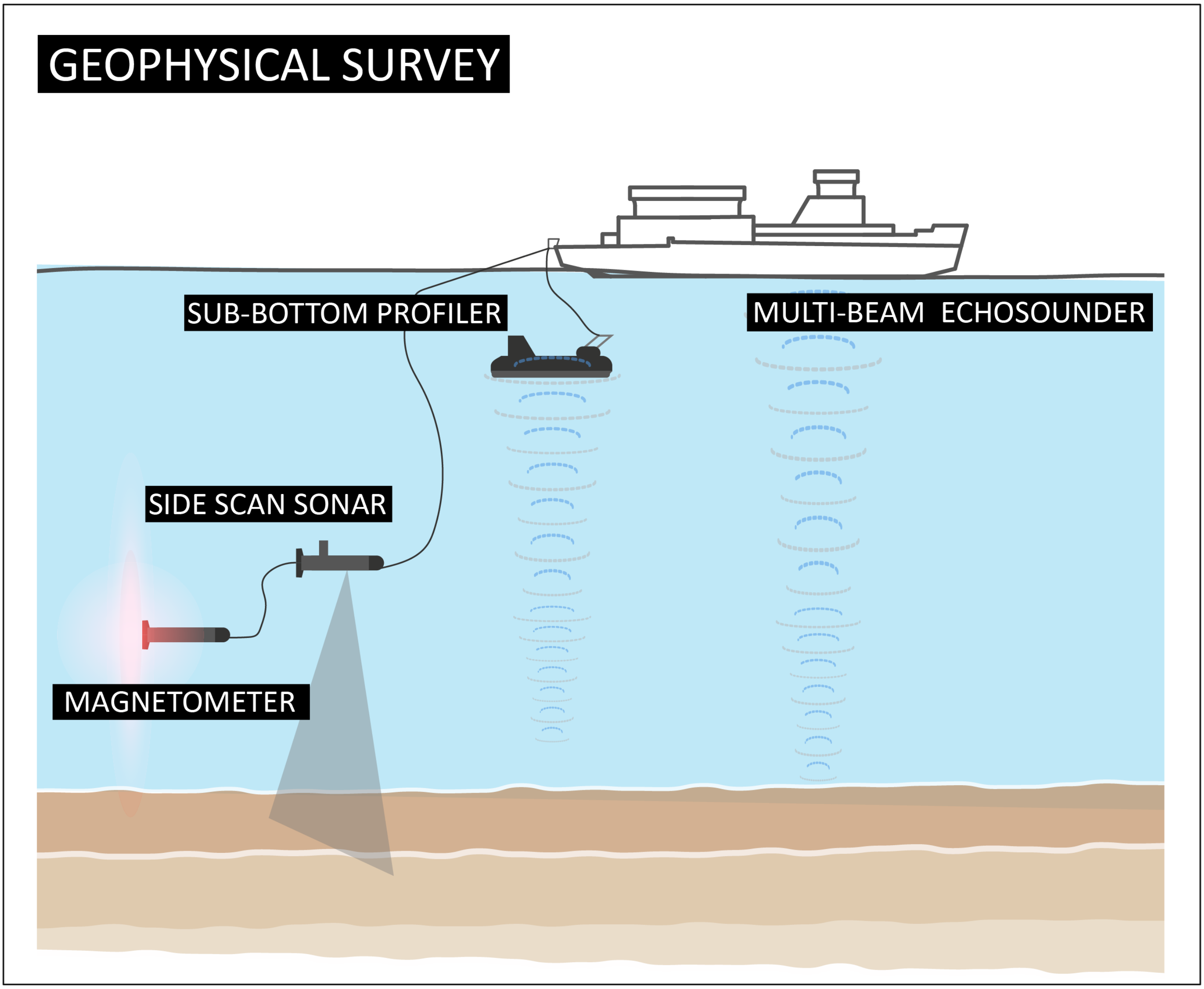
No social or heritage values were identified in the project area including State or Australian Marine Parks.

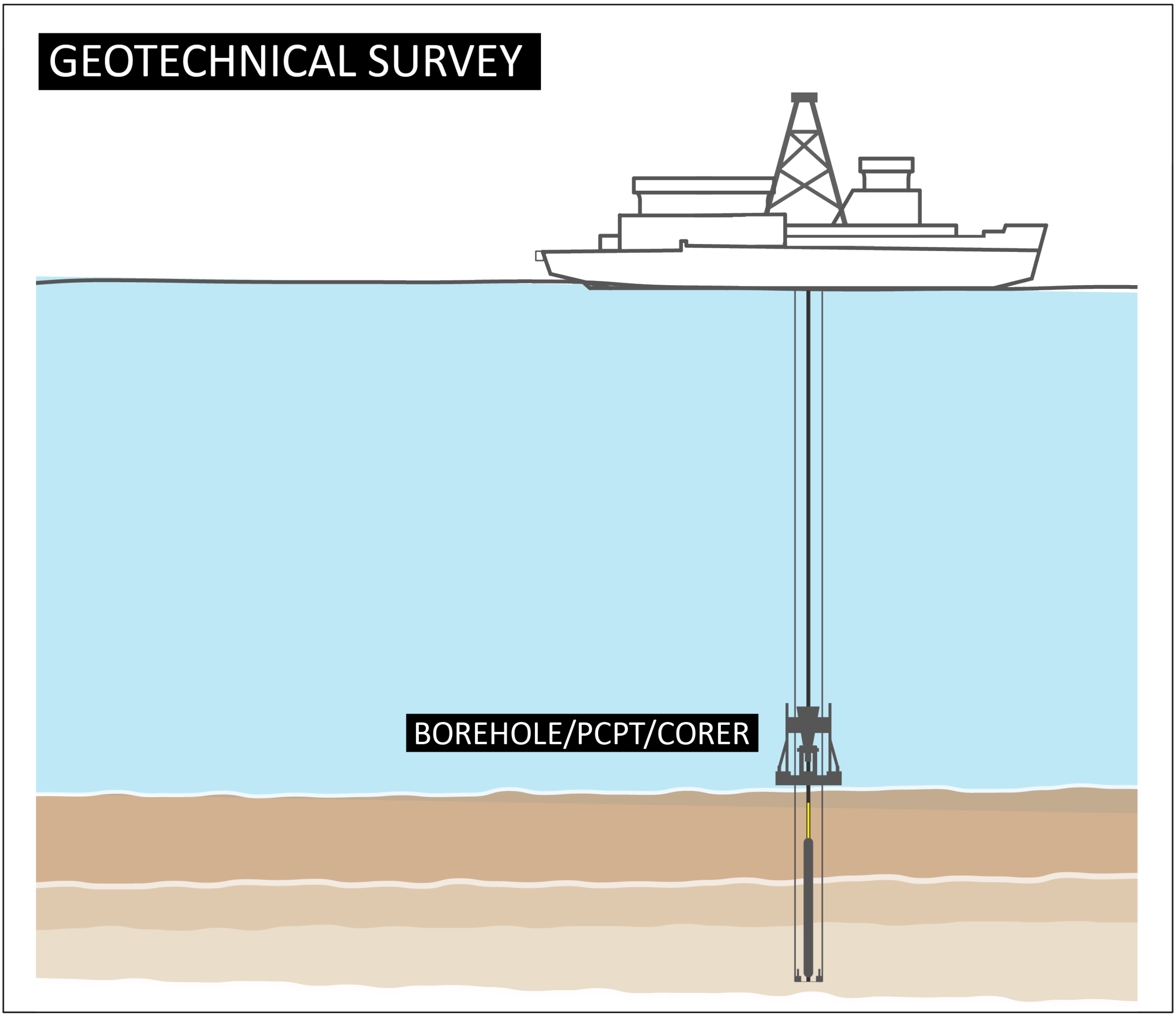
Seabed Assessment Activities

The seabed assessment activities will involve geotechnical and geophysical investigations from a survey vessels consisting of:

- **Geophysical survey program, including:**
  - o Echo sounder for measuring water depths
  - o Multibeam echosounder for bathymetry mapping
  - o Side-scan sonar for identifying seabed features
  - o Magnetometer to detect metallic objects on or below the seabed
  - o Velocity profiler to determine speed of sound in water
  - o Sub-bottom profiler (SBP) to identify shallow formation structures below seafloor.
- **Geotechnical survey program, including:**
  - o Piezocone penetration test (PCPT) to a maximum of 60 metres to measure the resistance of the seabed to continuous penetration
  - o Sample borehole drilled to a maximum depth of 150 metres using seawater or bentonite
  - o Core samples to a depth of 4 m for geological analysis.

The geotechnical survey will use a vessel that has drilling capability and therefore the geophysical survey may be undertaken by a different vessel to the geotechnical survey. The diagrams below show the common setup for the geophysical and geotechnical surveys.





Questions and Answers

Why are you undertaking the seabed assessment?

The seabed assessment is being undertaken to obtain detailed information on the bathymetry, seabed features and shallow geology at potential well locations and between the well locations and the Yolla platform. This information will be used to determine future drilling and infrastructure locations for the Bass Development.

What approvals are required before you can commence the seabed assessment?

An Environment Plan is required to be submitted to the National Offshore Petroleum Safety and Environment Authority (NOSPEMA) for approval under the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (the Regulations).

The contents of an Environment Plan are set out in the Regulations and 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.

The Environment Plan is made public on submission to NOPSEMA. If you would like to be notified of when the Environment Plan is published on the NOPSEMA website, you can register your interest on the NOPSEMA website at www.info.nopsema.gov.au/home/open_for_comment

Will the activities affect rock lobsters and scallops?

Sound from the seabed assessment equipment are of low intensity and based on modelling for higher intensity sound sources, sound levels will not reach the impact level referred to in the Day et al Report[1] at the seafloor and therefore impacts to scallops and rock lobsters are not predicted.

What will happen to any discharges from the borehole drilling?

Seawater and/or bentonite will be used to lubricate the drill bit and stabilise the borehole, as well as remove seabed material produced through drilling, called cuttings. As the fluids and cuttings come out of the borehole they will be deposited onto the seabed. Bentonite is an inert material that is classed as posing little or no risk to the environment.

Will the site assessments impact upon commercial fishing?

The seabed assessment area is located within existing designated Commonwealth and State fisheries. Engagement with fisheries has identified a low level of activity in the area. Each fishery covers a vast area, whereas the seabed assessments will only require access to a relatively small area for a period of up to 80 days.

Beach is committed to minimising the impact of its activities and will consult with commercial fishers on arrangements to ensure each other's operational plans are understood, helping to minimise any impacts to fishing activities.

How will you reduce the risk of collision with other vessels?

Survey vessels will operate in accordance with Australian Maritime Standards and ensure safe operations by:

- Having operational and navigation lighting
- Maintaining a 24-hour visual, radio and radar watch for other vessels
- Pre-survey start notifications
- Text messaging of vessel location, where requested.

Will an exclusion zone exist?

Exclusion zones will not be in place during the seabed assessment and normal navigational requirements will be followed.

To avoid entanglement and safety risks, fishing nets, lines or pots should not be placed in the seabed assessment area for the period of the seabed assessment.

Will the activities affect whales and dolphins?

Based on the low intensity of sound generated from the equipment any impact to whales and dolphins will be low and temporary based on the short duration of the seabed assessment. Shutdown and exclusions zones will be used to manage any impacts to whales that may be in the area during the seabed assessment. Avoidance of whales and dolphins will be undertaken in accordance with the EPBC Regulations (2000) including adherence to distance and speed requirements.

When will drilling occur?

Drilling is currently planned for late 2022 and stakeholders will be kept informed about the proposed drilling and development as Beach progresses further planning. Beach is required to prepare a drilling Environment Plan and Well Operations Management Plan for submission and acceptance by NOPSEMA. Stakeholders will be consulted as part of the development of the Environment Plan.

1 Day, R.D., McCauley, R.M. Fitzgibbon, Q.P., Hartmann, K., Semmens, J.M., Institute for Marine and Antarctic Studies, 2016, Assessing the impact of marine seismic surveys on southeast Australian scallop and lobster fisheries, University of Tasmania, Hobart, October. CC BY 3.0.

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 seabed assessments, drilling program and development activities.

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, copies of correspondence, including emails will be considered alongside technical and environmental assessments as the Offshore Project Proposal and Environment Plans are prepared for submission, and will be communicated to NOPSEMA as required by legislation.

Lang Lang Gas Plant, Victoria

Contact us

1800 797 011

community@beachenergy.com.au

beachenergy.com.au

beach

GD19-0146

Appendix F.3 October 2021 Information Email

Subject: Update – Trefoil Seabed Assessment Project in Bass Strait

TREFOIL SEABED ASSESSMENT PROJECT

Beach is continuing development of its offshore natural gas reserves in Bass Strait, and we write to provide an update on the Trefoil Seabed Assessment Project.

Seabed assessments are required to determine suitable locations for drilling new production wells and the installation of infrastructure to the existing Yolla Platform and pipeline to the Lang Lang Gas Plant. The seabed assessments involve two different surveys – Geophysical and Geotechnical - each using different vessels and equipment. (Please note that this is separate to the Prion Marine Seismic Survey Project and is not a seismic survey).

The accepted Environment Plan for the Trefoil Seabed Assessment project can be viewed at: https://info.nopsema.gov.au/activities/414/show_public

TIMING UPDATE

In June 2020, Beach completed the Geophysical survey. The Geotechnical survey was due to be completed by 31 December 2021. However, due to delays from availability of suitable vessels and supply-chain interruptions Beach will resubmit the Environment Plan to enable the project to be completed before 31 December 2022.

Beach will provide further notice to stakeholders before commencement of the final part of the Trefoil Seabed Assessments.

FURTHER INFORMATION

Further information on this project can be found at https://www.beachenergy.com.au/bass-basin/

If you have any questions, please don't hesitate to contact us on 1800 797 011 or community@beachenergy.com.au

Kind regards

Linda

Appendix F.4 November 2021 Information Email

UPDATE: Beach Energy activities in Bass Strait

BC

Beach Community <Community@beachenergy.com.au>

Wed 17/11/2021 12:07

Good afternoon

SUSPENDED WELLS INSPECTIONS
Beach is planning to undertake routine inspections of three suspended wells in Bass Strait starting approximately 17 December 2021, over 3 days subject to weather conditions. Further information and a location map can be found here: https://tinyurl.com/2rmvrvw8

SEABED ASSESSMENTS
Updating our last advice on 6 October 2021 regarding activity timing for seabed assessments, the remaining Geotechnical activities may be undertaken up to December 2023. The activities will take approximately 30 days and are most likely to occur between January and February 2022, or between November 2022 and February 2023, subject weather and vessel availability. At least 2 weeks' notice will be given in advance of the start date. Further information and a map can be found here: https://tinyurl.com/5y457n3h

PRION SIESMIC SURVEY
The survey recommenced yesterday after a short weather delay. Mariners will be advised if the vessel moves from the operation area, and can continue to contact the survey and support vessels directly, see: https://tinyurl.com/ppr43e5w

If you require further information please contact us: community@beachenergy.com.au or 1800 797 011

Kind Regards,

Linda

Beach Community Team
community@beachenergy.com.au

Appendix G Commercial Fisher Operating Protocol

Beach Energy Trefoil seabed assessment
Commercial Fisher Operating Protocol
1 July 2019

This protocol will be undertaken by Beach Energy (Beach) for the Trefoil seabed assessment with Fishers who have identified they fish in the area of the seabed surveys and/or well locations.

The aim of this Commercial Fisher Operating Protocol is to ensure that Beach and Fishers may continue their activities without unduly impacting on each other. These protocols are:

- Beach will notify Fishers a minimum of 4 weeks prior to the commencement of the seabed surveys and drilling program and provide the following information:
  - 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 or rig details including call sign and contact;
  - requested clearance from other vessels; and
  - Beach contact details.

  Note: coordinates will be provided as degrees and decimal minutes referenced to the WGS 84 datum.
- Beach will consider any reasonable requests to change the sequencing of a survey, however, where a change cannot be accommodated, Beach will inform the Fisher as to the reasons in a timely manner.
- Once the seabed surveys commence, Beach will provide regular (most likely daily) SMS messaging system updates on the locations the vessel will be operating and the expected duration, so Fishers can plan their fishing activities with the least disruption. Beach will request Fishers who wish to receive these SMS updates, to provide their mobile phone number, so they can be included in the distribution list. Beach will also have the vessel master put out daily radio messages on channel 16. The survey vessel will have AIS and so will be able to track any larger fishing vessels in their immediate area.
- The drill rig exclusion zone (500 m) will be communicated via Notice to Mariners. Fishers are to contact channel 16 if they wish to communicate with the rig at any time. The rig will be stationary until it is required to move to the next location. Beach will provide SMS messaging system updates 2 days prior to the rig moving to a new location detailing the new location and the expected duration at the location so Fishers can plan their fishing activities with the least disruption. Beach has undertaken an assessment of the Commonwealth and Victorian fisheries that overlap with the seabed assessment area and has identified low levels of fishing in this area.
- Where Fishers provide Beach with sensitive fishing data, Beach will maintain the confidentiality of that data as per Beach's privacy policy.

Given this assessment has identified low levels of fishing and commercial fisheries cover a vast area vs. Beach's seabed surveys and drilling that will only access a relatively small area over a short period of time, Beach's approach is to constructively work with Fishers in order to minimise impact to each other's activities. However, Beach has a stated position that Fishers should not suffer an economic loss as a result of our activities. Should a Fisher incur additional costs in order to work around our activities, or if they have lost catch, or have damaged equipment, Beach will assess the claim and ask for evidence, including, past fishing history and the loss incurred. Where the claim is genuine, Beach will provide compensation and will also ensure that the evidence required is not burdensome on the Fisher whilst ensuring genuine claims are processed.

Appendix H Surface oil Calculations

Inputs 3% wind and 100% current

Time	Time duration	12	hours			
Wind	Speed	17	kts		Bearing	Angle(degrees)
		31.484	km/h		N	0
					NNE	22.5
	Wind factor	3.00%	percent		NE	45
	Wind influence	0.94452	km/h		ENE	67.5
					E	90
	Direction (from)	225	degrees		ESE	112.5
	Direction (to)	45	degrees		SE	135
					SSE	157.5
	X offset/hr	0.668	km		S	180
	Y offset/hr	0.668	km		SSW	202.5
					SW	225
	X offset - wind total	8.015	km		WSW	247.5
	Y offset - wind total	8.015	km		W	270
					WNW	292.5
	Total wind distance	11.334	km		NW	315
					NNW	337.5
Current	Speed	0.18	m/s		N	360
		0.648	km/hr			
	direction (towards)	90	degrees			
	X offset/hr	0.648	km			
	Y offset/hr	0.000	km			
	X offset - current total	7.78	km			
	Y offset - current total	0.000	km			
	total current distance	7.776	km			
Results	total X offset	15.791	km	East		
	total Y offset	8.015	km	North		
	Distance	17.708	km			
	Bearing	63.09	degrees			

Inputs: 4% wind and 100% current

Time	Time duration	12	hours			
Wind	Speed	17	kts		Bearing	Angle(degrees)
		31.484	km/h		N	0
					NNE	22.5
	Wind factor	4.00%	percent		NE	45
	Wind influence	1.25936	km/h		ENE	67.5
					E	90
	Direction (from)	225	degrees		ESE	112.5
	Direction (to)	45	degrees		SE	135
					SSE	157.5
	X offset/hr	0.891	km		S	180
	Y offset/hr	0.891	km		SSW	202.5
					SW	225
	X offset - wind total	10.686	km		WSW	247.5
	Y offset - wind total	10.686	km		W	270
					WNW	292.5
	Total wind distance	15.112	km		NW	315
					NNW	337.5
Current	Speed	0.18	m/s		N	360
		0.648	km/hr			
	direction (towards)	90	degrees			
	X offset/hr	0.648	km			
	Y offset/hr	0.000	km			
	X offset - current total	7.78	km			
	Y offset - current total	0.000	km			
	total current distance	7.776	km			
Results	total X offset	18.462	km	East		
	total Y offset	10.686	km	North		
	Distance	21.332	km			
	Bearing	59.94	degrees			

Appendix I Beach Energy Domestic IMS Biofouling Risk Assessment Process

Scope

All vessels and submersible equipment mobilised from domestic waters to undertake the activity within the seabed assessment area must complete the Beach Domestic IMS Biofouling Risk Assessment Process prior to the initial mobilisation into the seabed assessment area.

The Beach Domestic IMS Biofouling Risk Assessment Process does not include an evaluation of potential risks associated with ballast water exchange given all 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 the activity within the seabed assessment area;
- identify the potential IMS risk profile of vessels and submersible equipment prior to deployment within the seabed assessment area;
- identify potential deficiencies of IMS controls prior to entering the seabed assessment 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 seabed assessment area).

Screening Assessment

Prior to the initial mobilisation of the vessel or submersible equipment to the seabed assessment 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 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
- 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 vessel / submersible equipment may be deployed into the seabed assessment 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 vessel / submersible equipment must be deemed low-risk prior to mobilisation into the seabed assessment area.

Basis of Detailed IMS Biofouling Risk Assessment

The basis by which an independent IMS expert evaluates the risk profile of a vessel / submersible equipment includes:

- age, type and condition of the vessel / submersible equipment;
- previous cleaning and inspection undertaken and the outcomes of previous inspections;
- assessment of internal niches with potential to harbour IMS;
- vessel / equipment history since previous inspection;
- origin of the 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 seabed assessment area;
- 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.

Appendix J Chemical Risk Assessment Process

The Hazardous Materials and Secondary Containment Directive detail the process for the assessing and approving hazardous materials such as chemicals that are used on Beach sites or activities. The Directive requires that where a hazardous material will or may be discharged offshore a risk assessment is required. The risk assessment is documented using the Hazardous Material Risk Assessment Form.

The following figure provides a summary of the Beach offshore chemical environmental risk assessment process. The risk assessment process considers aquatic toxicity, bioaccumulation and persistence data, along with the discharge concentration, duration, frequency, rate, and volume. The assessed level of risk determines the acceptance authority (in accordance with the Risk Management Plan) for approving the material for use. Approval is recorded on the Hazardous Material Risk Assessment Form.